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**North Little Rock, Arkansas
May 30–31, 1997**

Cover: Bottomland hardwoods, White River National Wildlife Refuge in Arkansas.

Photo by Bill Lea.

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SYMPOSIUM ON ARKANSAS FORESTS: A CONFERENCE ON THE RESULTS OF THE RECENT FOREST SURVEY OF ARKANSAS

May 30–31, 1997
North Little Rock, Arkansas

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Conference goals:

To present the initial results of the 1995–96 forest survey of Arkansas, conducted by the USDA Forest Service, Southern Research Station.

To discuss the existing economic and environmental conditions of Arkansas forests, changes in those conditions over time, and the implications of these changes for forest sustainability.

To strengthen the network of all Arkansans interested in the forest resources of Arkansas.

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John T. Shannon, State Forester, Arkansas Forestry Commission

Chris Barneycastle, Arkansas Forestry Association
Mark Clark, Arkansas Wildlife Federation
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University of Arkansas at Monticello, School of Forest Resources
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PLENARY SESSION

An Overview of Arkansas Forests

B.G. Blackmon, Moderator

OPENING ADDRESS

John T. Shannon[1]

I am glad to be here today to help open the symposium on Arkansas' forests. It is gratifying to see so many forestry leaders in attendance. I am particularly pleased to welcome my brother, State Forester from Oklahoma, Roger Davis; and representatives of the State Foresters from Tennessee and Louisiana.

It would be unfair and perhaps ill-advised for me to begin my comments with an inside joke about my short stature, so let me bring you in on it. For several years, Randall Leister was my boss at the Arkansas Forestry Commission. Since becoming State Forester over 3 years ago, I have been Randall's boss. Whenever I am making a public speech and Randall is in the audience, he always shouts from the back of the room, "Stand up, John." That Randall gets wittier with each passing day! To obviate that comment from Randall and to proceed with the symposium, I am pleased to announce that I am standing up.

The USDA Forest Service (Forest Service) and the Arkansas Forestry Commission completed the last forest survey in 1988. The World has changed greatly since then, as have forestry practices and policies. Let's look at four examples.

First, as recently as the mid-to-late 1980's, clearcutting was the primary silvicultural regimen practiced on the National Forests in Arkansas. Since then, changes in public attitudes about clearcutting and a "walk in the woods" with former Senator David Pryor caused a reversal in the harvesting practices. Today, the forest plans for the National Forests in Arkansas permit virtually no clearcutting.

Second, concerns about maintaining populations of spotted owls in the Pacific Northwest have arisen since 1988. Driven by the Endangered Species Act and with the direct involvement of President Clinton, timber harvesting on national forests in the Pacific Northwest has greatly declined.

Third, NAFTA has opened huge markets for timber grown in the United States. NAFTA may also exacerbate the flow of subsidized Canadian timber into the United States.

Fourth, remember the Soviet Union? Its vast Siberian conifer forest was to be developed into the "woodbasket of the world." There is no more Soviet Union, and that forest economic development never happened. Productive soils and adequate rainfall are crucial for forest growth, but political stability is crucial for capital investment.

We know that these four changes and others have affected Arkansas' forests. For instance, I have a hunch that the reduction of timber harvesting in the Pacific Northwest has led to an increase of timber harvesting in Arkansas. After today and tomorrow, we no longer will have to rely on hunches. The key function of this symposium is to provide the facts.

In a few moments, John Kelly will discuss the design of the forest inventory. He will frankly discuss design limitations. But the Forest Service and the Arkansas Forestry Commission do not conduct the decennial inventory through the windshield of a truck. We collect hard data from over 3,000 continuous forest inventory plots. Although all human endeavors are flawed, the forest inventory data is the best information we have. Within the limitations of the survey design and those human errors that must occur while collecting data at over 3,000 sites, the inventory data are unassailable.

Facts are difficult things. But facts will drive this symposium. For this symposium to be successful, we must start with good faith in each other and trust in the data. I am reminded of my mother requiring each of her five children to drink a teaspoon of cod liver oil every winter morning. I gagged it down, but, today, must admit that the cod liver oil was good for me. For those in the audience who are disappointed with the forest inventory data, please swallow hard and remember that facts, while difficult things, are good for us.

In addition to discussing the raw data, I expect several speakers to analyze the data and state opinions about changes in the forest resources. I ask all speakers to plainly label their opinions as such. Several audience members have asked me if the speakers will opine whether forest practices in Arkansas are sustainable. Specifically, several of you have asked for a sneak preview of Dr. John Gray's conclusions regarding the sustainability of the hardwood export chip mills. What will the speakers say? Darned if I know. I will hear their opinions and conclusions when you do. Before we go home on Saturday afternoon, we will have the most current snapshot of the forest resources of Arkansas and the opinions of key forestry leaders about trends in the forest resources and the significance of the data.

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Although cynicism can degenerate into mere negativity, a little cynicism is healthy. If the inventory data suggest that Arkansas' forestry leaders must act, you may want to ask, "What are you going to do about it?" If the data suggest that our forestry practices are endangering populations of those pesky, neotropical migratory birds, what is the Forest Service going to do about it? The Forest Service is in a good position to act; it owns half the country. If, on a regional basis, the forest products industry is cutting timber faster than the timber is growing, what is the forest products industry going to do about it? If the data suggest that private, nonindustrial owners of forest land are not implementing Best Management Practices or are making other ill-advised forest management decisions, you should ask, "Okay, Mr. Big-Shot State Forester, what are you going to do about it?" The real work of this symposium, therefore, commences at adjournment.

Forests are tremendously dynamic, but people prefer to remain static. Change is difficult. In order to wisely act in response to the data and analysis provided during the next 2 days, Arkansas' forestry leaders will need that same gift that the Wizard presented to the Cowardly Lion—courage. If cutting practices are simply not sustainable, leaders of the forest products industry must have the courage to face the issue head-on by cutting less timber or growing more. To effectively pursue their legitimate goals of healthy and sustainable forest ecosystems, members of the forest environmental community must have the courage to understand that under Arkansas law, "the right of property is before and higher than any constitutional sanction." Accordingly, cooperation with private landowners is the essential element for forest resource protection. Conversely, private owners of forest land must have the courage to understand that there is great public interest in private land. Finally, if the forest inventory data suggests that forest resource challenges are ahead, and if I determine that the forestry commission's policies and legislative charge do not address those challenges, I must have the courage to set aside time-worn policies and implement new ones. Mostly, I must have the courage to ask the Arkansas General Assembly to change the forestry commission's enabling legislation to shift the agency from a timber commission to a forest resource conservation commission.

In closing, I think we all need to lighten up. I have lived in other States and have traveled extensively in Arkansas. Only four States have more timberland than Arkansas, and our forest land has increased by 2 million acres during the past 20 years. As we debate the issues and argue about the numbers during the next 2 days, we should be mindful that, in Arkansas, life is good.

Thank you for being here. Enjoy the symposium!

GENERAL SESSION I

Forest Survey Data—History and Status of Arkansas Forests

B.G. Blackmon, Moderator

ARKANSAS FORESTS, 1600–1988

Joanne L. Faulkner[1]

Abstract—A general history of Arkansas forests from 1600-1988 reveals many changes in the resource. From pre-European settlement to the late 1800's, the abundant timber was used primarily for shelter and fuel for heating and cooking; occasionally, land was cleared for farming. The 'Big Cut' era occurred in Arkansas from 1890 to 1920. As the resource dwindled in the South, some eyes turned to the Pacific Northwest for a new source of timber, whereas others stayed in the South and applied forest management concepts to the remaining resource. From 1920 to 1950, 'peckerwood' sawmills and the newly emerging pulp and paper industry made use of the smaller trees left behind after the 'high-grading' that occurred during the 'Big Cut' era and the new growth emerging on cut-over lands. The creation of the Arkansas Forestry Commission in 1931 helped control the fires that yearly destroyed millions of acres of timberland in the State. Lumber production was suppressed during the Depression, but with the advent of World War II, production began to increase again. During the 1950's, sawmills became fewer in number but larger in size, whereas pulp mills increased in number and size. Forest area decreased during the 1960's and 1970's but began increasing again in the 1980's.

EARLY HISTORY OF ARKANSAS

The early inhabitants of Arkansas lived in an area that was about 95 percent forested (Ashmore 1978). The three main regions of this area, the Ozark-Ouachita, Delta, and Pineywoods, teemed with all kinds of wildlife from buffalo, black bear, deer, and cougar to a wide variety of birds and fish. The area contained vast virgin stands of pine and hardwood (Ashmore 1978). In 1541, the Spanish explorer Hernando de Soto first touched ground in Arkansas near the present Mississippi River town of Helena. More than a century later, European explorers reentered the area when Jacques Marquette and Louis Jolliet voyaged through part of Arkansas in 1673. In 1682, La Salle claimed Louisiana for France. This claim included the region that was to become Arkansas. The first settlement began in 1686 at Arkansas Post, a few miles inland from the Mississippi River. These early settlers used the abundant timber primarily for shelter and fuel for heating and cooking. Occasionally the land was cleared for farming.

The Louisiana Purchase in 1803 included the area that became the territory of Arkansas in 1819 and the State of Arkansas in 1836 (Ashmore 1978, Fletcher 1947). Although the initial era of commercial timber cutting began in the 1890's, some pioneers began cutting timber commercially as early as 1826. Arkansas' first steam-powered sawmill is believed to have been operating in Helena at about this time (Anon. 1936, Davis 1983). In 1883, Arkansas and Missouri lumber manufacturers organized the first trade association in the South (Davis 1983, USDA Forest Service 1988). In some regions, such as the Ozark-Ouachita mountain regions, white and red oaks were cut for barrel staves and wagon stock (Davis 1983).

THE INITIAL ERA OF TIMBER CUTTING

When timber supplies in the Northern United States began to dwindle, eyes turned toward the South for a new source of timber to meet the demands of the growing country. The initial era of timber cutting in Arkansas began in the 1890's and lasted up to 1920 (Roberts and others 1942, Widner 1968). As local timber supplies declined, land speculators and lumber company "millmen" came to Arkansas from the North looking for cheap timberland (Widner 1968). The 1876 revision of the Southern Homestead Law of 1866 aided "land speculators" in their purchase of millions of timberland acres in Arkansas (Clark 1984). Large tracts of timberland came under single ownership by sawmill operators or timber companies (Davis 1983, Widner 1968), and the push to harvest the great timber resource of Arkansas began. By 1909, there were two dozen big sawmills, such as Dierks, Crossett, Fordyce, Bradley, Southern, and Union Mills, in Arkansas (Davis 1983, Widner 1968). During these years of peak production, forested area was reduced from 32 million to 22 million ac (Davis 1983, Roberts and others 1942). The amount of lumber produced ranged from 79 million board feet in 1869 to 2 billion board feet in 1909 when Arkansas ranked fifth in the Nation in lumber production (Arkansas Forest Industries Committee 1962, Davis 1983, Roberts and others 1942, Widner 1968).

Lack of an adequate railroad system to transport timber to the sawmills hindered initial efforts to harvest much of the State's timber. In some areas, thanks to Arkansas' large network of navigable streams and rivers, logs were floated downstream to sawmills or railroad depots (Rafferty 1980). As the demand for timber increased, timber companies often built their own railroads. Whole towns sprang up to serve communities of loggers, mill workers, and railroad workers. As timber in an area was depleted, these company towns often relocated, exemplifying the "cut-out and get-out" philosophy of the time. In some cases, buildings were moved on railroad cars down the track to the next logging site where they were unloaded to house a new community. Many of these towns, such as Rosboro, are no longer visible on a map, but, in their heyday, they were home to several thousand families who made their living working for the lumber companies (Smith 1986).

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During this era, the first national forest in the South was established in Arkansas. The Arkansas National Forest was established in 1907 in west-central Arkansas; it was renamed the Ouachita National Forest in 1926. Areas in southeast Oklahoma were added later under the administration of President Theodore Roosevelt. In 1908, the Ozark National Forest was created in northwest Arkansas. Federally unappropriated public lands made up a vast portion of these forests, but some tax-delinquent lands were added as well as forest lands cut over by lumber companies and later purchased by the Federal Government. A third national forest, the St. Francis, was created in 1960 along Crowley's Ridge in east Arkansas. Today, these forests cover nearly 2.7 million ac (Bass 1981, Roberts and others 1942, Smith 1986).

This initial period of exploitation severely depleted Arkansas forest resources. Timber was viewed as a never-ending resource. As timber became scarcer in the South, many companies' sights turned to the Pacific Northwest (Clark 1984, Reynolds 1980, Smith 1986). Whereas some lumber companies moved West in search of virgin timber, others stayed and applied forest management concepts to the remaining resources. Following the examples set by Henry Hardtner's experiments in reforestation, selective cutting, and timber management, Arkansas lumbermen began to use new techniques to ensure a continuous yield of timber for their mills (Clark 1984, Davis 1983, USDA Forest Service 1988).

In the 1920's, "peckerwood" sawmills began operation in Arkansas. These small, portable sawmills manufactured the bulk of the lumber in the South during the 1920's and 1930's. In many areas, including the Ozark region of Arkansas, farming supplemented a sawmiller's income and vice versa (Davis 1983). In the late 1920's, the construction of a kraft-specialty mill introduced the pulp and paper industry to Arkansas (Arkansas Forest Industries Committee 1962). These two new forest industries (peckerwood sawmills and the pulp industry) used smaller trees often left behind after the "high-grading" timber cutting (cutting the best and leaving the rest). They also took advantage of the new growth emerging on the cut-over lands (Bass 1981, Davis 1983, Troutman and others 1981).

DEVELOPMENT OF ORGANIZED FORESTRY

In 1928, the Arkansas Forest Protection Association was created. This organization worked to establish a State forestry commission to aid in controlling fires that yearly destroyed millions of acres of Arkansas timberland. After some political opposition and a year of rallying among the citizens, the Arkansas State Legislature authorized the creation of the Arkansas Forestry Commission in 1931. Since no funds were allocated, it was a forestry commission in name only. Under the administration of President Franklin D. Roosevelt, the Federal Government offered to set up Civilian Conservation Corps (CCC) camps in Arkansas if the State would provide the funds for the forestry commission. In 1933, the legislature again denied the funds. It took the efforts of Governor J.M. Futrell and his public appeal for donations before some $8,000 was collected to fund the commission. On May 23, 1933, Charles Gillett was appointed the first State Forester (Davis 1983, Roberts and others 1942, Widner 1968).

The commission went to work to prevent or decrease the forest fires that plagued the State. Humans caused most of these fires. Burning timberland to clear out snakes and ticks and to clear land for agricultural or homesteading purposes was common practice, and fire could escape from railroad right-of-ways and logging operations. Arsonists also caused many fires. Through the efforts of the CCC, the Arkansas Forestry Commission, the Forest Service, and forest industry, fire towers, roads, and telephone lines were constructed across Arkansas to enable quick action in the event of a fire. Tree nurseries were also established to provide seedlings for planting cut-over, burned-over, and abandoned acreages on private and public land. The commission and the Forest Service worked to educate Arkansans about fire control through forest festivals or special showings of current movies, often preceded by words from a visiting forester (Bass 1981, Davis 1983, Roberts and others 1942, Smith 1986, Widner 1968).

Through the 1930's and 1940's, forest management and conservation efforts continued. The Cole-Crutchfield Forest Fire Law, passed in 1935, illustrated the importance of these efforts to the forests and economy of Arkansas. This law placed restrictions on burning and assessed fines for violations. It prohibited people from setting fires on land not their own and required them to notify fire control personnel in their area before burning. During this time, large forest landowners voluntarily donated 2 cents per acre per year to the Arkansas Forestry Commission for fire control efforts (Troutman and others 1981, Widner 1968). The severance tax law was enacted in Arkansas in 1923. This measure, still in effect, taxes all natural resources removed or severed from their natural state for commercial purposes. These resources include everything from minerals, precious stones, oil, gas, and gravel to timber, turpentine, and all other forest products. In the beginning, the severance tax revenue went to the counties for roads and schools, but, in 1937, the State Legislature reassigned the funds to the forestry commission (Roberts and others 1942, Widner 1968).

In 1933, the Crossett Experimental Forest was created in south-central Arkansas on land leased from the Crossett Lumber Company. On this holding, the Forest Service, Southern Forest Experiment Station (SFES), set out to study management of second-growth timber stands (Reynolds 1980, USDA Forest Service 1988). Today, research is conducted on multiresource management. The SFES Forest Survey began in Arkansas in 1934. The aim was to provide information on timber inventory, growth, removals, and mortality of the timber resource in Arkansas (USDA Forest Service 1937). The initial survey did not inventory the Ozark region. The first survey to include the entire State was completed between 1947 and 1951 (USDA Forest Service 1953). This research, along with contributions by Federal, State, and private groups, provided insights into the use and availability of the second-growth timber, sustained yield management, and new, improved technologies for cutting, hauling, and processing timber (USDA Forest Service 1988).

During the Depression, lumber production was suppressed, which in turn gave the second-growth forest a chance to grow (Clark 1984). Reversions of abandoned farmland to timberland and tree planting by the CCC bolstered the forest resource (Clark 1984, Widner 1968). With the advent of World War II, lumber production began to increase again, but with new production techniques, new uses for wood, and new forest management ideals, the future of Arkansas timber was more secure.

In 1945, the Arkansas Forestry Commission was consolidated into the Resources and Development Commission. The resulting combination was called the Division of Forestry, and the severance tax revenue was moved to the general fund. In the fall of 1952, more than 150,000 ac of timberland in Arkansas burned. This event helped lead to the re-establishment of the Arkansas Forestry Commission in 1953. The severance tax was increased and reassigned to the commission for forest fire control, management, education, insect and disease control, and seedling growth and distribution. This increase in funding allowed the commission to expand its efforts, including establishment of another nursery and the Poison Springs State Forest in 1957. This State forest was established in south Arkansas on land purchased from the Federal Government (Troutman and others 1981, Widner 1968). During the 1940's, a 2-year program of study in forestry was established at Arkansas A&M University (now the University of Arkansas at Monticello). In 1950, the program was expanded to 4 years and offered a Bachelor of Science degree in forestry. It remains the only such program in the State of Arkansas (Troutman and others 1981).

DEVELOPMENT OF MODERN FOREST INDUSTRY

During the 1950's, expansion of the pulp and paper industry fueled the forest industry sector and gave the second-growth forest a marketplace. New pulp mills were created, and existing ones were upgraded. With the introduction of debarkers and chippers came a shift in sawmills. Peckerwood sawmills began to disappear, and the few large sawmills grew even larger. Slabs and edgings from the cuttings in these mills were chipped for use in the pulp mills (Arkansas Forest Industries Committee 1962, Sternitzke 1960). The first commercial facilities in the South for converting sawmill waste into chips for pulp mills were in Bradley County in southeast Arkansas (Arkansas Forest Industries Committee 1962). Forest land decreased in the Delta region of Arkansas as farming the fertile soil in that area became more profitable. Small subsistence farms and pastures were abandoned by the population for a more urban existence, thus increasing the forest land in the upland regions. Forested area increased overall during the 1950's (Sternitzke 1960).

The 1960's and 1970's saw a decrease in forest area in Arkansas. Land clearing in the Delta for crops, in other regions for pastureland, and across the State for urban expansion left about 50 percent of the State forested by 1978 (Van Hees 1980, Van Sickle 1970). Even with this decrease in forest area, growing-stock volumes were slightly higher; but, most of this volume was in smaller trees. More efficient use and management of the forest resource ensured a constant supply of timber. Sawmills continued to become larger in size, but fewer in number. Pulpwood production boomed to 179.1 million ft^3 in 1977, partly because of technological changes that provided for the use of hardwood for pulp (Van Hees 1980). Although two-thirds of the timber harvested was softwood (mostly pine), Arkansas remained a major producer of hardwood cooperage and handle stock (Van Sickle 1970).

Federal and State assistance programs have helped to convert millions of acres of idle land into productive timberland. Programs such as the Agriculture Conservation Program (ACP), the Conservation Reserve Program (CRP), and the Forestry Incentives Program (FIP) have paid funds to private landowners to help defray the cost of planting trees and managing the timber on their land (Troutman and others 1981, Troutman and Porterfield 1974, USDA Forest Service 1988). Under new programs, such as the CRP, many acres of land cleared in the 1960's and 1970's in the Arkansas Delta are being reforested.

The forest industry has often been the largest manufacturing industry in the State, thus providing significant employment opportunities and economic benefits to the overall economy of Arkansas (Arkansas Forest Industries Committee 1962, Troutman and others 1981, Tucker 1985). Arkansas forests also provide many recreational and aesthetic benefits to its inhabitants and visitors (Troutman and Porterfield 1974).

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ARKANSAS FORESTS, 1988–1996: HIGHLIGHTS OF THE TIMBERLAND RESOURCE FROM THE SEVENTH FOREST SURVEY OF ARKANSAS

James F. Rosson, Jr.[1]

Abstract—Highlights of the seventh forest survey of Arkansas are presented. Key elements important in assessing the sustainability of the forest resource are discussed. These include forest area, volume, growth, removals, and status of softwood plantations. Forest area and volumes appear stable or increasing or both. However, the amount of harvested acreage is high, and prompt and adequate stand regeneration after harvest will become more important in helping to meet the sustainability goals of the State.

INTRODUCTION

The highlights of the seventh forest survey of Arkansas are presented in this paper. There are numerous publications already released about this survey–four forest survey unit reports (Rosson and others 1995, 1997; Rosson and London 1997a, 1997b) and a county statistical report (London 1997). A comprehensive State analytical report is in preparation. Timber issues will be dealt with primarily in this paper; various aspects of the forest resource situation in Arkansas will be addressed by other papers in these proceedings.

The survey is dated 1995. Even though plots were measured between June 1994 and October 1996, the majority of plots were measured in 1995. A total of 3,198 forested sample plots had measurements recorded. On these plots, 70,044 trees $\geq$ 5.0 in. in d.b.h. were tallied and measured. Additionally, 41,353 trees $\geq$1.0 but < 5.0 in. in d.b.h. and 9,114 trees <1.0 in. in d.b.h. were recorded and measured. Trend analyses, unless otherwise noted, are made between the 1988 and the 1995 forest surveys.

The survey is administered by the U.S. Department of Agriculture, Forest Service, Southern Research Station, headquartered in Asheville, North Carolina. The McSweeney-McNary Act of 1928 directs the Forest Service to conduct periodic assessments of the Nation's forest resources. Recent legislation has expanded the mission of the forest survey: (1) the Forest and Rangeland Renewable Resources Planning Act of 1974; (2) the National Forest Management Act of 1976; and (3) the Forest and Rangeland Renewable Resources Research Act of 1978.

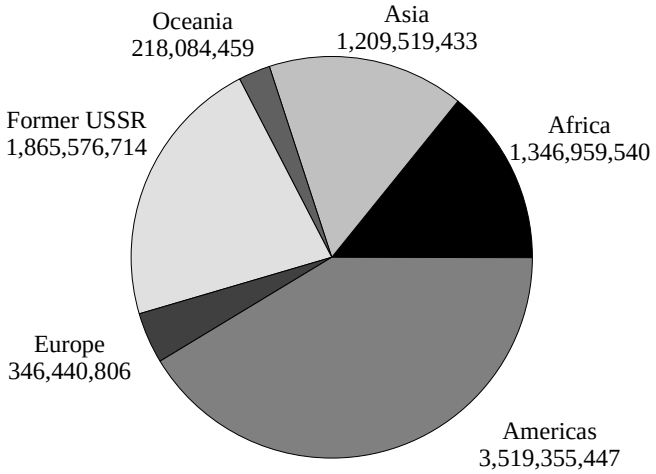
FINDINGS

Timberland Area

Timberland area increased 1,147,500 ac (16.7 percent) since the 1988 survey to 18,392,300 ac. However, this is still below the 19,341,800 ac reported in 1951, the first year the entire State of Arkansas was surveyed. A total of 1,750,900 ac reverted from a nonforest use to timberland, and 603,500 ac diverted from timberland to a nonforest use, resulting in the net increase of 1,147,500 ac of timber for the survey period. Increases in timberland area are the ongoing trend in other Mid-South States as well.

It is interesting to consider larger perspectives of scale when conducting such large-scale State surveys. Currently in the World, there are 8,505,936,000 ac of forest land (fig. 1). The largest plurality of this area is in the Americas. Seven countries account for 62 percent of forest land on the Earth. The United States ranks fourth at 517,847,788 ac (table 1). In the United States, Arkansas ranks fifth in the area of timberland (table 2). On the large-scale perspective, Arkansas contains < 0.3 percent of worldwide forest land and slightly < 4.0 percent of the 490,000,000 ac of timberland in the United States.

Most of the timberland in Arkansas is held by nonindustrial private forest (NIPF) landowners. Currently, they hold



World Forest Land = 8,505,936,000

Figure 1—World forest land in acres (World Resources Institute 1994).

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10,599,200 ac (58 percent) of timberland. Forest industry owns 4,497,400 ac (24 percent) and 3,295,700 ac (18 percent) is in the public domain.

The predominant forest-type group in Arkansas is the oak-hickory type (7,127,400 ac). This type decreased by 142,000 ac (2 percent) since 1988. Other minor shifts occurred in the oak-pine and bottomland hardwood forest-type groups (fig. 2). The greatest shift occurred in the loblolly-shortleaf forest-type group. Area increased by 885,000 ac, a 21-percent increase.

Since the 1988 survey, Arkansas' forests have matured as noted by the increase in acreage of poletimber and sawtimber stands whereas the proportion of sapling/seedling-sized stands has decreased (fig. 3). Currently, 8,538,700 ac (46 percent) of timberland in the State are in sawtimber-sized stands. Such shifts to stands with larger trees are important for three reasons: (1) incremental growth is at an optimum in the later years of stand rotation; (2) the quality of the hardwood resource increases with size, e.g., larger diameters are a major component of the better hardwood tree grades; and (3) it may represent an increasing lack of desire by a segment of owners to manage for higher quality timber products.

Table 1—Ranking of the top 7 countries by forest land area[a]

Rank	Country	Area
		Acres[b]
1	USSR	1,865,475,661
2	Brazil	1,398,584,137
3	Canada	610,733,877
4	United States	517,847,788
5	China	330,612,799
6	Indonesia	285,826,538
7	Zaire	280,002,471

[a] From World Resources Institute (1996).
[b] Includes reserved land.

Volume

Total live-tree volume for Arkansas is 23,784 million ft^3 and 76,961 million board feet (International 1/4-inch rule). This

Table 2—Ranking of the top 10 States in the United States by timberland area[a]

Rank	State	Area
		Acres
1	Georgia	23,631,000
2	Alabama	21,932,000
3	Oregon	21,614,000
4	North Carolina	18,710,000
5	Arkansas	18,392,000
6	Michigan	17,442,000
7	Mississippi	16,991,000
8	Maine	16,987,000
9	Washington	16,238,000
10	California	16,200,000

[a] Arkansas area based on 1995 survey; all others based on Powell and others (1993).

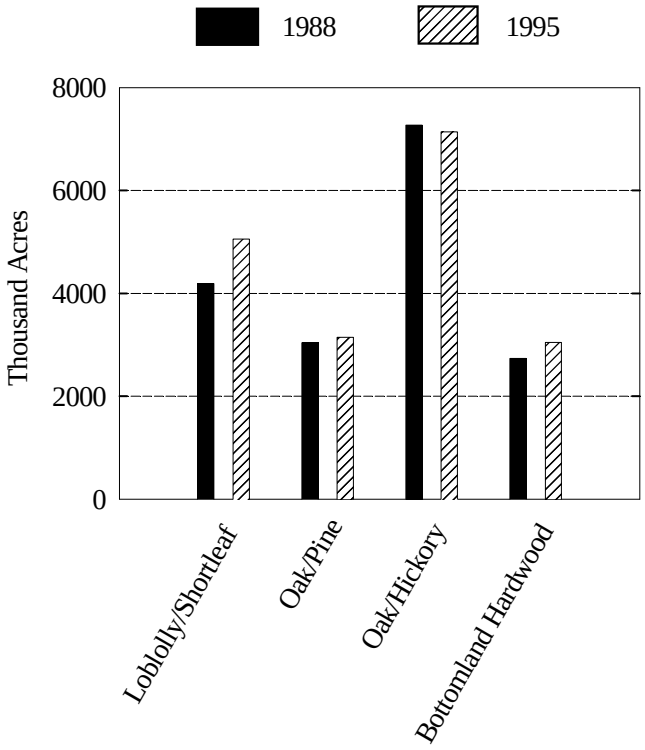

Figure 2—Changes in forest type group, Arkansas 1995.

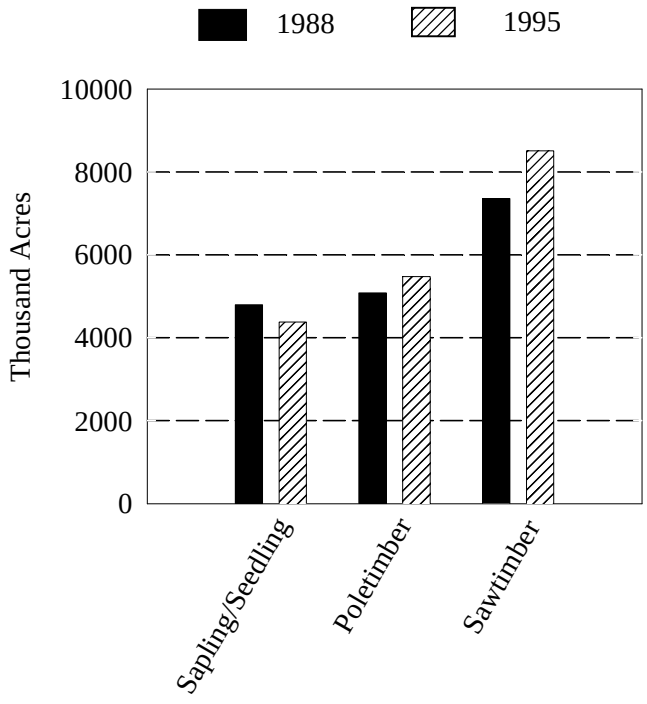

Figure 3—Change in stand size, Arkansas 1995.

represents a 13- and 15-percent increase, respectively, over volumes reported for 1988. Interestingly, softwoods make up 40 percent of cubic-foot volume but 51 percent of board-foot volume. This means that softwoods are generally larger in size than the hardwood component as Arkansas' stands become older. Loblolly pine (*Pinus taeda* L.) is the dominant tree in the State (21 percent of total live-tree volume), followed by shortleaf pine (*P. echinata* Mill.), white oak (*Quercus alba* L.), sweetgum (*Liquidambar styraciflua* L.), and post oak (*Q. stellata* Wangenh.) at 16, 9, 7, and 4 percent, respectively. These five species account for 56 percent of Arkansas' live-tree volume.

Softwoods—Softwood live-tree volume increased 18 percent from 8,085 million ft^3 in 1988 to 9,542 million ft^3 in 1995. This volume increase was distributed across the range of diameter classes below 22 in. (fig. 4) with sizable increases occurring in the 8-, 10-, 12-, 14-, and 16-inch diameter classes.

The softwood resource is not evenly distributed across the State. For instance, 67 percent of Arkansas' timberland is comprised of stands with < 500 ft^3 per acre of softwood volume (fig. 5). On the other hand, 31 percent of the State's softwood volume occurs on only 6 percent of the timberland base. These are stands with > 2,000 ft^3 per acre of softwood volume.

Softwood Growth, Mortality, Removals—Softwood gross growth increased substantially (44 percent) since the 1988 survey, from 418 million to 604 million ft^3 per year (fig. 6). Mortality changed little at 49 million ft^3 per year. Removals are running 433 million ft^3 per year, up 6 percent since 1988. This means that Arkansas' softwood resource increased, on average, at the rate of 122 million ft^3 per year between survey periods (fig. 6). This is a turnaround from the 1988 survey when removals exceeded growth (1.09 to 1.0). The growth-to-removal ratio currently stands at 1.28 to 1.0. Based on the latest surveys of the Midsouth States, only Arkansas, eastern Oklahoma, and Tennessee are growing more softwood volume than they are removing. When all the Midsouth States are aggregated, the data shows the Midsouth in balance between growth and removals (1.03 to 1.0).

Hardwoods—Hardwood live-tree volume increased by 12 percent and stands at 14,242 million ft^3 for the 1995 survey. This volume gain was most notable in the 10- to 18-in. diameter classes, with smaller gains throughout the larger diameter classes (fig. 7). This is encouraging in that the hardwood resource is maturing and, along with the increase in size across the d.b.h. spectrum, is the potential for increasing quality.

As was the case with softwood volume, the hardwood volume is not distributed evenly throughout Arkansas' timberland. However, the imbalance is not as pronounced as in the softwood distribution. Approximately 47 percent of the timberland acres in the State are occupied by stands with < 500 ft^3 per acre of hardwood volume (fig. 8). In turn, 27 percent of the hardwood occurs on slightly < 8 percent of the timberland. These are stands with > 2,000 ft^3 per acre in hardwoods.

Hardwood Growth, Mortality, Removals—There were very slight shifts in Arkansas' hardwood growth, mortality, and removals since the 1988 survey (fig. 9). Gross growth decreased 3 percent to 524 million ft^3 per year. There was

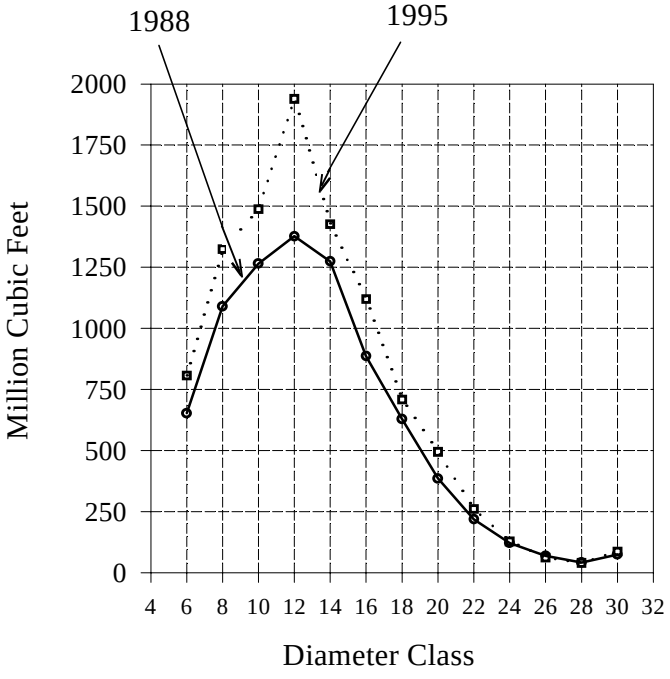

Figure 4—Softwood volume by diameter class, Arkansas 1988, 1995.

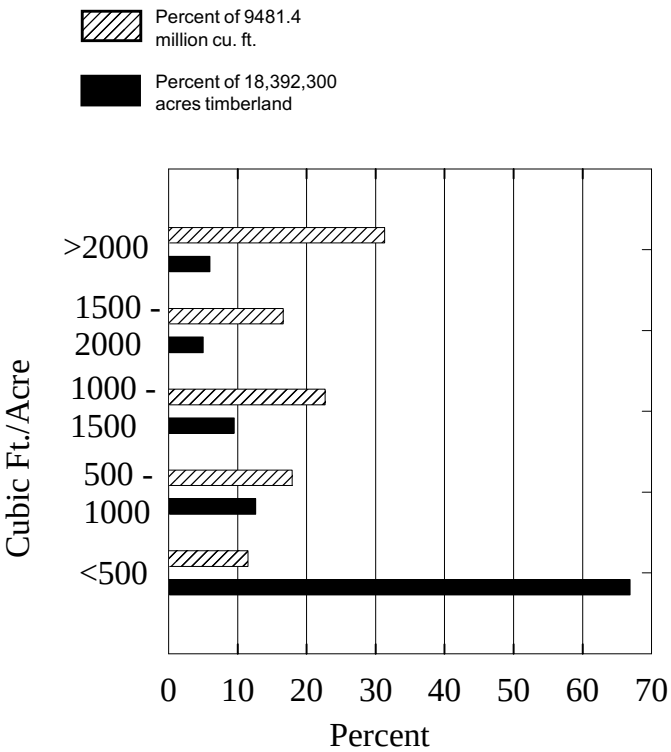

Figure 5—Effective density of softwood volume, Arkansas 1995.

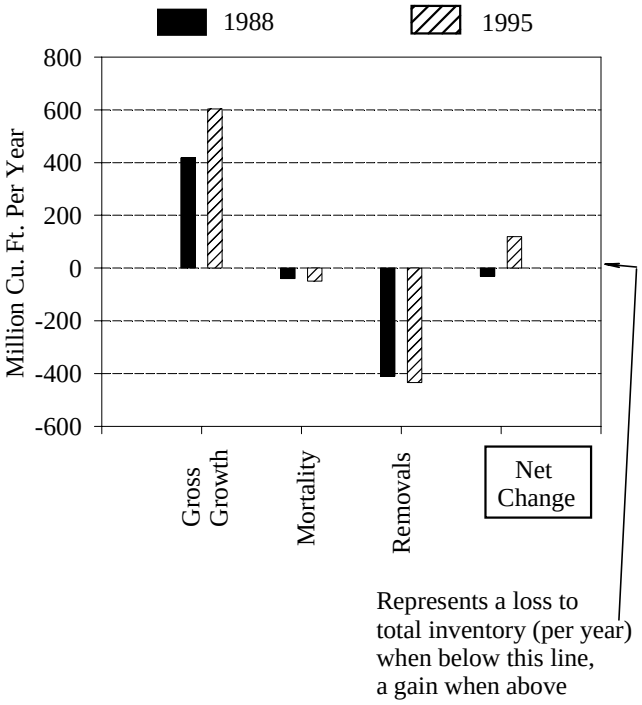

Figure 6—Softwood live growth, mortality, and removals, Arkansas 1988, 1995.

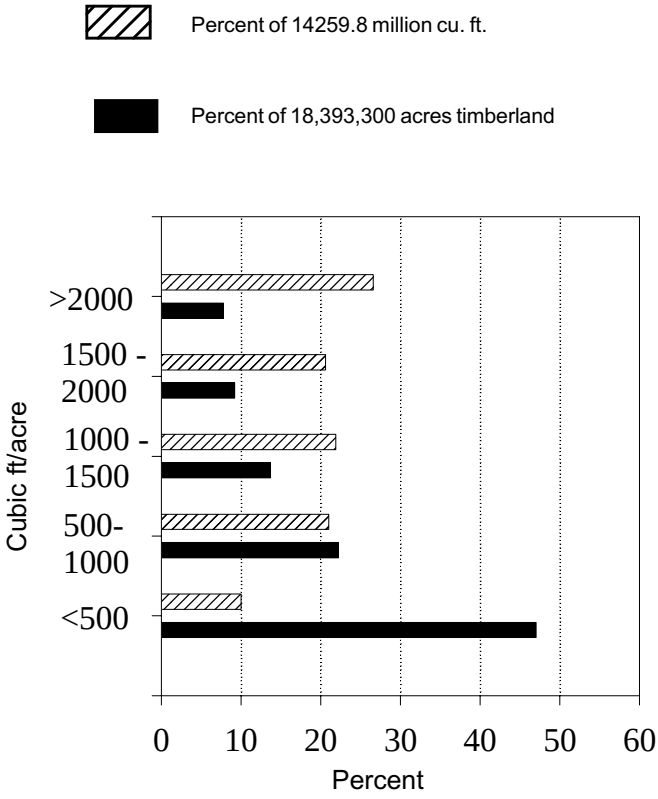

Figure 8—Effective density of hardwood volume, Arkansas 1995.

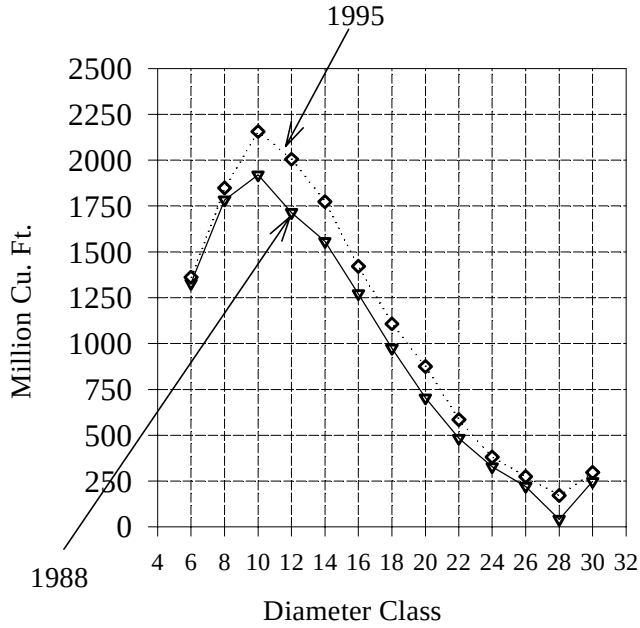

Figure 7—Hardwood volume by diameter class, Arkansas 1988, 1995.

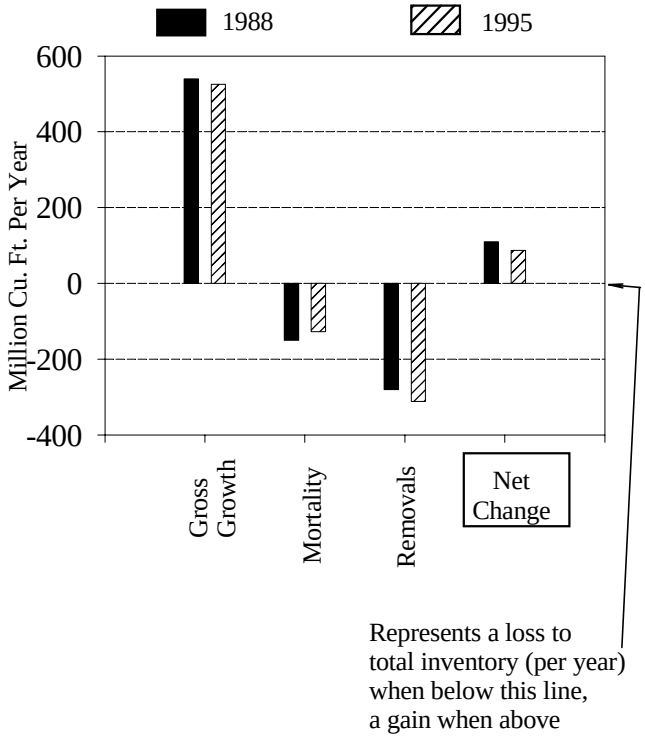

Figure 9—Hardwood live growth, mortality, and removals, Arkansas 1988, 1995.

also a slight decrease in mortality from 150 to 127 million ft^3 per year. Removals increased 11 percent to 311 million ft^3 per year (fig. 9).

Although mortality decreased (even with a maturing of the hardwood resource), the decline was not enough to offset the decrease in growth and increase in removals. Thus, even though Arkansas is still growing more hardwood volume than it is removing, it is doing so at a slower pace. In 1988, the net change for hardwood volume was an increase of 109 million ft^3 per year. For the 1995 survey, net change dropped to 87 million ft^3 per year. This means that the growth-to-removal ratio has dropped from 1.38 to 1.0 to 1.28 to 1.0. This is still on target for the Midsouth average—1.32-to-1.0. East Oklahoma, Tennessee, and Alabama are ahead of Arkansas in hardwood growth-to-removal ratios. Only one of the seven Midsouth States (Mississippi) is cutting more hardwood volume than it is growing.

Disturbance and Regeneration

Between 1979 and 1996, 7,852,500 ac (43 percent) of Arkansas' timberland underwent some form of commercial harvest (fig. 10). Harvesting on about 5,409,800 ac was a partial harvest, which left some form of a residual stand. Another 2,007,900 ac were clearcut.

Seventy-eight percent of clearcuts and 52 percent of partial harvests were implemented on pine-type stands. Based on this finding, it is important to examine the softwood resource on lands that were pine-type (> 25 percent stocking in pines) prior to harvest.

Of concern is the large discrepancy between naturally and artificially regenerated upland stands (fig. 11). Naturally regenerated sapling-sized stands have substantially more acres with < 200 softwood trees per acre than plantations. This is below the consensus established for optimum production and quality of softwoods (Hughes and Kellison 1983). Whether this is low enough to cause a volume shortfall later in stand rotation needs further study. Low stocking could be caused by an inadequate seed source or inadequate seedbeds. It is important that natural pine regeneration becomes established before competing vegetation takes over the site. However, young stands with marginally low initial stocking levels risk becoming understocked poletimber and sawtimber stands, especially where conditions (drought, competition, pests, disease, and poor seedling quality) increase softwood seedling and sapling mortality.

Reference to Arkansas' softwood timberlands being understocked is only in reference to maximized softwood production. It has been shown that total stand volume in poletimber- and sawtimber-sized stands is slightly higher in natural stands than plantations (1,549 versus 1,404 ft^3 per acre) (Rosson 1995). However, the same study showed softwood volume higher in plantations (1,241 versus 958 ft^3 per acre).

Plantation establishment is very expensive and may not be justified in offsetting many objectives of a multitude of owners for whom economics and esthetics both play a role. Natural reproduction of southern pine stands in conjunction

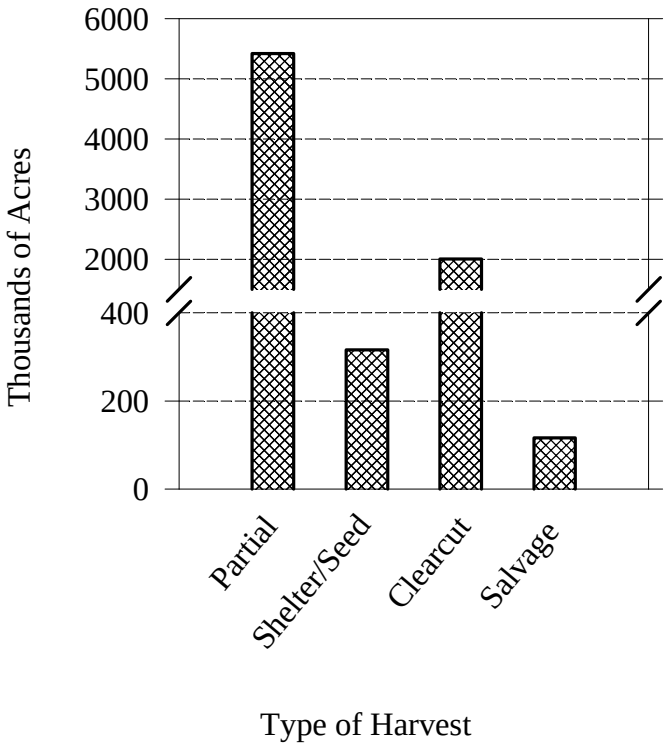

Figure 10—Area of timberland harvested, Arkansas, 1979–1996.

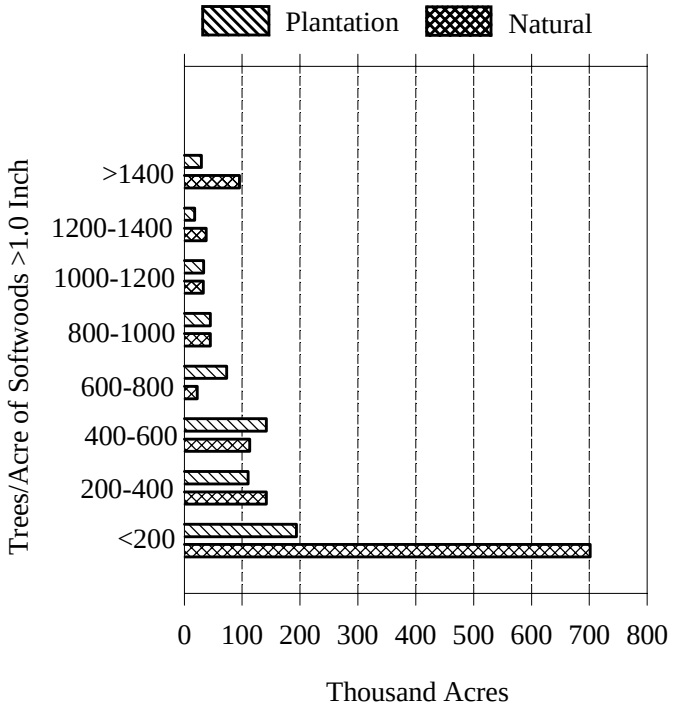

Figure 11—Area of upland sapling-sized stands (where pines are present or where formerly present) by stand density, Arkansas 1995.

with proper cutting methods is also an effective means of regenerating southern pines. This may be more in line with the majority of NIPF owners' economic criteria.

Between 1979 and 1996, 1,374,500 ac of timberland were put into softwood plantations following harvest. Currently, Arkansas has 2,565,000 ac in softwood plantations, of which 1,625,900 ac are in the southwest unit of the State. Most of these plantations are owned by forest industry (1,558,200 ac). Approximately 20 percent of the State's softwood volume is in plantations. However, only 13 percent of softwood sawtimber volume is in plantations.

Currently Arkansas ranks fourth in plantation area among the seven Midsouth States. Approximately 17,000,000 ac are in plantations in the Midsouth (17 percent of the 99,000,000 ac of timberland) (Rosson 1995).

CONCLUSION

When reporting the attributes of a State-level forest survey, it is important to examine the characteristics, that reflect upon the long-term sustainability of the resource. These include changes in: (1) timberland area, (2) tree volume, (3) growth-to-removal ratios, (4) amounts of harvested acreage, and (5) plantation dynamics and stand-establishment attributes.

The important changes for the 1995 forest survey of Arkansas include the 6.6-percent increase in forest area. Timberland area stands at 18,392,300 ac. Along with the increase in area was the increase in softwood and hardwood live-tree volume of 18 and 12 percent, respectively. Arkansas is currently growing more softwood and hardwood volume than it is cutting; the ratio of growth-to-removals stands at 1.28 to 1.00 for both softwoods and hardwoods. Harvested area is high—7,852,500 ac between 1979 and 1996. This provided the opportunity for the 34-percent increase in plantation acreage since 1988. Plantation area is currently 2,565,000 ac.

The forest resource situation in Arkansas is stable. Timberland area has increased and volumes are up. However, harvesting pressure is high and likely to increase. It is important that the harvested areas be regenerated quickly and with adequate stocking levels in order to ensure the long-term sustainability of the forest resource.

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ARKANSAS FORESTS—THE TIMBER RESOURCE

Richard A. Williams[1]

INTRODUCTION

Arkansas has bountiful forest lands totaling 18.3 million acres. In fact, Arkansas is over 50 percent forested, which is much higher than the United States average of 21 percent (fig. 1). Many of Arkansas' forested areas are timberlands or commercial forests, meaning that each acre can produce a minimum of 20 ft^3 of wood volume per year. Lower percentages were noted for woodland forests (other than timberlands) in Arkansas compared with the United States averages. These lands have provided Arkansans with employment, areas for recreation, scenic beauty, and opportunities for investments.

Arkansas has developed a strong wood-based industry because it has historically had a vast acreage of forest lands. Wood-based employment is very important to Arkansans. A study by Schallau and others (1987) found Arkansas to be the most timber-dependent State in the South with regard to employment. The forest products industry, which accounts for one of every six basic jobs, is the second largest component of Arkansas' economic base. Direct employment related to wood-based manufacturing exceeds 40,000 Arkansans with an annual payroll of $700 million, the largest of any manufacturing sector (Leister and others 1988). Twenty-one counties (28 percent) in Arkansas have wood-based industry as their number one manufacturing employer. Additionally, 23 counties have wood-based industry as the second or third largest manufacturing employer. Thus, 44 of the 75 counties in Arkansas rely heavily on wood-based manufacturing employment (USDC Bureau of the Census 1991).

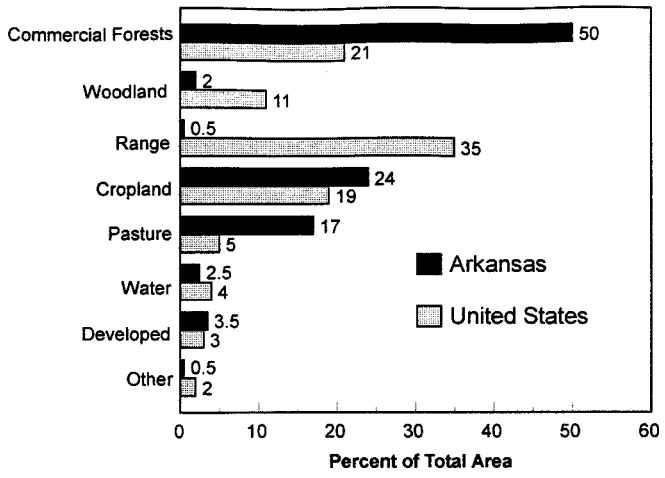

Figure 1—Percentage of land use in Arkansas and the United States, 1987. (Source: USDC Bureau of the Census 1991).

With wood-based industries making up such a substantial portion of Arkansas' economy, it is imperative that current forest inventory data be available for making good decisions regarding the use of Arkansas' forests. Currently, the Southern States rely on USDA Forest Service Forest Inventory and Analysis (FIA) data for forested inventories. These inventories are presently on a 7-yr cycle in Arkansas. Typical measurements include species, size class, number of trees, growing-stock volume, removal volume, and ownership categories and volume. Volume is represented by the growing-stock volume, which is the cubic-foot volume of sound wood in trees at least 5.0 in. in d.b.h., from a 1-ft stump to a minimum 4.0-in. top diameter measured outside the bark (Hines and Vissage 1988).

In addition to growing-stock volume, the state of existing forest stands is important. One method of evaluating a stand's condition is to examine the stocking of trees on an acre. Overstocking occurs where the forest has more trees that it can sustain over time. Crowded conditions weaken trees, making them more susceptible to attack from insects or diseases. The other extreme is nonstocked forest land. These areas do not have many desirable trees on the site and, of course, this condition is not conducive to the continued success of the wood-based industry and economy in Arkansas. A third condition is an understocked stand of trees. Desirable trees are found, but the site is capable of growing more trees than currently exist. Each of these conditions can be improved with good management practices.

Two conditions may exist in the forest, which suggest a well-balanced mix of trees. These are well- and fully stocked stands, both highly desirable forest conditions.

Recent trends in the State's forest resources and their use concern the forest product industry leaders, researchers, and planners. One of these concerns is the status of the forest resources resulting from increased harvesting activity. Stands have recently been harvested at a more rapid rate to meet the demand for wood products caused by restricted wood supplies from other areas of the country.

Thus, it is prudent to evaluate the status of the forest resources. Long-range planning and sustainable forestry have to evaluate the forest resources in order to meet the current demand while providing for tomorrow's

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opportunities. The changes occurring throughout the State with regard to the timber resources on Arkansas' forested lands are examined in this study.

METHODOLOGY

The overall objective of this study is to determine the current status of Arkansas' forest lands related to past forest inventories. More specifically I want to: (1) evaluate forest land ownerships by physiographic region, (2) examine stocking levels, (3) determine if tree volumes are increasing, and (4) compare net annual growth with net annual removals and tree mortality.

Forest inventory and land ownership patterns were recovered from various sources, plotted, mapped, and analyzed. Transformations of the data were performed as necessary to convert the data to the same basis. The USDA Forest Service has periodically surveyed all of the Southern States including Arkansas, compiling many forest resource statistics. The data are averaged over the intersurvey period to derive average annual numbers. Evaluating several survey reports can indicate the status and trends of the State's forest resources. Thus, the emphasis of this report is the 1996 forest inventory. However, its full appreciation cannot be ascertained without examining past inventories. Data were entered into spreadsheets for analysis and linked to GIS for spatial analysis.

RESULTS

Ownership

The ownership pattern for Arkansas' forest lands is similar to that of other Southern States, in that most are privately owned. Arkansas' largest forest land ownership group, the nonindustrial private forest (NIPF) landowners own 57.9 percent of the total forested acreage (fig. 2). There are estimated to be over 160,000 individuals who own land and are classified as NIPF owners (Arkansas Forestry Association n.d.). Forest industry companies are the second largest ownership group of Arkansas' forest lands with 25 percent of the forested acres (Rosson and others 1997b).

Public ownership is land controlled by the U.S. Government, State Government, or municipalities. In Arkansas, the largest public landowner is the USDA Forest Service, whose national forests total 12 percent of the total. Other public timberland totals 921,000 ac or 5 percent of the total. These other public lands are managed by Federal agencies, such as the U.S. Fish and Wildlife Service, Corps of Engineers, National Park Service, State agencies, or municipalities (Rosson and others 1997b).

Arkansas is divided into four physiographic regions including the Delta, Coastal Plain, Ouachita, and Ozark (fig. 3). Ownership patterns differ from one physiographic region to another. Private ownerships including NIPF owners, and forest industry companies own the largest portion of the Coastal Plain region of south Arkansas (fig. 4). In fact, they own 3.27 and 3.42 million ac, respectively. Ninety-seven percent of the Coastal Plain region is privately owned (Rosson and others 1995).

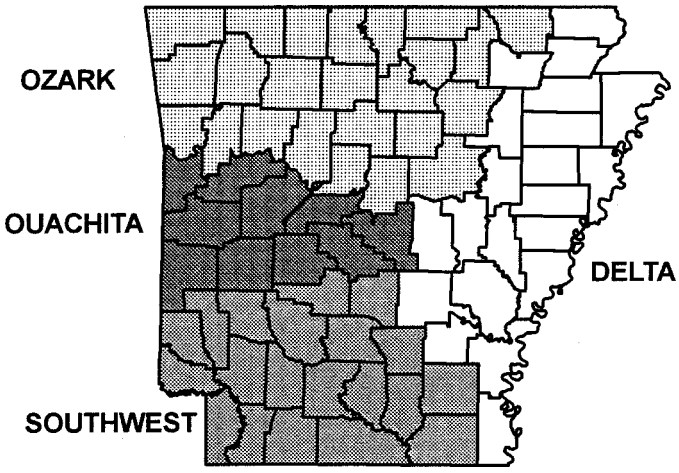

Figure 3—Physiographic regions of Arkansas. (Source: Hines and Vissage 1988)

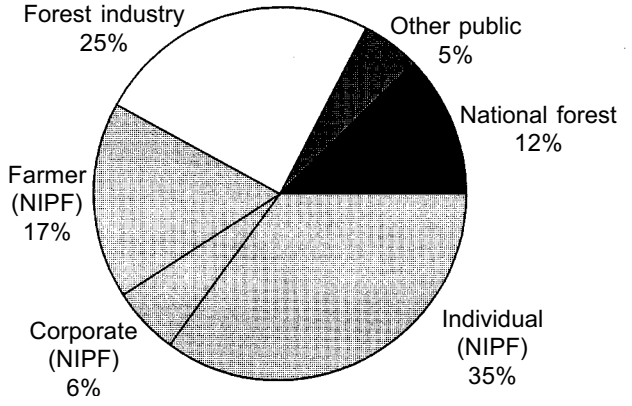

Figure 2—Arkansas timberland ownership, 1996. (Source: Rosson and others, 1997a)

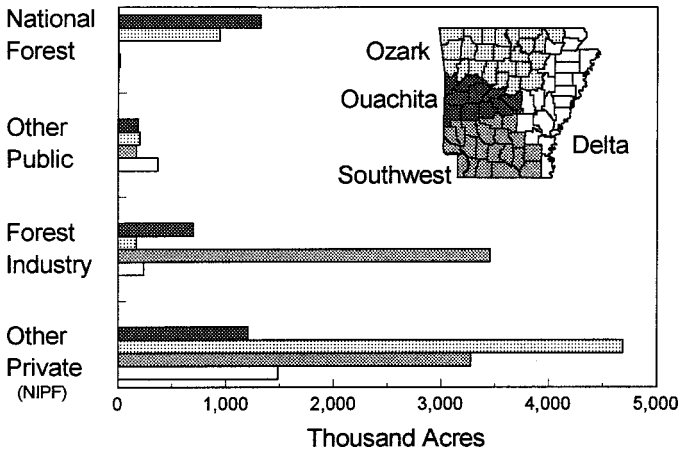

Figure 4—Forest land ownership by Arkansas' Physiographic Regions, 1996. (Source: Rosson and others, 1997a)

The Ouachita region has a large block of Federal public ownership, the Ouachita National Forest, under the management of the USDA Forest Service. There are 1.3 million ac in the national forests. This region also finds significant private owners including forest product companies with 679,000 ac and NIPF ownerships with 1.2 million ac (Rosson and others 1997).

NIPF landowners have the largest portion of the forested areas in the Ozark region (78 percent of the forested acres totaling 4.68 million). There is a sizable national forest in this region containing 941,000 ac. A distinct difference between the Ozark region and the Ouachita and Coastal Plain regions is the small acreage owned by forest industry companies. Forest industry companies own 174,000 ac in the Ozark region (Rosson and others 1997b).

The fourth physiographic region, the Delta, is owned largely by NIPF landowners with some public and forest industry ownerships. The NIPF landowners have 1.48 million ac, which comprise 70 percent of the total forested land. Forest industry companies own 241,000 ac of timberland (Rosson and others 1997a). Thus, ownership patterns vary by physiographic region.

Forest Stocking Levels

Total growing-stock volume in Arkansas was 18.9 billion ft^3 in 1988. The highest percentage of tree volume in Arkansas is in hard hardwood trees such as oaks and hickories (42.7 percent). Soft hardwood trees including sweetgum, cottonwood, and elms totaled 15.5 percent of the cubic-foot volume. Pine volume totals 40 percent, which is less than hardwood—a fact many Arkansans do not realize. Other softwoods, primarily cypress and cedar, make up the rest with 1.8 percent of the total (Hines and Vissage 1988). The 1997 data shows 21.6 billion ft^3 of growing-stock volume (fig. 5). This volume is comprised of 41 percent pine, 57 percent hardwood, and 2 percent other softwood (Rosson and others 1997b). Thus, since 1988, the actual volume of wood has increased on forested acres in Arkansas.

Figure 6 shows stocking levels by ownership category. NIPF landowners have 2.7 million ac in an understocked condition of trees and 144,000 nonstocked acres (Rosson and others 1997b). This combination totals 70 percent of the acres in Arkansas that could be improved by managing the number of trees growing on these areas. Thus, these owners have the greatest opportunity to improve their stocking levels and thereby enhance the value of their forest lands. Forest industry owns 848,000 ac that need stocking improvement, which is 19 percent of the acres needing improvement. This shows that the private sector can contribute substantially to the growth of trees in Arkansas.

Management and use of nonindustrial forests depend upon the individual owner's wants and needs. The NIPF landownership segment is often difficult to predict due to the large number of owners. There is abundant opportunity to increase the growing stock of trees on private lands, especially NIPF timberlands.

Tree Volume

Pine and hardwood tree volumes have increased since the 1988 survey. Additionally, volume of pine trees has increased 4.1 billion ft^3 since 1952. In fact, pine volume has almost doubled since the early 1950's and now stands at 8.7 billion ft^3. The volume of hardwood trees was about 9.4 billion ft^3 in 1952 and steadily decreased until the early 70's when it was 8.8 billion ft^3 (Van Sickle 1970). Since 1970, hardwood volume has risen to the present volume of 12.3 billion ft^3, an all-time high (Rosson and others 1997b).

Figure 7 shows pine inventory for 1968, the projected inventory for 1998, and the present 1996 inventory. Pine volume was 6.4 billion ft^3 in 1968 and now totals 8.7 billion ft^3. The projection made approximately 30 years ago was to have a pine inventory of 7.9 billion ft^3 by 1998 (Van Sickle

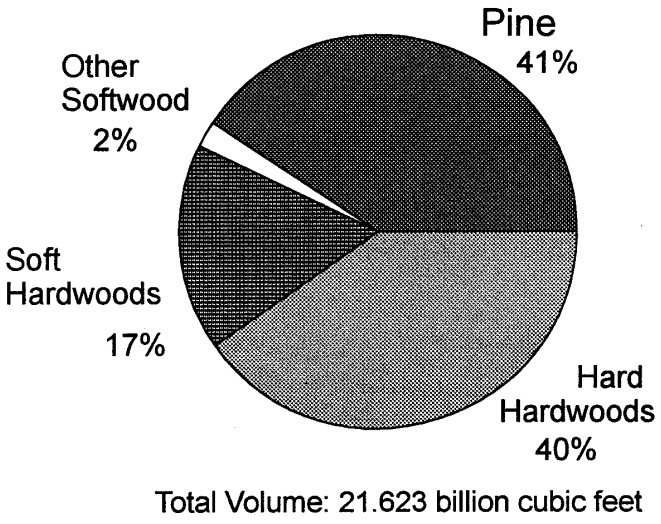

Figure 5—Growing stock volume in Arkansas, 1996. (Source: Rosson and others, 1997a)

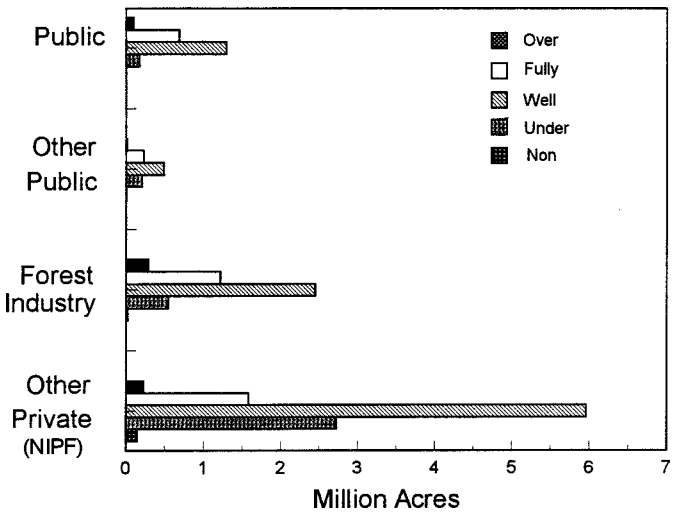

Figure 6—Area of timberland in Arkansas by stocking class and ownership, 1996. (Source: Rosson and others, 1997a)

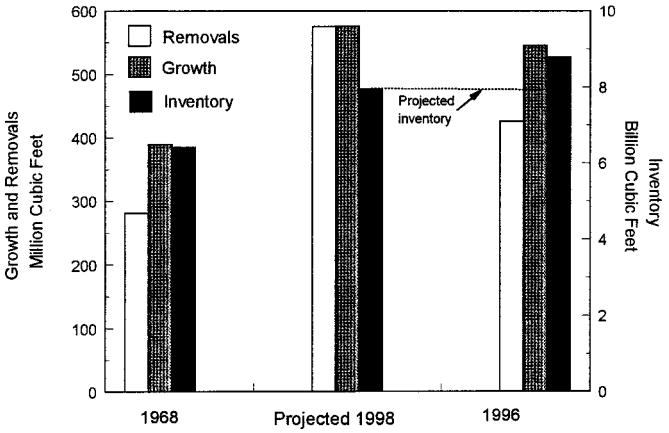

Figure 7—Net annual growth, average annual removals, and inventory of pine species in Arkansas forests. (Source: Van Sickle 1970, Rosson and others 1997a.

1970). This projection was somewhat conservative in its estimate. However, the projected level of growth and removals was too high as was evident by the 1996 survey. Removals were 281 million ft^3 in 1968 and 426 million ft^3 in 1996. The projection estimated that 575 million ft^3 of pine volume would be harvested in 1998. This projection overestimated total for pine removals by 35 percent.

The 1998 projection for hardwood inventory volumes was conservative. Hardwood inventory stands at 12.3 billion ft^3 whereas the projection estimated the inventory at 10 billion ft^3. Removals of hardwood are less today than during the late 1960's. In 1968, 289 million ft^3 of hardwood volume was removed whereas the 1996 level was 281 million ft^3. In 1970, Van Sickle projected hardwood removals would reach 440 million ft^3 by 1998, which overestimated the use of hardwood trees by 57 percent (fig. 8). There have been some new markets for hardwood trees that did not exist until the mid-1990's, which might increase the volume of hardwood trees being harvested in Arkansas.

Stand type refers to the dominant trees occupying a site. For example, a pine type is an area with pine trees making

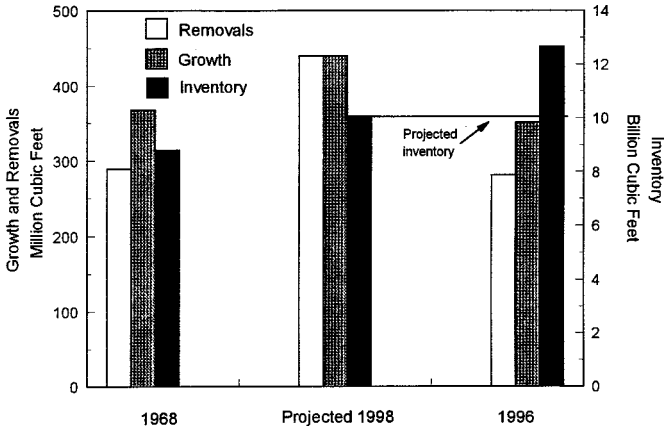

Figure 8—Net annual growth, average annual removals, and inventory of hardwood species in Arkansas forests. (Source: Van Sickle 1970, Rosson and others 1997a)

up over two-thirds of the larger or dominant trees. Pine trees are not the only trees, but comprise the majority of the trees. Since the 1968 survey, most stand types have remained fairly constant including oak-pine, oak-gum-cypress, and elm-ash-cottonwood. However, the acreage of pine stands has increased (fig. 9). A corresponding decrease has occurred in the oak-hickory stand types.

The size of the trees is larger now compared to 1968. Forested acres with sawtimber-sized trees (12 in. in diameter and larger) have increased from 5.4 to 8.4 million ac. There has also been a slight increase in acres with poletimber-sized trees (5 to 12 in. in diameter) from 4.7 to 5.4 million ac. The seedling and sapling-sized trees comprised 7.9 million ac in 1968 and 4.4 million ac in 1996 (fig. 10). The forests in Arkansas today have more larger

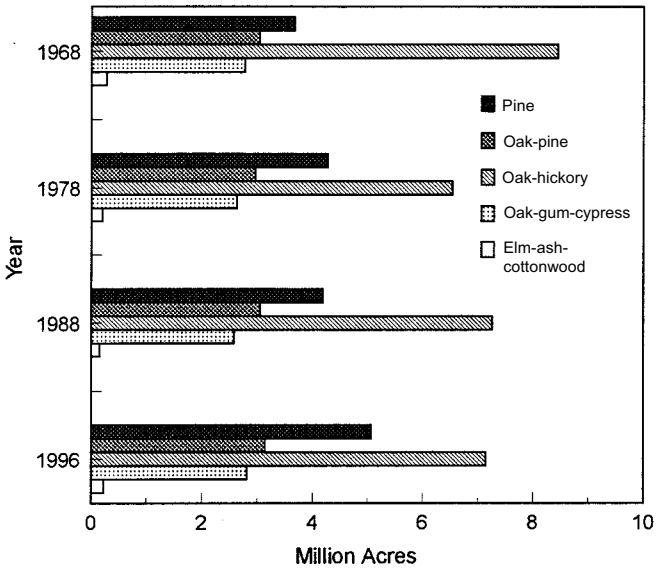

Figure 9—Area of commercial forest land by forest types in Arkansas. (Source: Van Sickle 1970, Quick and Hedlund 1980, Hines and Vissage 1988, Rosson and others 1997a)

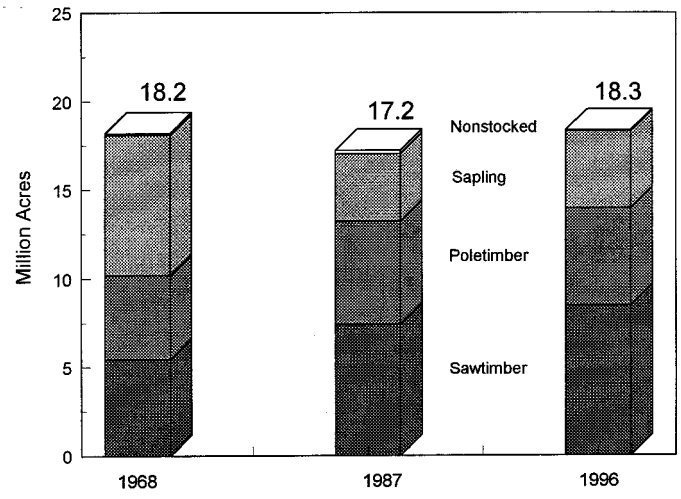

Figure 10—Area of commercial forest land in Arkansas by stand size. (Source: Van Sickle 1970, Hines and Vissage 1988, Rosson and others 1997a)

trees growing on them in the poletimber- and sawtimber-sized classes compared to 1968.

Growth and Removals

Another factor in determining the present condition of the forest is the net growth/removal ratio. Simply stated, this means—how much tree volume the forest is growing compared to the amount being removed. Mortality volumes are already subtracted from growth, which means that the net annual growth is the wood growth minus mortality. Dividing growth by removals provides a ratio that can describe the pressure being exerted on the forest by humans. Figure 11 shows the growth/removal volumes by major species groups. The statewide totals indicate that only sweetgum trees have removals exceeding growth. Figure 12 shows that statewide, for both pine and hardwood species, growth exceeds removals. The 1988 FIA inventory revealed growth/removal ratios for pine volumes of < 1 to 1 (Hines and Vissage 1988). However, in 1996 there was more pine volume being grown whereas the level of removals remained fairly constant at the 1988 level.

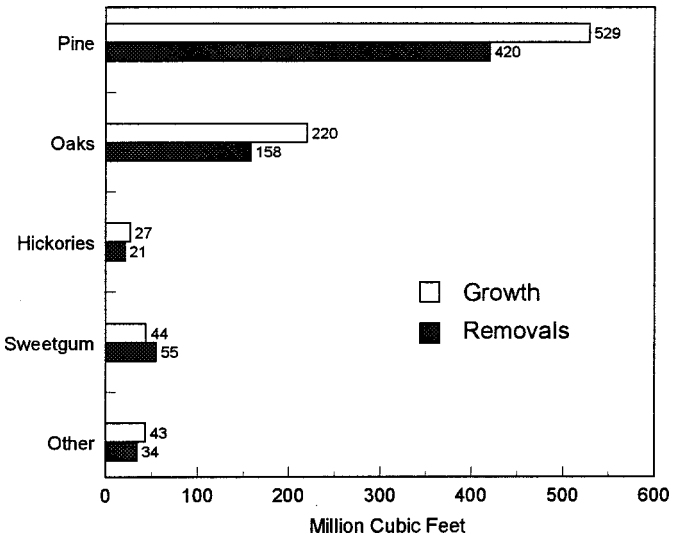

Figure 11—Arkansas growth and removals by selected tree groups, 1996. (Source: Rosson and others 1997a)

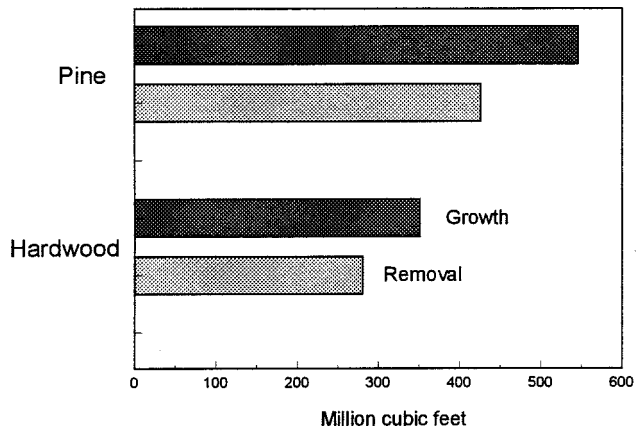

Figure 12—Net annual growth and average annual removals in Arkansas between 1986 and 1996. (Source: Rosson and others 1997a)

There is a high demand for Arkansas' pine volume to be converted into building materials and paper products. The 10-yr average removals in Arkansas ending in 1996 revealed that removals were 419.8 million ft^3 (Rosson and others 1997b). Growth/removal ratio comparisons for all pine species and products show that nine counties are in the low condition (fig. 13). The low condition indicates that growth is exceeding removals; therefore, inventory decreases. This is a dramatic change from the 1988 FIA survey where 22 counties had growth levels less than removals.

Statewide hardwood growth/removal rates are shown in figure 12. Hardwood inventories increase where growth rates exceed removals, and, in some areas, this surplus growth is substantial. However, these comparisons are for the State as a whole, whereas individual counties may have unique pressures on their hardwood resource that are masked by the statewide totals. In 1988, Hines and Vissage noted that 12 counties had growth/removal levels for hard hardwood species at the low level where the inventory was being reduced. Figure 14 illustrates the 1996 survey where 23 counties had growth levels lower than removals (Rosson and others 1997b).

Soft hardwood trees had low growth/removal conditions in 14 counties in 1988, whereas the 1996 survey had 27 counties (fig. 15). Hardwood trees are under pressure in isolated areas, but statewide, a positive growth/removal ratio exists. As evidenced by the survey data, the pressure on the hardwood resource has not equaled the pressure on the pine resource in Arkansas (Hines and Vissage 1988, Rosson and others 1997b). However, a marked increase in the utilization of hardwood trees is apparent from 1988 to 1996 due to new demands for hardwood fiber.

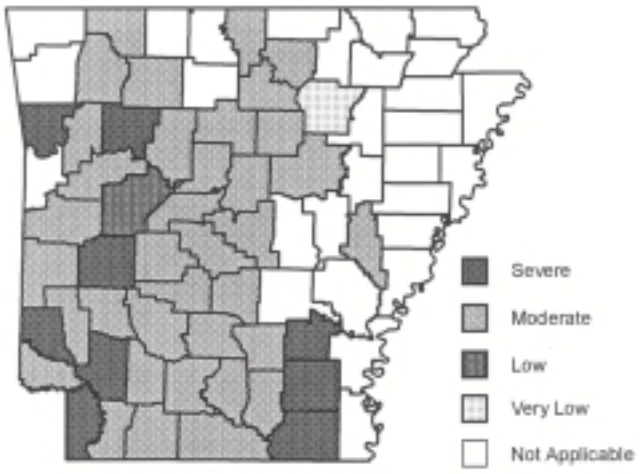

Figure 13—Growth/removal ratios by Arkansas counties for all pine species and products. (Source: Rosson and others 1997a)

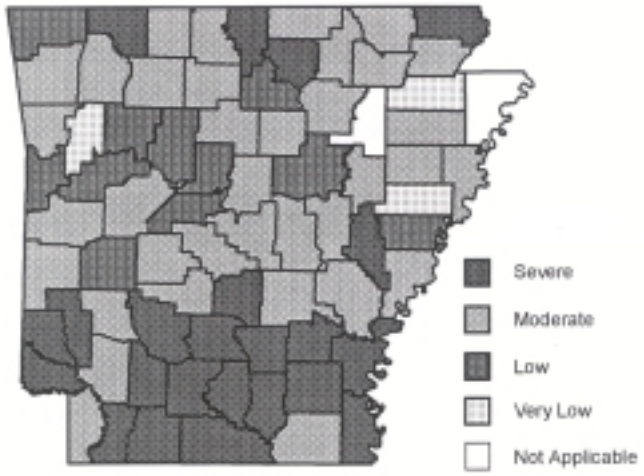

Figure 14—Growth/removal ratios by Arkansas counties for all hard hardwood species and products. (Source: Rosson and others 1997a)

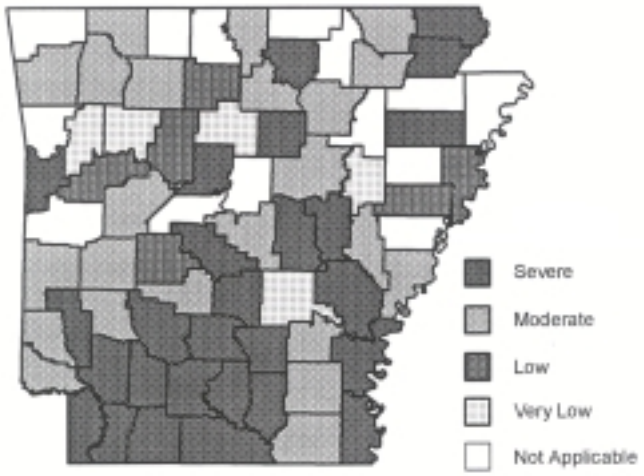

Figure 15—Growth/removal ratios by Arkansas counties for all soft hardwood species and products. (Source: Rosson and others 1997a.

CONCLUSIONS

Private ownership of forest lands makes up the largest segment of Arkansas owners. These forests have provided many benefits over the years and are still growing strong. Along with the positive aspects of Arkansas' forest lands, some negatives do exist, including poorly and nonstocked forest lands, primarily on NIPF lands. Gains in tree-stocking levels and some reforestation efforts could provide additional benefits to Arkansas by increasing the growth and stocking levels on forest lands. Increased tree volumes on forest lands could lead to possible mill expansions, wood volumes for export markets, or the development of new wood-based facilities, thereby adding jobs and benefits to Arkansas' economy. Additionally, the increase in the number of trees will be providing other benefits such as aesthetics and wildlife habitat.

Some other concerns include local areas of harvesting where removals exceed growth. Whereas the statewide numbers are good for growth and removals, there are counties where the growth/removal ratio is < 1 to 1. The number of counties where removals exceed growth has doubled since the 1988 survey for hardwoods. A decrease in the number of counties where pine removals exceeded growth was noted since the 1988 survey.

The FIA inventory of Arkansas' forest lands provides valuable information regarding ownership, tree size, and tree types. The growth/removal tables indicate the harvesting pressure on Arkansas' forested lands for wood products. The ability to examine previous surveys with current surveys indicates the status of Arkansas' forests today.

Some Important Inventory Facts

1. Arkansas' timberland acreage has increased by 1 million ac since the 1988 survey and is approximately the same as the 1968 survey acreage.

2. Pine inventory has increased, and growth exceeds removals and mortality, statewide.

3. Hardwood inventory has increased, and growth exceeds removals and mortality, statewide.

4. Nonstocked acres are fewer than the 1988 survey.

5. Arkansas' sawtimber acreage has increased since the 1968 survey whereas seedling and sapling acres have decreased.

6. Acreage dominated by pine trees has increased since the 1968 survey, whereas acreage comprised of trees in the oak-hickory category has decreased.

7. Forested acres represented by bottomland hardwood species (oak-gum-cypress and elm-ash-cottonwood) have remained fairly constant since the 1968 survey.

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LANDSCAPE CONTEXT AND REGIONAL PATTERNS IN ARKANSAS' FORESTS

Victor A. Rudis[1]

Abstract—Recent results from Forest Inventory and Analysis (FIA) surveys provided an opportunity to explore the spatial and temporal context for Arkansas' forests, including associated range, recreation, water, and wildlife habitat resources. Noted were damage agents and multipurpose resource indicators: evidence of human-associated activities (harvesting, hunting, livestock grazing, restricted activity signs, trash dumping, etc.), land cover, forest ownership, forest fragmentation, forest type and stand-diameter class, and proximity to nonforest features. For comparison purposes, analysis was by ecological subregion (province and section): Mississippi Alluvial Basin, Western Mid-Coastal Plains, Arkansas Valley, Ouachita Mountains, Boston Mountains, and Ozark Highlands. I illustrated patterns in areas with maps of their location, tabular statistics of area frequency and change over time, and tree statistics relevant to wildlife habitat concerns. Findings noted pasture land dominating to the north, cropland uses to the east, and forest land to the west. Since the 1978 survey, continuing losses of shortleaf and increases in loblolly suggested the increased importance of remaining shortleaf stands. Some locales were prone to forest damage or more likely harvested, fragmented, grazed by livestock, disturbed by other human uses, or associated with specific forest-community types. Trash was most evident near roaded areas. Signs restricting activities associated with forests occurred in dense concentrations between extensively and sparsely forested regions. A cumulative habitat value index based on the proportion of earth (land and water) cover by community type, and weighted by 1988- to 1995 area change and community type replacement cost (in years), summarized the status, change, and landscape context. Since the 1988 survey, evidence suggested increased restricted access was the most important change. Tabular statistics summarized these and other differences by ecological subregion and selected multipurpose resource attributes.

INTRODUCTION

Like most land-based resources, nonmarket uses and income-generating opportunities from forest land depend heavily on their location. Forest land not suited for sustainable timber production often occurs in areas uneconomical to harvest. Forest resource inventories provide location information, direct measures of timber value, and indirect measures of their suitability and availability as range, recreation, and wildlife habitat resources. Together with periodic monitoring and mapping at the landscape (500- to 50,000- acre) and regional (100,000- to 10 million-acre) scale, coincident sample observations of human and other uses furnish clues to associated values and processes.

Ecological processes, such as weather shaped historic forest resource distributions, still dominate today's landscape patterns. Though rarely under individual owner control, many of these processes influence owner decision-making. Ice storms, insect outbreaks, and even animal damage seemingly occur at random within the lifetime of a forest owner's tenure but may be recurring risks in specific locales when aggregated to coarser scales. Local markets for commodities influence forest uses such as occasional livestock grazing near cattle processing plants and pine plantation establishment near wood processing plants. Indirect effects, such as sightseeing or urban development along forested travel corridors, affect timber availability, game populations, and quality forest recreation opportunities. Knowing where damage agents, markets, and indirect effects predominate, decision-makers may take steps to minimize risk or alter the mix of planned resource outputs. Knowledge of the landscape affects selection of damage-resistant species for reforestation, management to minimize negative esthetic impacts, and investment in wood production, silvopastoral operations, recreation development, and other uses.

Though designed chiefly to assess timber resources, forest inventory and monitoring surveys address range, water, wildlife, and recreation resources by evaluating the status, distribution, and change in forested landscapes. Of concern to wildlife conservation interests in forests are (1) older age community types, because they take longer to regenerate than others; (2) frequent or common community types, because they often impact more of the region's faunal populations than others; (3) rapidly changing community types, because they may precipitate an unsustainable change in selected wildlife populations; and (4) regions with a rare or a wide diversity of community types, because they may support more wildlife species and recreational opportunities for wildlife viewing. Occurrence and change in forest plantations, forest fragment size, livestock grazing, timber harvesting, and other human intrusions provide additional indices of the regional character, uses, and trends important to a range of resource users.

Indices of resource value should be technically feasible, regionally aggregated, scientifically valid, and politically important. The proportion of forest land available for production is one such index that varies with time and the surrounding landscape. Forest land in pasture-dominated landscapes is more often a producer of shade than of wood

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products. Forest land in landscapes with better-than-average soil and climate for wood production is often as valuable for game production and the generation of recreational visits. Such areas recover rapidly from human intrusions and quickly produce 20–inch diameter trees needed by large-bodied birds of prey. Forest land in forest-dominated landscapes is more likely to sustain forest-dependent wildlife populations than that in landscapes dominated by nonforest uses.

Timber production may not be feasible in landscapes with small or roadless forest fragments. In larger forest fragments, bird species diversity is greater, and selected bird species are more abundant (Hunter 1990). Animals incompatible with human uses or perceived as threats, such as black bears, benefit from large forests without human access. Hunters and other primitive-oriented recreation users may value southern lowland hardwood community types more if they are part of large, unfragmented forests (Rudis 1995). Easily accessed, small forest fragments may be sufficient for picnics and other convenience-oriented recreation activities but have limited value for hunting large game animals. Criticized for lacking vegetative components essential to some wildlife populations (Allen and others 1996), pine plantations may contain fewer large-diameter trees, potential cavity trees, and food-producing species when compared with natural pine and hardwood forest types.

Changes in earth (land and water) cover and use of landscapes affect wildlife populations, recreation opportunities, and the value of remaining resources. Recently harvested landscapes are valued for fauna that need young-aged stands. Eventually, stands age and their value changes. A forested landscape with reduced access, such as a roadless area, retains greater value for those interested in conserving black bear habitat and wilderness values. Trash occurrence is a major impediment to a satisfying forest recreation experience—more than a clearcut stand or livestock grazing (Rudis 1987). Forests in landscapes dominated by roads may appear unmanaged and are viewed by some segments of the public as "undeveloped wasteland" suited for dumping household garbage.

I present indicators that reflect resource uses, the surrounding landscape context, and changes to both of these. Included are mapped patterns and tabular statistics in natural and man-made disturbances, livestock grazing, recreation opportunities, land cover, use, human use, forest fragmentation, damage agents, and wildlife habitat attributes of forest composition. Additional reports for Arkansas and other South Central States (Devall and Rudis 1991; Rudis 1991, 1993a, 1995, 1998; Rudis and Tansey 1995) provide additional, associated details about these indicators.

METHODS

I used USDA Forest Service, Forest Inventory and Analysis (FIA) survey data, mapped sampled locations with multipurpose indicators of resource value, and assembled other data in tabular form. Maps provided spatial information for a qualitative interpretation of spatially autocorrelated attributes and hypotheses about landscape scale processes.

FIA surveys gathered sample-based information about Arkansas' earth cover, land use, and forest resources (FIA Research Work Unit 1987, 1994). Included with both 1995 and 1988 surveys was an array of indices about other forest resources. I used data primarily from the 1995 survey, incorporated estimates of change since the 1988 survey, and where possible, comparable data from the 1978 survey.

FIA estimated forest resources in three steps. First, FIA interpreted locations for forest and nonforest land use from 1:58,000 color aerial photographs for 149,300 locations throughout Arkansas. Second, crews verified forest and nonforest photointerpretation with an on-the-ground sample of 8,950 1–acre locations (London 1997). Third, crews observed and recorded land use (Anderson and others 1976) on 5,972 systematically located areas sampled at approximately 3–mile intervals.

FIA calculated area with particular attributes by summing the number of sampled locations and multiplying by the expansion factor (portion of county area that each sampled location represented). Forest land was land with $\leq$10 percent tree crown cover and land temporarily with <10 percent tree crown cover not developed for other uses, 1 acre in size, and $\leq$120 feet wide (Anderson and others 1976). Forest land capable of producing $\leq$20 cubic feet/acre/year of industrial wood was timberland (not reserved from timber production) or reserved forest land (reserved from timber production by public statute). Other forest land (woodland in earlier forest survey reports) did not have the potential to produce 20 cubic feet/acre/year of industrial wood due to adverse site conditions. Area estimates, measurements, and sampling variance by county referenced the 1995 (London 1997), 1988 (Hines and Vissage 1988), and 1978 (Staff of Renewable Resources Evaluation Research Work Unit 1980) surveys.

Crews inventoried forest land characteristics and uses from 1–acre samples and a subsample of trees by species, stem density, and condition. Crews tallied previously surveyed and currently live trees with ten, 37.5–square-foot basal area variable-radius prism sample for trees $\leq$5.0 inch in diameter at breast (4.5 feet) height (d.b.h.), and three 7.1–foot fixed-radius plots for live trees 1.0 to 4.9 inches d.b.h. Standing dead trees were $\leq$ 5.0 inches d.b.h., $\leq$4.5 feet high, and categorized by soundness (<50, $\leq$50 percent of sound tree volume) and species group (pines, redcedar, baldcypress, hardwoods) from one 0.1–acre fixed-radius plot within the 1–acre sample area.

Mapped and Nontraditional Data

I employed ArcView software (Environmental Systems Research Institute, Inc. 1996) to create plot attribute maps. Each sample plot represented approximately 6,000 acres, the average per-plot expansion factor. Nominal accuracy of plot locations was 1,000 feet (±300 m) for the South Central States (Rudis 1998). Attributes displayed by location permitted a qualitative interpretation of spatially autocorrelated attributes.

I used the National Hierarchical Framework of Ecological Potential (ECOMAP 1993) to compile FIA statistics for Arkansas by subregion (province and section). A province was a region primarily controlled by climatic weather patterns; a section was a subdivision of a province having broad areas of similar geomorphology, drainage patterns, topography, and regional climate (McNab and Avers 1994). Rudis (1998) assigned each ecological subregion by county according to plurality province, and within provinces to a plurality section. Using the resulting six ecological subregions permitted grouping of data with similar ecological relationships and afforded an opportunity to provide more detailed summaries for western Arkansas than was possible using the four traditional FIA Units (fig. 1).

Using recent aerial photos, FIA survey crews tallied forest fragment size associated with each forest plot sampled, proximity to nonforest land ≥10 acres (Anderson and others 1976), and water sources (≥one-eighth acre in size or ≥40 feet in width). Collecting data on forest fragmentation since 1974 in the South Central States, FIA crews indexed the potential for forest size dependent owner assistance and profitable timber harvesting (Wells and others 1974), wilderness recreation (Rudis 1986), wildlife habitat (Rudis and Tansey 1995), and other resource uses (Rudis 1995). A forest fragment was a contiguous forest ≥1 acre, unbroken and bounded by nonforest earth cover ≥120 feet wide. FIA crews estimated size with 1:20,000- and 1:40,000-scale black and white aerial photographs in the 1970s and 1:58,000-scale color aerial photographs since 1986. Crews did not consider a change in ownership, forest type, age class, land use, or nonforest areas <120 feet wide as a break in contiguous forest cover. Fragment size estimates were in broad classes (represented by midpoints in tables and figures): 1 to 10 (5), 11 to 50 (30), 51 to 100 (75), 101 to 500 (300), 501 to 2,500 (1,500), 2,500 to 5,000 (3,750), and >5,000 acres (in calculating averages, arbitrarily set to 8,208). Significant chi-square tests of association ($P(\chi^2)<0.05$) used the Pearson product-moment correlation (r) (SAS Institute Inc. 1990) to determine the association's direction and strength.

Crews recorded occurrence of fences and signs (no hunting, hunt club, hunting restricted, posted, no trespassing, keep out, or other signs indicating restricted activities) and most developed access roads (paved, dirt or gravel roads, or no roads or trails) on the way to forested plots from a nonforest area and within one-quarter mile of the plot. Crews also recorded harvest activity (clearcut, selective cut, salvage), slope (in percent), seasonal water sources, trash (paper, glass, metal, or plastic beverage or food containers; other bottles, cans, glass, or metal containers of unknown contents; discarded machinery and other objects not in use). They based estimates of garbage or trash dumping on the amount and arrangement of trash, fire or recent trail or road use on tire marks and damage to vegetation structure, and tree damage on new growth of overstory stems. For each plot, crews recorded livestock evidence if they observed cattle or other livestock, their tracks, dung, trails, or other physical evidence of livestock occurrence; and hunting evidence if they observed a tree stand, shotgun or rifle shell, or other evidence of hunting activity. I classified plots that were part of a contiguous

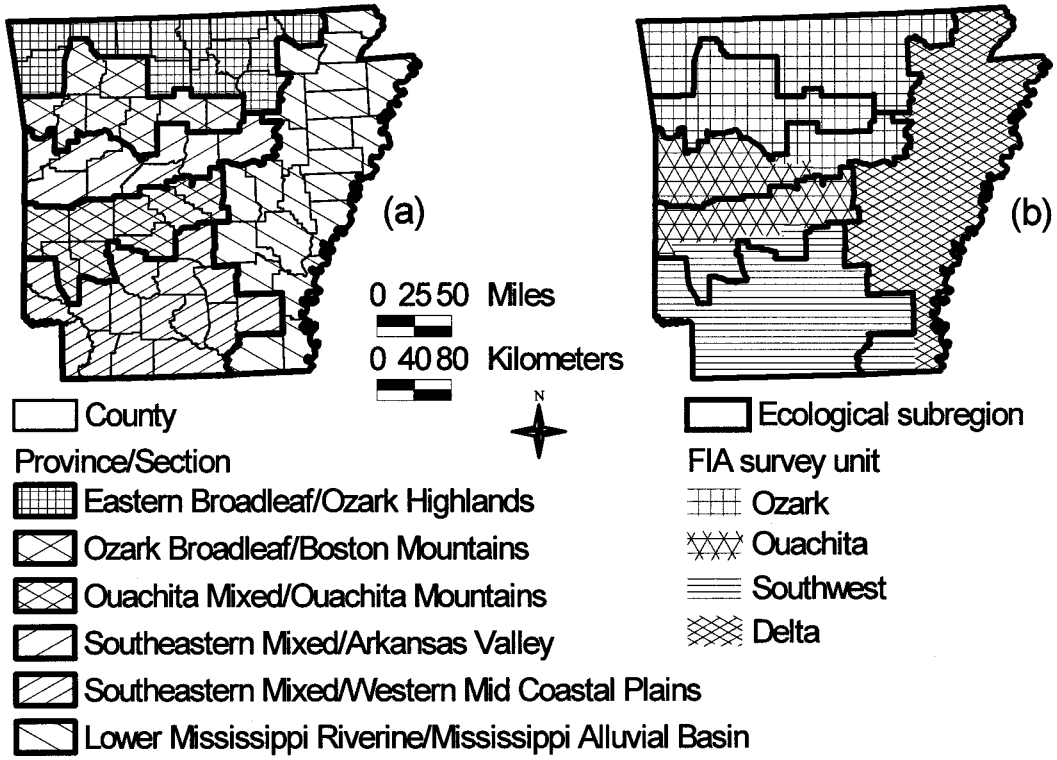

Figure 1—Arkansas divisions by ecological subregion (province and section) and (a) county, (b) Forest Inventory and Analysis survey units.

>2,500–acre forest, one-half mile or more from truck-operable roads, and without trash, as having a primitive recreation opportunity.

I reassembled existing FIA plot and tree information to address important aspects of wildlife habitat in forests. These included FIA area statistics by forest type and stand diameter (stand size in timber-oriented publications) class, and estimates of potential mast producing tree species and dead (potential den) tree stem density by tree condition, species, and diameter class. Other wildlife characterization was lacking, however, as there was no inventory concurrent with the Arkansas FIA survey to account for understory shrubs, vines, herbaceous species, fruit production, or animal populations.

Value Indices

To incorporate the landscape context, I used area and change statistics to create a cumulative habitat evaluation value index (hereinafter value index) that was modeled after Graber and Graber's (1976) and Iverson and others' (1989) assessment of generic bird habitat. Essentially, the largest value indices were in subregions with a large proportion of earth cover in forests and with rapidly declining, older community types; the smallest value indices were in subregions with a small proportion of earth cover in forests with rapidly increasing, older community types. To minimize truncated variability and obtain more normally distributed expected values, I modified calculations of the value index to accept negative sums and used Naperian logarithms (base e) to reduce geometric variability.

The value index was earth cover frequency by community type, weighted by its vulnerability and cost (age, in years) to replace it. A larger weight occurred with a more vulnerable (scarce, declining) and older community type, and a smaller weight to a less vulnerable (common, increasing) and younger community type. Scarcity was the log (total earth cover/community type). To incorporate a frequency term, I used - p(log(p)) where p was the proportion of the subregion's area in a particular type. A subregion's landscape diversity (D) was D = sum(- p(log(p))) .

I used a simplified schedule of the cost, in years, to replace the community type from a clearcut condition. Stand-diameter class (also known as stand-size class in timber-oriented publications) was a proxy for this time period. If forested, I assigned replacement time by forest type and stand-diameter class: sapling-seedling, 10 years; poletimber, 20 years; pine sawtimber plantations, 30 years; oak-pine sawtimber stands, 40 years; and hardwood stands, 50 years. I arbitrarily assigned nontimberland (productive-reserved and other forest land) a 10–year replacement time; nonforest land (agriculture and urban land) a 2–year replacement time; and water a 1–year replacement time.

The forest attribute-neutral index for a region reflected the status and change in forest area by community type. Forest attribute-specific indices reflected forested area with a particular context or disturbance feature. Preliminary assessment suggested a logarithmic distribution for the expected range of value indices. As an interim guide for this report, I defined important attribute-specific value indices as those 80 percent or more different from the attribute-neutral index.

Attributes featured were multipurpose, like forests associated with water, or indicators identified with range, recreation opportunities, and wildlife habitats. Context attributes were: forests that were part of forest fragments >2,500 acres, forests ≤1 mile from urban or built-up land, those ≤one-eighth mile from agricultural land, and those within one-fourth mile of paved roads, water sources, all roads or trails, signs restricting activities, and fences. Other attributes were: forests with livestock use, permanent water, trash, and with recent ≤2 years) fire evidence, logging activity, and trail or road use. A forest area with primitive recreation potential was a forest area with no trash, no recent trail or road use, and part of forest fragments >2,500 acres.

RESULTS

Land Use

Forest land was the majority earth cover in all but the Mississippi Alluvial Basin subregion. Timberland represented 98 percent of Arkansas' forest land. Reserved forest land and other forest land each represented about 1 percent of the forest land, with most in the north and western subregions (table 1). Nonforest land was primarily cropland to the east and pastureland to the north and west (fig. 2).

On forest land, slopes averaged 10 percent statewide. The Mississippi Alluvial Basin (MAB) and Western Mid-Coastal Plains (WMCP) subregions had the most level terrain (≤4 percent slope) and the greatest average potential wood productivity (≥100 cubic feet/acre/year). Representing averages for up to nine plots, mapped data on potential wood productivity illustrate the spatial detail (fig. 3).

Pine plantations represented more of the forest land in the WMCP (20 percent) and Ouachita Mountains (30 percent) than in other subregions. Most planted stands were loblolly pine, situated in southwest Arkansas (fig. 4) and in landscapes dominated by forest industry ownership (fig. 5). Results corroborated a 1988 report (Beltz and others 1992) that noted 69 percent of Arkansas's pine plantations on forest industry land.

Livestock evidence occurred on 9 percent of the forest land, with greatest concentration in the Ozark Highlands (23 percent) subregion. Much of the standing timber may have been incidental to livestock feeding operations, as the majority of forest land with livestock evidence was in landscapes dominated by nearby pastureland (fig. 6) and low potential wood productivity (fig. 3). These landscapes had extensive areas of farm ownership (fig. 5) and limited evidence of recent commercial harvest or timber management activity. Most (90 percent) forest land area with livestock evidence was in upland forests, with more than half in oak-hickory forest type.

Table 1—Area of earth (land use and water) cover, forest land-use class, and percent reserved by ecological subregion, Arkansas 1995

Ecological subregion	Earth cover	All forest land	Unreserved forest land		Reserved forest land	
			Timber-land	Other forest[a]	Area	Proportion
	1,000 acres					*Percent*
Mississippi Alluvial Basin	10,088	2,502	2,498	0	4	0.2
Western Mid-Coastal Plains	7,142	5,600	5,597	0	3	.0
Arkansas Valley	3,813	2,313	2,273	19	22	1.0
Ouachita Mountains	3,691	2,679	2,632	11	37	1.3
Boston Mountains	3,657	2,523	2,407	24	92	3.8
Ozark Highlands	5,646	3,173	2,986	113	75	2.5
Statewide	34,037	18,790	18,392	167	231	1.3

Rows and columns may not sum to totals due to rounding.
[a] < 20 ft^3/acre/year, a.k.a. woodland in prior reports.

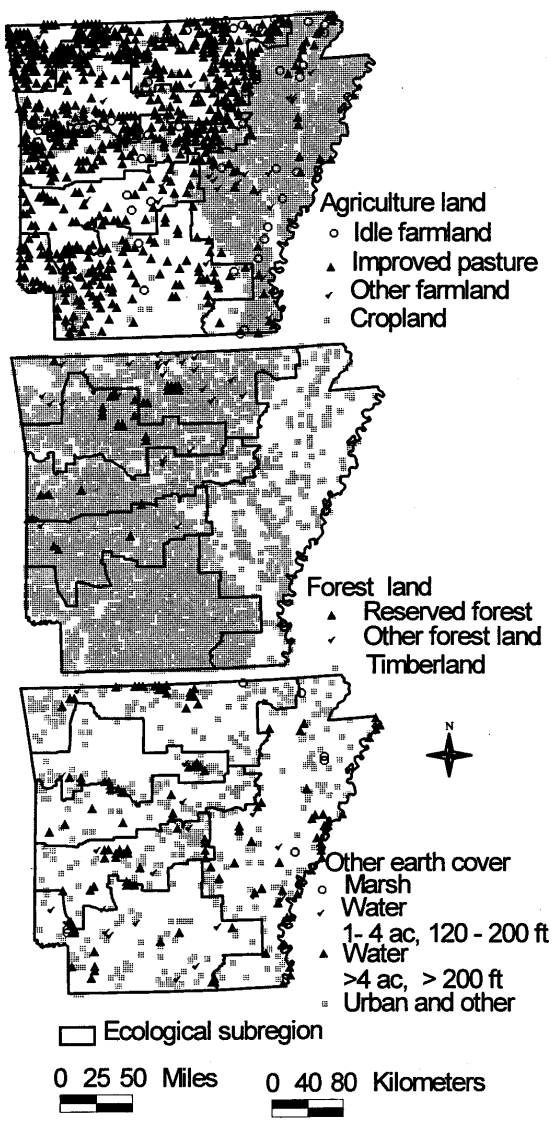

Figure 2—Land and water area by land use class, Arkansas 1995.

Hunting evidence occurred on 10 percent of the forests statewide, with the greatest concentration in the more wood-productive MAB subregion (24 percent). Areas with the most potential for active agroforestry operations (occasional livestock grazing with active timber production and limited hunting activity) were most likely on the few pine-growing areas with nearby pastures.

Comparing classifications between the six ecological subregions and the traditional four survey units (Delta, Southwest, Ouachita, and Ozark) showed ecological subregions afforded a more detailed portrait of land in west central and northwest Arkansas (table 2, fig. 7a, b). Area statistics tabulated from the 1995 survey by either classification method were similar when estimated by forest land or timberland, because forested nontimberland area represented only a small fraction (2 percent) of the forest land (table 2).

Selected Human Uses on Forest Land

A qualitative examination of spatial patterns by harvest activity suggested that partial cutting was the dominant activity for the 1978 to 1988 and 1988 to 1995 periods (fig. 8). The WMCP and Ouachita Mountains received the most harvest activity for both periods. Areas in Howard, Pike, and Saline Counties (Ouachita Mountains) in 1988 had a notably dense pattern of clearcut harvests that was absent by the time of the 1995 survey.

Crews found trash (miscellaneous litter of human origin) on 37 percent of forest land throughout Arkansas forests in 1995, up from 29 percent in 1988. Garbage or trash dumping—a subset of trash based on a field interpretation of abundant and dense concentration of litter of human origin occurred on 6 percent of the forest land in 1995. Garbage or trash dumping occurrence patterns appeared to follow the road network (fig. 9).

Twenty-six percent of Arkansas' forest land had restricted-activity signs in 1995. Many signs in 1995 occurred near the border between the MAB and the largely upland ecological

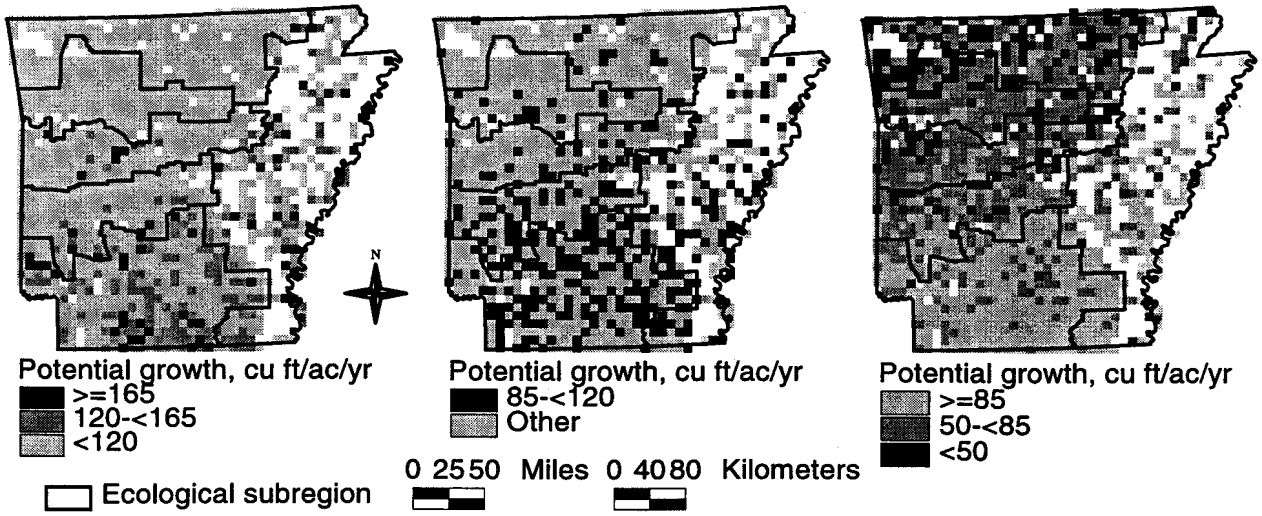

Figure 3—Average forest site productivity class, Arkansas 1995. Each 9-mile by 9-mile cell had a value representing the plurality site productivity class from up to nine adjacent forested plots.

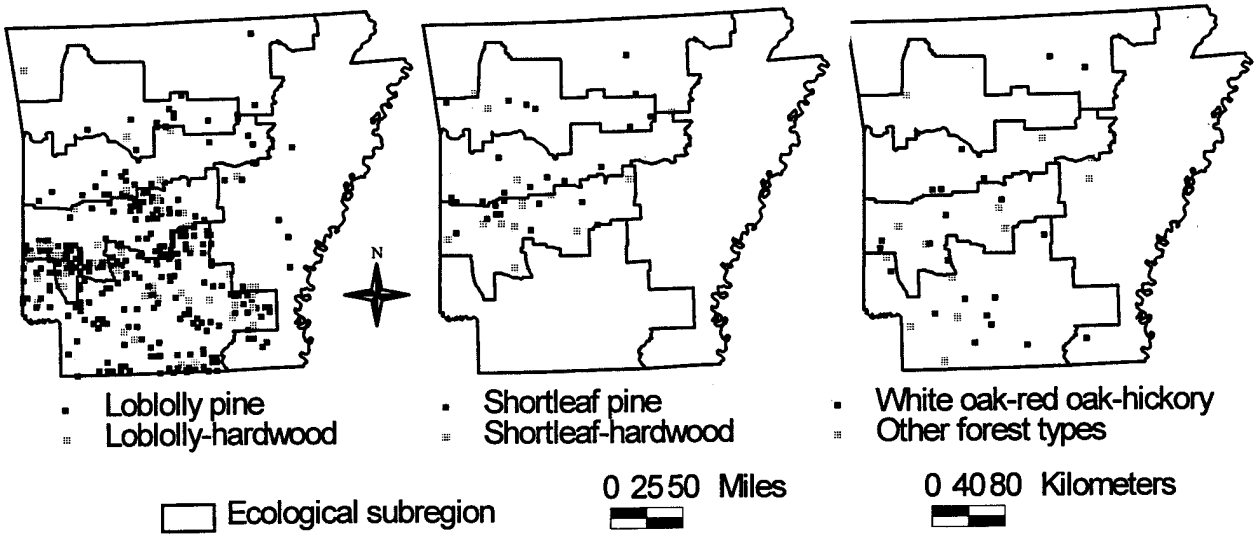

Figure 4—Forest plots in plantations by forest type, Arkansas 1995.

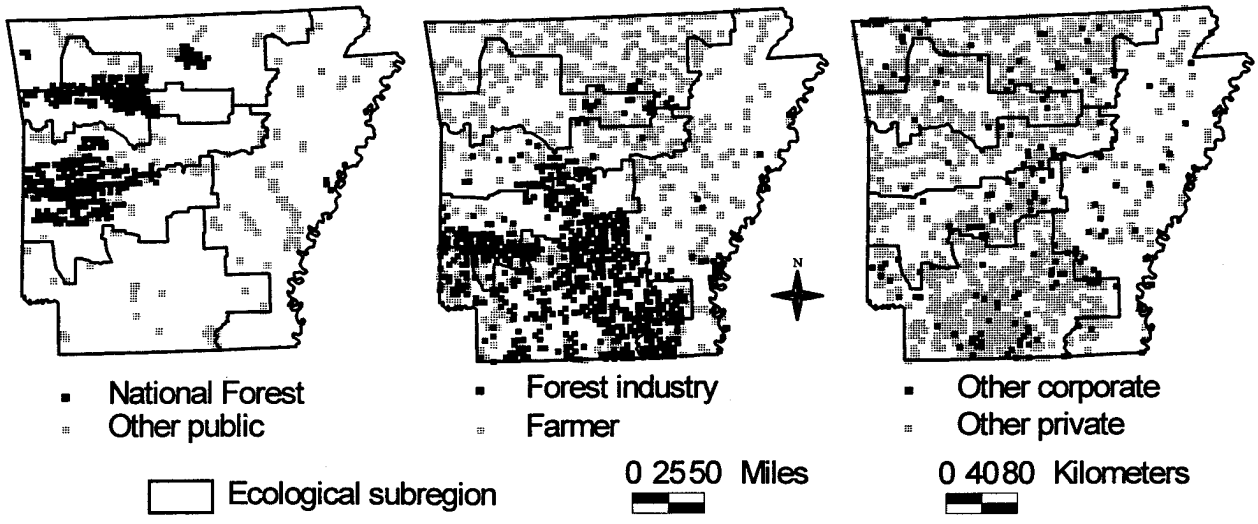

Figure 5—Forest plots by ownership class, Arkansas 1995.

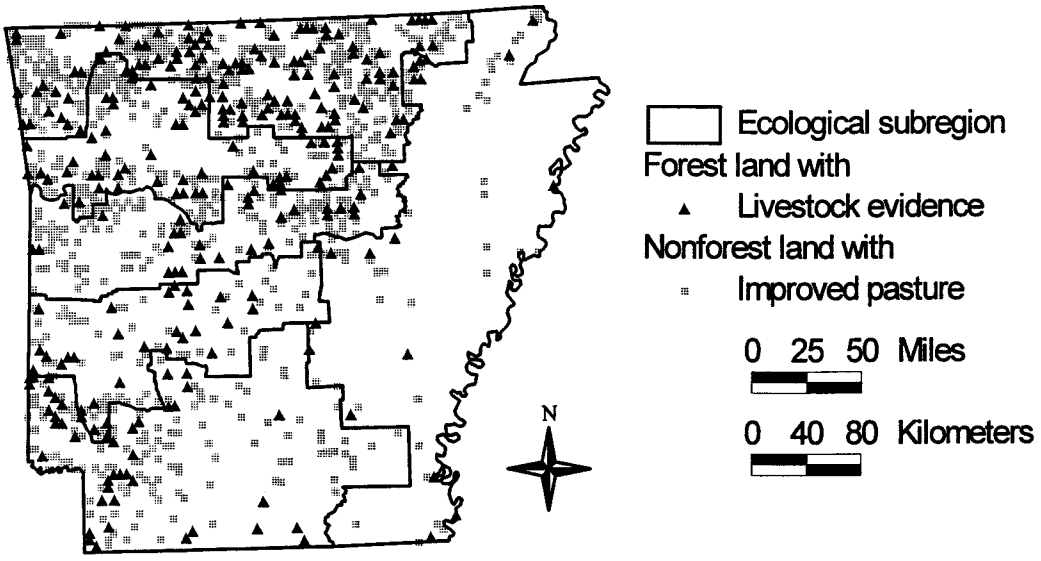

Figure 6—Forest plots with livestock grazing evidence and nonforest land with improved pasture, Arkansas 1995.

Table 2—Proportion of earth cover and average potential productivity and slope, and proportion in planted stands, with livestock evidence, and with hunting evidence by ecological subregion and Forest Inventory and Analysis Unit, Arkansas forest land (timberland), 1995

Group and subgroup	Proportion of earth cover	Average		Proportion		
		Potential productivity	Slope	Planted stands	Livestock evidence	Hunting evidence
	Percent	*Ft³/ac/yr*		*Percent*		
Ecological subregion						
Mississippi Alluvial Basin	25 (25)	110 (110)	3 (3)	5 (5)	4 (4)	24 (24)
Western Mid-Coastal Plain	78 (78)	115 (116)	4 (4)	20 (20)	4 (4)	9 (9)
Arkansas Valley	61 (60)	73 (73)	12 (12)	9 (10)	7 (7)	7 (7)
Ouachita Mountains	73 (71)	84 (85)	14 (14)	30 (30)	7 (7)	7 (7)
Boston Mountains	70 (66)	61 (62)	19 (18)	5 (5)	13 (13)	6 (6)
Ozark Highlands	56 (53)	56 (58)	17 (16)	2 (2)	23 (23)	8 (8)
Forest Inventory and Analysis (FIA) Unit						
Delta	22 (22)	108 (108)	3 (3)	4 (4)	5 (5)	27 (27)
Southwest	77 (77)	114 (114)	4 (4)	22 (22)	4 (4)	9 (9)
Ouachita	71 (70)	75 (76)	15 (15)	17 (17)	6 (6)	5 (5)
Ozark	59 (56)	59 (61)	16 (16)	4 (4)	18 (18)	8 (8)
Statewide						
Forest land (timberland)	55 (54)	88 (89)	10 (10)	13 (13)	9 (9)	10 (10)

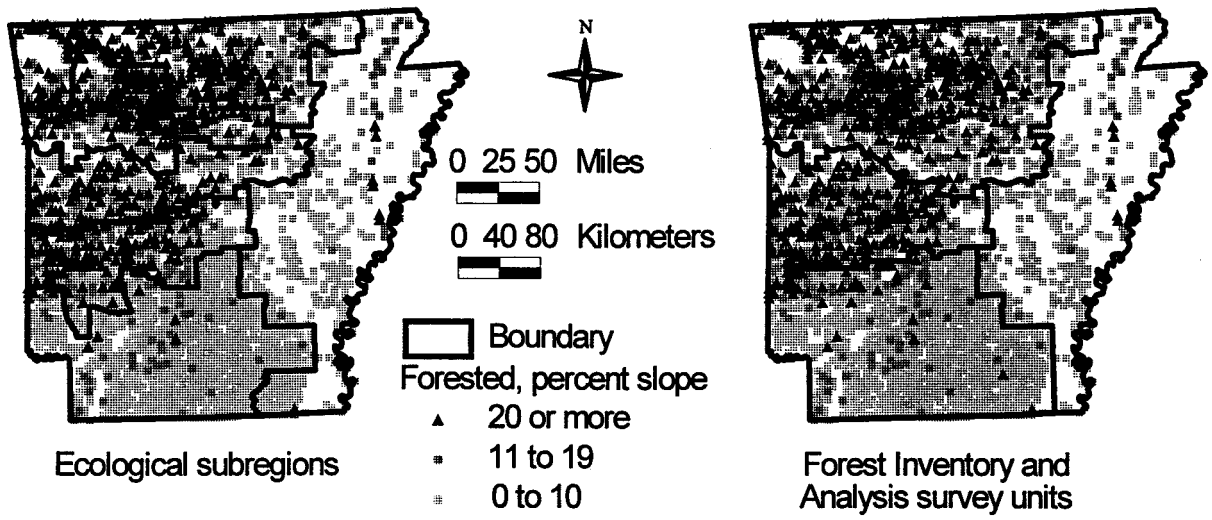

Figure 7—Forest plots by percent slope, Arkansas 1995, by ecological subregion and Forest Inventory and Analysis survey unit.

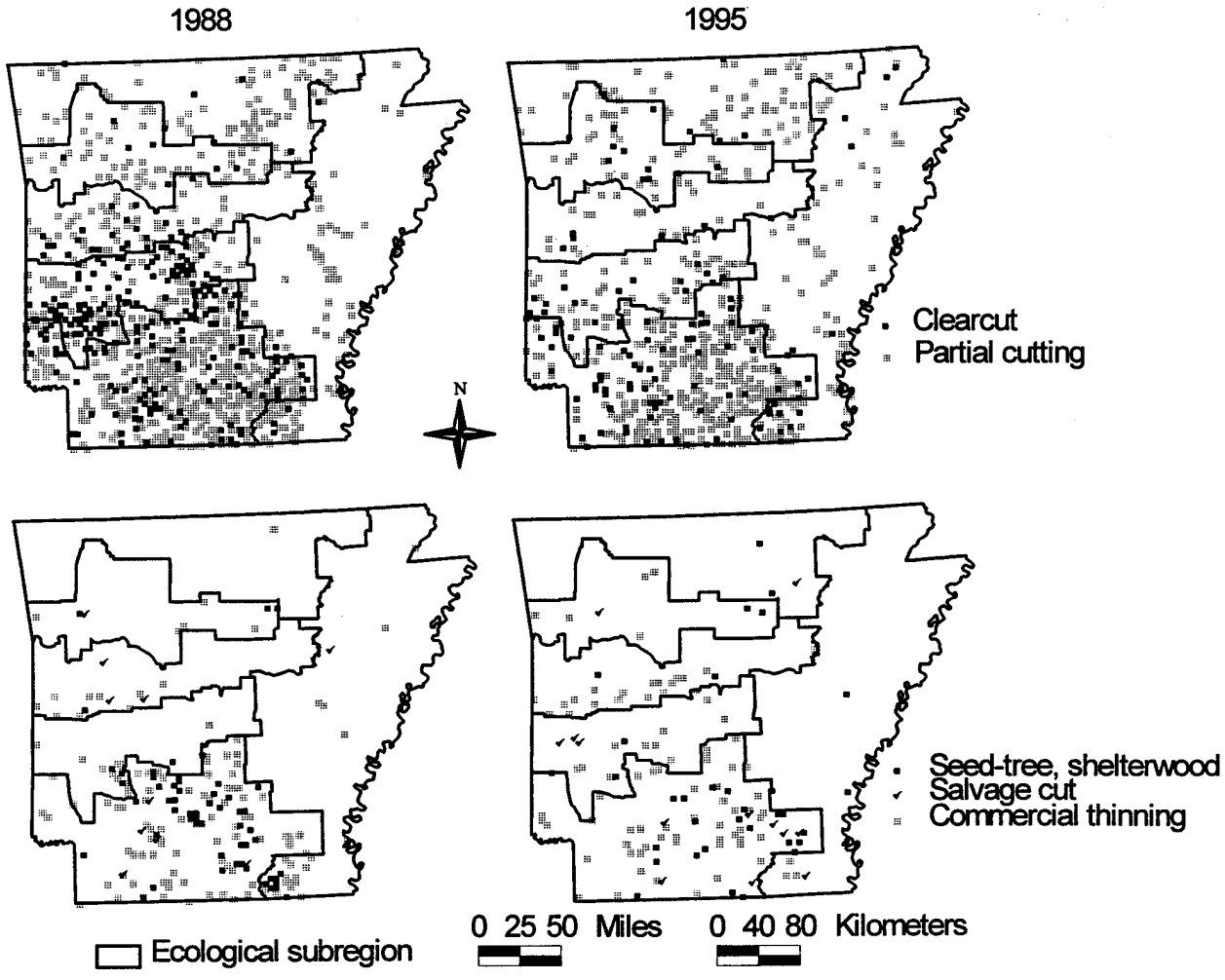

Figure 8—Forest plots with harvest activity by type of activity since the previous survey, Arkansas 1988 (period 1978–88) and 1995 (period 1988–95).

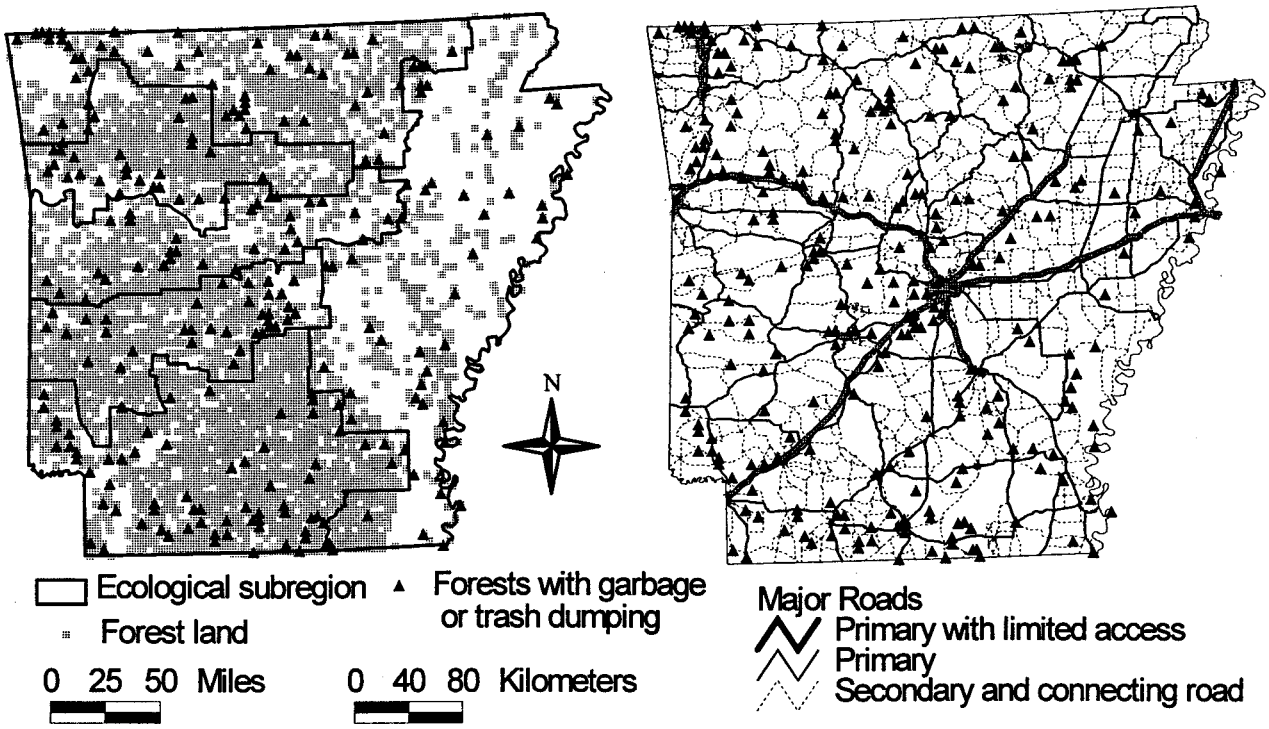

Figure 9—Forest plots with garbage or trash dumping evidence, Arkansas 1995, with forest plots and major connecting roads.

subregions to the west. The 1995 estimate was two times the percentage of the 1988 survey (fig. 10). Dense concentrations were in the WMCP south of Little Rock in both 1988 and 1995. The recent widespread use of purple paint as an indicator of posted land, rather than lettered signs, may have contributed to some of the increase between surveys. Nevertheless, patterns in this indicator suggested increasing owner interest in private, or fee-paid hunting, and trespass concerns in selected locales. Implicit in this finding is the suggestion that there was a reduction in the supply of publicly-accessible recreation opportunities on private land.

Hunting activity evidence was widespread (fig. 11a, b). Hunting evidence increased from 7 to 10 percent of the forest land since the 1988 survey. Areas with a dense

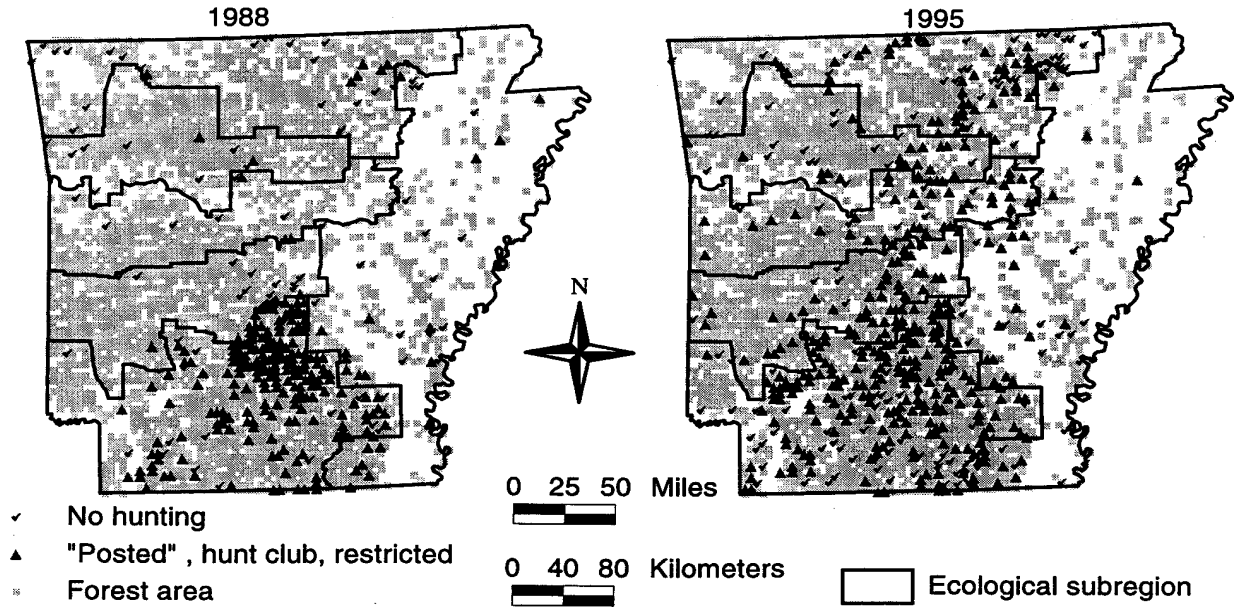

Figure 10—Forest plots within one-quarter mile of hunting activity restricted signs (posted, no hunting, hunt club), Arkansas 1988 and 1995.

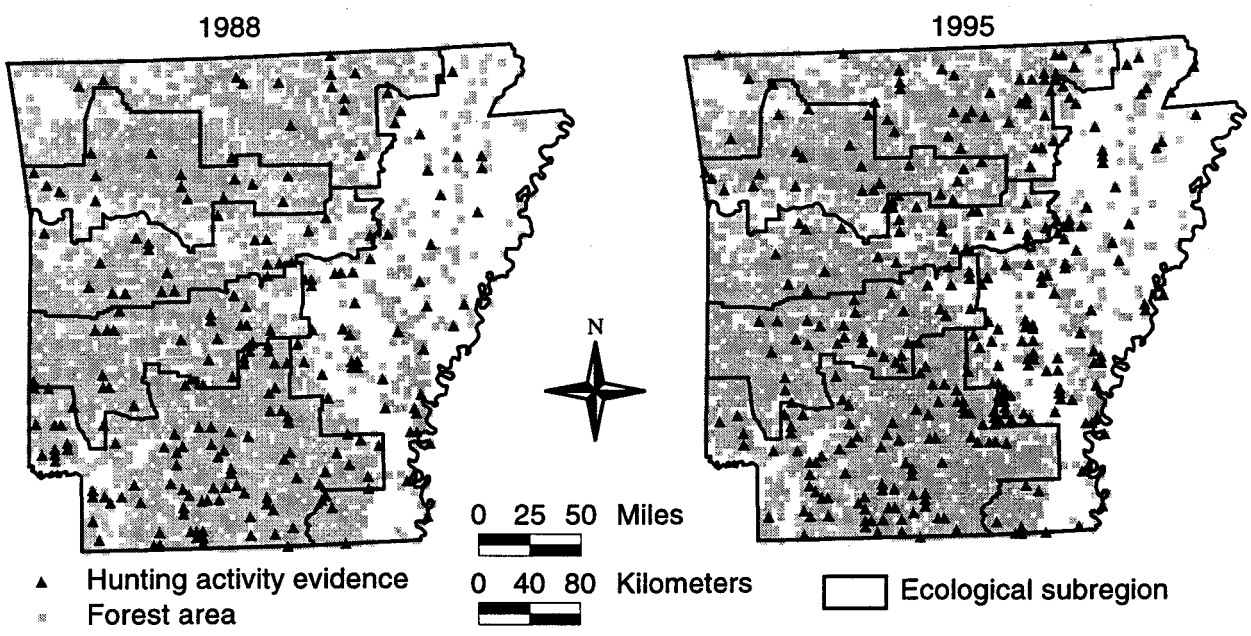

Figure 11—Forest plots and locations with hunting evidence (tree stands, shells, or other evidence), Arkansas 1988 and 1995.

concentration of hunting evidence were between areas of large, forested and large, nonforested landscapes. Comparisons between areas with dense hunting evidence (fig. 11) and restricted-activity signs (fig. 10) suggested that forest land able to satisfy hunter demand was increasingly becoming accessible only on a fee-paid or specific-permission basis.

Forest Fragmentation

In Arkansas, many of the fragments were in the range of 501 to 2,500 acres (table 3). Most of the largest fragments were in the Boston Mountains and the WMCP, and the smallest in the MAB, Ouachita Mountains, and Ozark Highlands (fig. 12). Average forest fragment size statewide was 1,985 acres. By subregion, averages were: Boston Mountains, 2,983; Arkansas Valley, 2,103; WMCP, 2,037; Ouachita Mountains, 1,856; MAB 1,554; and Ozark Highlands, 1,463.

There was a net decline in forest fragment size between 1978 and 1995, with increases between 1988 and 1995 primarily in the mid-sized fragment category (table 4, fig. 13). For the MAB, fragment size changes were significant between 1978 and 1995, but the change in direction was

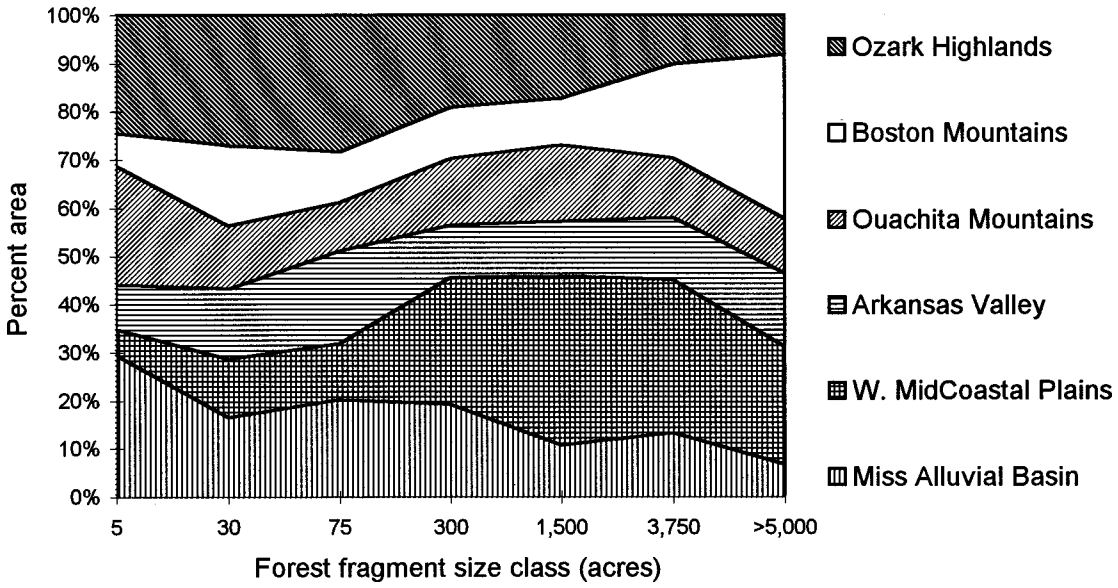

Figure 12—Proportion of forest area by forest fragment size class, Arkansas 1995.

Table 3—Area of forest land and timberland by forest fragment size class and ecological subregion, Arkansas 1995

Land use and size of forest fragment	All subregions	Mississippi Alluvial Basin	Western Mid-Coastal Plains	Arkansas Valley	Mountains		Ozark Highlands
					Ouachita	Boston	
Forest land							
Fragment size				*1,000 acres*			
1–10	202	60	11	19	50	13	50
11–50	708	117	86	103	93	118	192
51–100	1,005	203	117	194	100	106	285
101–500	3,538	676	938	385	489	375	675
501–2,500	9,010	970	3,170	1,020	1,427	863	1,561
2,501–5,000	2,889	381	923	372	359	560	294
>5,000	1,437	96	353	220	162	489	118
All forest land	18,790	2,502	5,600	2,313	2,679	2,523	3,173
Timberland							
Fragment size				*1,000 acres*			
1–10	196	60	11	12	50	13	50
11–50	697	117	86	103	87	112	191
51–100	940	199	117	187	100	91	245
101–500	3,509	676	938	385	489	368	652
501–2,500	8,911	970	3,168	1,015	1,420	843	1,495
2,501–5,000	2,818	381	923	369	351	524	269
>5,000	1,322	96	353	200	135	455	83
All timberland	18,392	2,498	5,597	2,273	2,632	2,407	2,986

Rows and columns may not sum to totals due to rounding.

Table 4—Sample size, tests of association between increasing fragment size class and survey year by ecological subregion, Arkansas timberland

Survey period	All subregions	Mississippi Alluvial Basin	Western Mid-Coastal Plains	Arkansas Valley	Mountains		Ozark Highlands
					Ouachita	Boston	
	Sample size, chi-square, Pearson r (x100)						
1978–88	5995, 49, -7	789, 13, NS	1864, 33, -12	699, 18, NS	909, 23, -14	824, 17, NS	910, 33, -9
1988–95	6195, 41, +3	826, 15, NS	1905, 36, +13	753, 13, NS	915, 13, NS	826, 13, NS	970, 4, NA
1978, 88, 95	9130, 86, -3	1218, 29, NS	2823, 48, NS	1088, 53, NS	1369, 37, -9	1229, 27, NS	1403, 55, -8

$P(X^2>15) = 0.01$, $P(X^2>13) = 0.025$, $P(X^2>11) = 0.05$ with 5 degrees of freedom. Fragment size classes 1–10 and 11–50 acres were combined.
Unless otherwise noted, Pearson r ±2 standard errors > 0.
NA = $P(X^2<11) = > 0.05$, Pearson r not applicable. NS = Not significant, Pearson ±2 standard errors include 0.

not significantly different from zero (table 4). Increases occurred in mid-sized classes and declined in the 5,000+ acre class—a pattern similar to that found in the MAB encompassing portions of Arkansas, Louisiana, and Mississippi (Rudis, in press). For the WMCP, fragment size declined between 1978 and 1988 followed by an increase between 1988 and 1995. A net decline in fragment size occurred between 1978 and 1995 for the Ouachita Mountains and Ozark Highlands. In the Arkansas Valley and Boston Mountains, fragment-size distribution was significantly different between 1978 and 1995, but direction was not significantly different from zero.

Landscapes dominated by public ownership retained the largest fragments between 1978 and 1995 (compare fig. 14 with fig. 5). Landscapes dominated by other ownerships varied in fragment size during the period. For areas that declined then increased in fragment size, the temporary

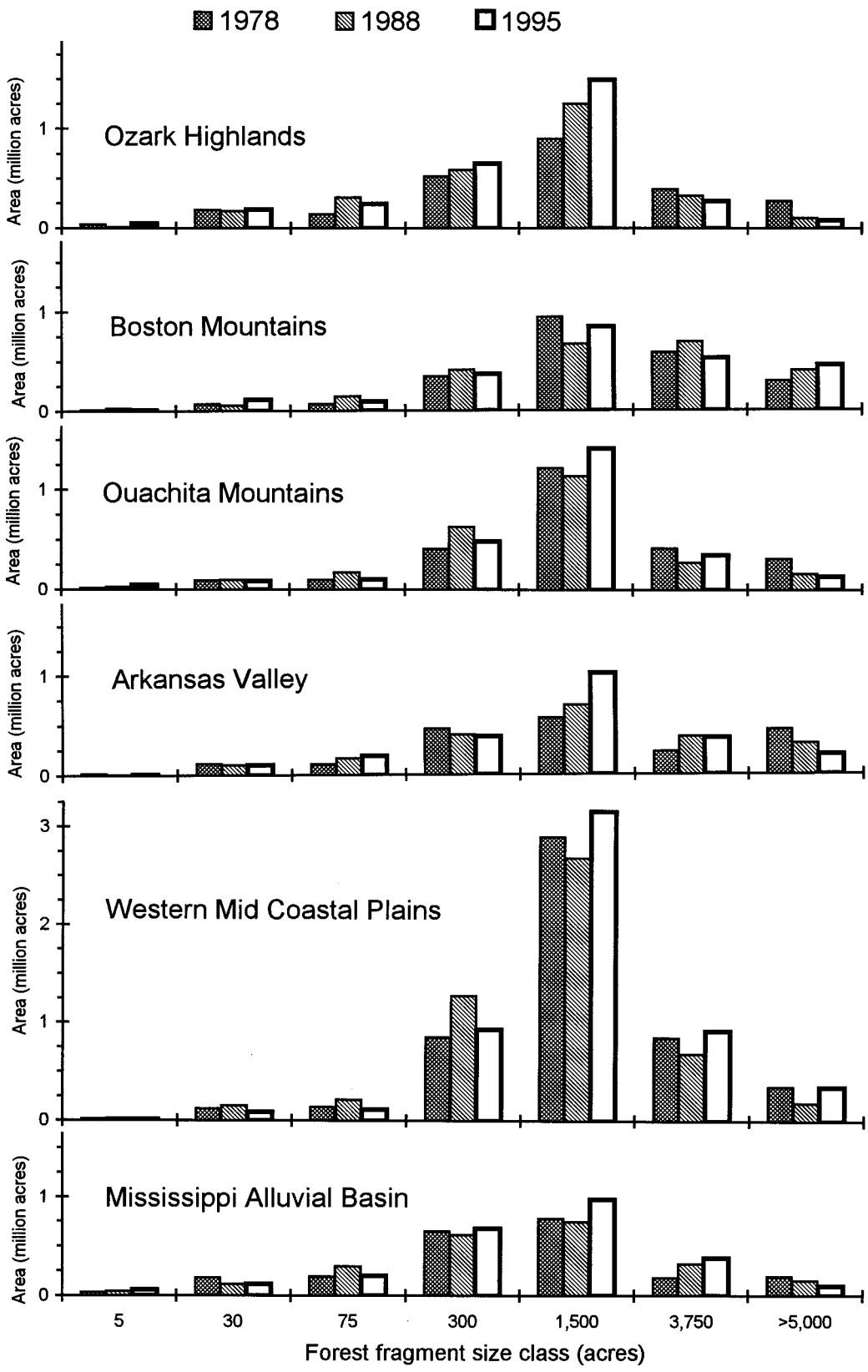

Figure 13—Forest area by forest fragment size class and ecological subregion, Arkansas 1978, 1988, and 1995.

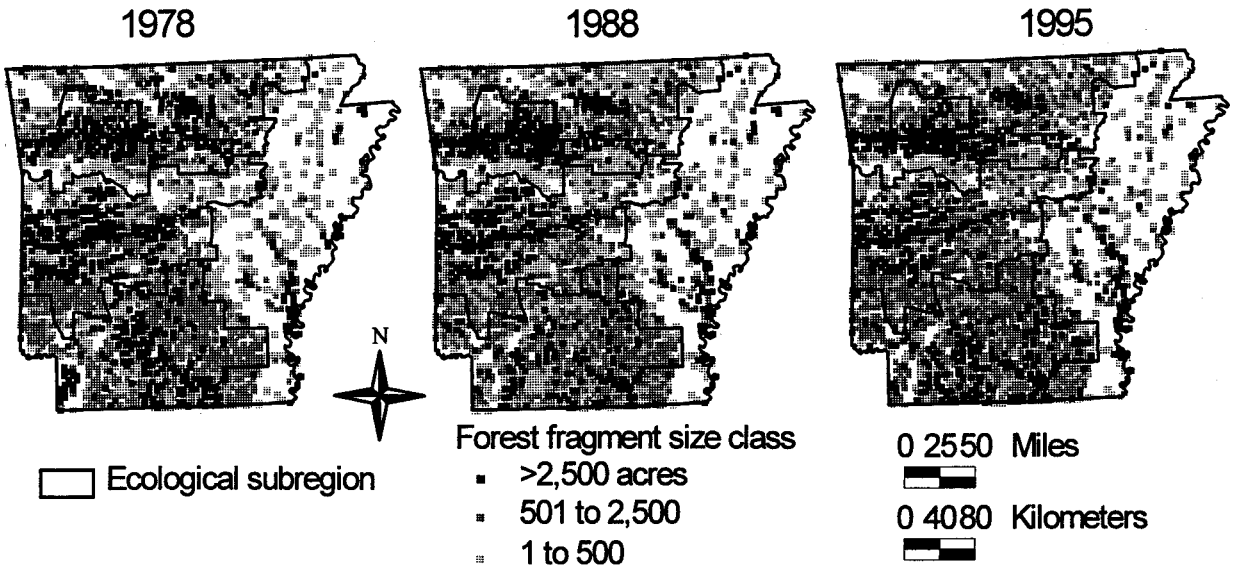

Figure 14—Forest plots by forest fragment size class, Arkansas 1978, 1988, and 1995.

fragmention was probably a result of periodically intense forest management impacts. In areas with young plantations or recently clearcut harvest areas (e.g., landscapes in Howard, Pike, and Saline Counties in 1988), forest fragment boundaries were probably the temporary logging roads used in clearcut harvest operations and narrow access roads used in young plantation management operations. Boundaries became obscured in formerly harvested areas with the passage of time as temporary roads regenerated, nonforest boundary width diminished, and forests (primarily tree branches) covered formerly wider access roads.

Forest Composition

Forest types in Arkansas generally were pine types to the south, oak-hickory type to the north, and lowland hardwood to the east. Figure 15 shows the distribution of food-producing tree species by region and species group. Stem

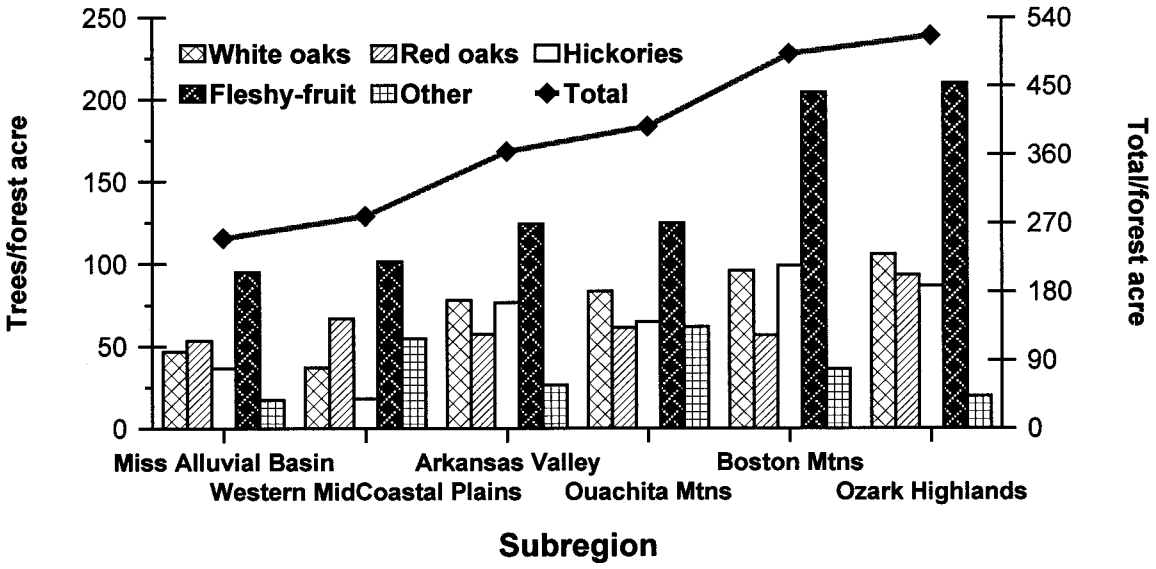

Figure 15—Density of 1.0 inch and larger diameter of food-producing trees by subregion and species group, Arkansas forests, 1995. Within groups, species composition was in descending importance. White oaks: White, post, overcup, chinkapin, swamp chestnut, bur, shingle, Delta post, Durand. Red oaks: Southern red, black, water, Northern red, blackjack, willow, cherrybark, Nuttall, shumard, laurel, pin, bluejack, live. Hickories: Black, mockernut, pignut, shagbark, bitternut, water, pecan, shellbark, nutmeg. Fleshy-fruit species: Flowering dogwood, blackgum, eastern and southern redcedar, common persimmon, American holly, sugarberry and hackberry, sassafras, serviceberry, red mulberry, hawthorn, other cherry and plum species, sparkleberry, water tupelo, white mulberry, swamp tupelo, redbay, apple, chinaberry. Other: Nut-bearing (other than oak and hickory): ironwood, bluebeech, American beech, Black walnut, buckeye, chinkapin, Ohio buckeye, Allegheny chinkapin, butternut; Cone-like: sweetbay, bigleaf magnolia, cucumbertree; Leguminous: honeylocust, black locust, waterlocust, Kentucky coffeetree. Nomenclature follows Little (1979).

density of most food-producing stems, particularly fleshy-fruit species, dominated northern Arkansas.

Wildlife Habitat Attributes—Densities of potential cavity trees, i.e., live trees ≥5 inches d.b.h. and more than one-third of gross volume in a rotten condition, and standing dead trees ≥5 inches d.b.h., were greatest in poletimber and sawtimber hardwood forest-community types (table 5). Large-diameter ≥19.0 inches d.b.h.) density of both live and dead trees was greatest in sawtimber stands (table 5). Planted pine stands had fewer dead trees than natural pine stands, regardless of stand-diameter class.

One-half of potential cavity trees were rotten or dead but ≥50 percent sounds—qualities suggesting greater value for cavity nesters. Tree density varied more by forest type and stand-diameter class than by tree condition, however. Sawtimber- and poletimber-sized stands and hardwood forest types favored an abundance of potential cavity trees. More than three times the density of potential cavity trees occurred in poletimber-sized natural than in plantation pine stands; differences were not as great with other diameter-class stands.

Damage Agents—The 1995 Arkansas survey included damage agents associated with the primary cause of tree

Table 5—Sample size, forest area, and number of live, rotten, and dead trees by diameter at breast height class (d.b.h. in inches) by forest type, stand diameter class, and condition, Arkansas forest land, 1995

Stand diameter and forest type	Sample size	Forest area	Live trees, d.b.h.			Standing dead ≥5.0	
			5.0–18.9	≥19.0	Rotten ≥5.0	≥50% sound	<50% sound
		1,000 acres	*Trees/100 acres*				
Sawtimber stands							
Planted pine	82	467	16,545	154	30	235	97
Natural pine	382	2,212	15,704	268	71	298	237
Oak-pine	204	1,180	14,819	394	168	175	396
Oak-hickory	484	2,764	12,205	541	360	183	527
Lowland hardwood							
Seasonally wet	315	1,886	11,230	988	230	190	535
Permanently wet	28	165	12,829	1,102	324	229	875
Total	1,495	8,673	13,486	538	215	216	420
Poletimber stands							
Planted pine	146	827	29,885	14	13	110	99
Natural pine	99	523	23,472	71	147	411	251
Oak-pine	184	1,079	18,399	125	206	209	343
Oak-hickory	464	2,740	17,056	144	311	169	483
Lowland hardwood							
Seasonally wet	72	440	16,307	277	144	432	390
Permanently wet	3	17	30,788	213	144	0	0
Total	968	5,626	19,777	125	218	211	369
Nonstocked, sapling, and seedling stands							
Planted pine	96	546	6,509	14	43	94	215
Natural pine	103	602	6,280	97	61	192	421
Oak-pine	159	947	6,871	85	74	111	218
Oak-hickory	316	1,856	5,444	71	92	86	214
Lowland hardwood							
Seasonally wet, mixed	87	505	4,135	135	137	52	216
Permanently wet	5	29	3,284	159	74	176	704
Nontyped and nonstocked	1	6	0	0	0	0	0
Total	767	4,491	5,825	78	83	103	246
All types and sizes	3,230	18,790	13,537	305	185	188	363

Rows and columns may not sum to totals due to rounding.

death. Maps of three of these—ice, southern pine beetle, and beavers—suggested spatial dependence of occurrence patterns. Plots with evidence of ice damage were in southeastern Arkansas (fig. 16a). Those with southern pine beetle damage occurred primarily in the WMCP (fig. 16b). Selected areas had plots with beaver damage (fig. 16c), but I had no readily-available information on minor drainage areas to assess associations. The co-occurrence of ice and southern pine beetle damage in southeast Arkansas suggested spatial dependence but was not definitive.

Patterns in Forest Composition—Mapped FIA data on forest composition suggested changes in the distribution of forest types (fig. 17). Between 1978 and 1995 surveys, increases were notable in eastern redcedar-hardwood and oak-hickory types. Most notable, however, were increases in the distribution of loblolly pine and declines in shortleaf pine types between 1978 and 1995. Dominated by forest industry ownership (fig. 5), forest land within the Ouachita Mountains subregion (specifically Howard, Pike, and Saline Counties) underwent a major transformation. In 1978, shortleaf pine dominated these areas. Extensive clearcut harvest activity occurred in these areas for the 1978 to 1988 period (fig. 8). By 1995 many of the same areas were planted in loblolly pine.

Area and Value Indices

Area and percent change, scarcity, frequency, and landscape diversity by community type are straightforward multipurpose indices for a number of interdisciplinary applications. Coupled with these are value indices, which essentially summarize the status, change since the last survey, and landscape context for timberland (table 6) and earth cover (table 7).

Findings based on statewide area change revealed that forest land with fire, primitive recreation opportunities, or livestock evidence or with no trash, nearby fences, or roads was declining (table 8). Forest land near urban areas, permanent water, paved roads, and agricultural land, as well as the occurrence of large forest fragments was increasing. Also increasing was forest land with recent trail or road use, water sources, restrictive activity signs, and with no recent logging activity. The largest value index suggested forests with no trash were rapidly declining among older community types, and the smallest index suggested forests with restrictive activity signs were rapidly increasing among older community types. Restricted-activity signs was the one attribute that had an important ($\geq$80 percent different) shift when compared with the statewide index (table 8).

Contrasts in value indices among subregions by attribute suggested their comparative age, change, and relative frequency in the landscape (table 9). The largest value indices by attribute were in the WMCP with 7 of the 16 top scores: forest land, forests with no trash, no nearby fences, agriculture, and water sources, with fire evidence, and no recent logging activity. Four attributes were greatest in the Arkansas Valley: forests with primitive recreation opportunities, no nearby roads or trails, part of large forest fragments, and near urban areas; two in the Ouachita Mountains: forests with recent trail or road use and with permanent water; and one each in the MAB: forests with signs restricting activities, and Ozark Highlands: forests with livestock grazing. The smallest value indices were in the Ozark Highlands with six of the bottom scores, the MAB with four, the Arkansas Valley with three, the Ouachita Mountains with one, and the WMCP with none.

All subregions had attribute-specific indices that were different with their subregion's attribute-neutral index (table 9). Most differences were in the Ozark Highlands, with 12 of 15 rated important. Forest area became the Ozark Highlands' majority earth cover, i.e., 56 percent forested in 1995, an increase of 7 percent since 1988. The increase included a substantial increase in older communities. By contrast, for the 11 attribute-specific indices with important

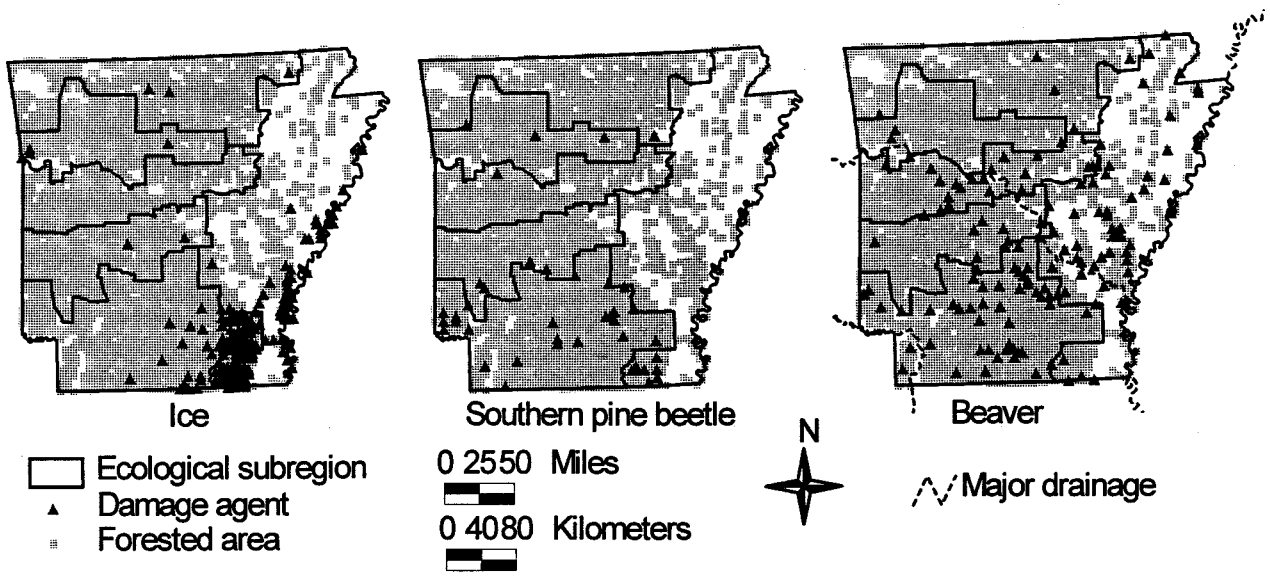

Figure 16—Forest plots and locations with one or more trees damaged by ice, southern pine beetles, and beavers, Arkansas 1995.

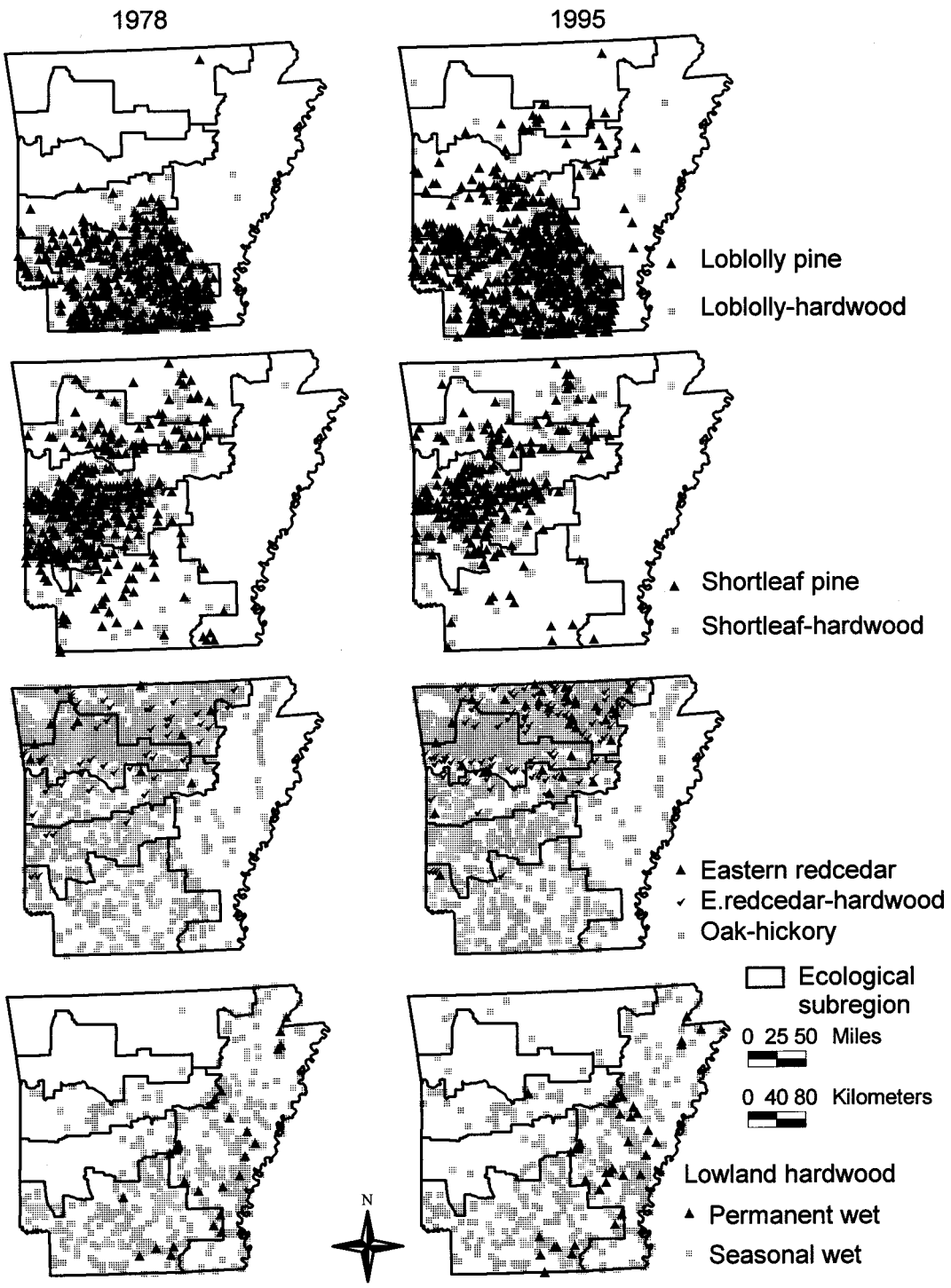

Figure 17—Forest plots by forest type group, Arkansas 1978 and 1995 surveys. Forest type groups above conform to Forest Inventory and Analysis loblolly-shortleaf pine: loblolly pine, shortleaf pine, eastern redcedar; oak-pine: loblolly pine-hardwood, shortleaf pine-hardwood, and eastern redcedar-hardwood. Permanently wet lowland hardwoods are oak-gum-cypress stands dominated by baldcypress-water tupelo and sweetbay-swamp tupelo-red maple. Other lowland hardwoods contain elm-ash-cottonwood and other oak-gum-cypress forest species.

Table 6—Area, scarcity, frequency, and landscape diversity, 1995, and area change and value indices, 1988–1995, Arkansas timberland

Attribute	1995 area	1988–95 change		1995			Replacement value	Value index[c]
		Area	Proportion	Scarcity[a]	Frequency	D[b]		
	Percent	*1,000 acres*	*Percent*		*Percent*		*Years*	
Planted pine								
Sawtimber	467	268	134	4.3	1.37	0.06	30	-1.7
Poletimber	827	542	190	3.7	2.43	.09	20	-3.4
Nonstocked, sapling, and seedling	546	-163	-23	4.1	1.60	.07	10	5.1
Natural pine								
Sawtimber	2,185	235	12	2.7	6.42	.18	40	-0.07
Poletimber	492	-144	-23	4.2	1.45	.06	20	9.4
Nonstocked, sapling, and seedling	567	153	37	4.1	1.67	.07	10	.1
Oak-pine								
Sawtimber	1,157	-46	-4	3.4	3.40	.11	50	29.1
Poletimber	1,052	233	28	3.5	3.09	.11	20	-.5
Nonstocked, sapling, and seedling	928	-89	-9	3.6	2.73	.10	10	6.0
Oak-hickory								
Sawtimber	2,683	463	21	2.5	7.88	.20	50	-8.5
Poletimber	2,624	-183	-6	2.6	7.71	.20	20	18.9
Nonstocked, sapling, and seedling	1,820	-422	-19	2.9	5.35	.16	10	9.7
Bottomland hardwood								
Seasonally inundated, mixed								
Sawtimber	1,882	242	15	2.9	5.53	.16	50	-1.2
Poletimber	440	-70	-14	4.3	1.29	.06	20	8.2
Nonstocked, sapling, and seedling	51	80	19	4.2	1.48	.06	10	.6
Permanently inundated								
Sawtimber	165	22	16	5.3	0.48	.03	50	2.9
Poletimber	17	-5	-22	7.6	.05	.00	20	.8
Nonstocked, sapling and seedling	29	29	2,920	7.0	.09	.01	10	.0
Nontyped, nonstocked	6	1	9	8.5	.02	.00	1	.0
All timberland	18,392	1,148	7	0.6	54.04	1.71	NA	74.9

Rows and columns may not sum to totals due to rounding. NA = non applicable.
Percent change = 100*(area 1995 - area 1988)/(area 1988 + k), where k = 1 if area 1988 = 0, 0 otherwise.
[a] Log(total earth cover area/[area with the attribute]).
[b] D = -p(log(p)) where p = frequency/100 and landscape diversity = sum(-p[log(p)]).
[c] Vulnerability*D* (replacement time) where vulnerability = scarcity - x* log(10* absolute value [percent change/7 years]) and x = -1 if area change is decreasing, +1 otherwise.

Table 7—Area, scarcity, frequency, and landscape diversity, 1995, and area change and value indices,1988–1995, Arkansas earth (land and water) cover

Attribute	1995 area	1988-95 change		1995			Replacement value	Value index[c]
		Area	Proportion	Scarcity[a]	Frequency	D[b]		
	Percent	*1,000 acres*	*Percent*		*Percent*		*Years*	
Forest land								
Timberland (from table 6)	18,392	1,148	6	0.6	54.04	1.71	NA	74.9
Nontimberland								
Productive-reserved	231	27	13	5.0	0.68	0.03	10	0.7
Other forest land	167	-69	-29	5.3	.49	.03	10	2.4
All forest land	18,790	1,106	6	.6	55.21	1.77	NA	78.0
Nonforest land and other cover								
Agriculture	11,968	-1,115	-9	1.0	35.16	.37	2	2.6
Urban and other	2,424	99	4	2.6	7.12	.19	2	.3
Marsh	38	8	28	6.8	.11	.01	2	.0
Census water	709	-1	0	3.9	2.08	.08	1	.3
Noncensus water	108	-99	-48	5.7	.32	.02	1	.2
All nonforest and other	15,247	-1,108	-7	.8	44.79	.67	NA	3.4
All earth cover	34,037	-3	0	1	100.00	2.43	NA	81.4

Rows and columns may not sum to totals due to rounding. NA = not applicable.
Percent change = 100*(area1995 - area1988)/(area1988 +k), where k = 1 if area1988 = 0, 0 otherwise.
[a] Log(total earth cover area/[area with the attribute]).
[b] D = -p(log[p]) where p = frequency/100 and landscape diversity = sum(-p(log[p]).
[c] Vulnerability*D* (replacement time) where vulnerability = scarcity - x*log(10*absolute value[percent change/7 years]) and x = -1 if area change is decreasing, +1 otherwise.

larger values than the attribute-neutral index, comparatively fewer older communities increased or increases were in younger-aged communities.

Implications

Knowledge of the spatial distribution and past change in forest land area and resource values are basic to its management. Such information indicates past natural resource management and program activities and can suggest future modifications. To make predictions, however, one must assume subsequent conditions will remain the same.

With these caveats in mind, this report's maps and indices facilitate broad area overviews useful in assessing the relative abundance or rarity of selected resource supplies, uses, or practices. Garbage or trash dumping, for example, appeared greater in specific travel corridors and at the edge of densely forested and urban or built-up landscapes, suggesting priority sites in need of litter clean-up and education efforts.

Analysis of attributes and value indices requires further investigation to assess their relevance to specific wildlife species and recreational opportunities. Some of these are addressed elsewhere, e.g., for black bears (Rudis and Tansey 1995). At the very least, however, the indices suggest increasing restrictions in the public use of largely private forests. This, in turn, may shift the demand for nonfee hunting and other forms of recreation access onto public land.

Livestock grazing on forests is in decline, but the practice persists on a fourth of the Ozark Highlands forests. There could well be an increase in timber management in this subregion if forest industries were to increase their holdings, or if silvicultural programs could accommodate apparent demand for livestock grazing on nonindustrial land.

Intensive timber management, primarily dominated by loblolly pine plantations, continues in west-central Arkansas, particularly in the Ouachita Mountains and WMCP subregions. Greater retention of fruit-bearing tree species and standing dead trees for wildlife needing them in these subregions could alleviate some wildlife conservation concerns. Reforestation efforts might be more effective at satisfying both timber production and apparent hunter demand if centered near the boundary between the MAB and western subregions.

Table 8—Percent forest and area, frequency, and landscape diversity, 1995, and area change and value indices, 1988–95, by attribute, Arkansas

Attribute	Forest area	1995 area	1988–95 change	1995		Value index	
				Frequency	Landscape diversity	Actual	Relative to forest
	Percent	*- - 1,000 acres - -*		*Percent*			*Percent*
Earth cover	NA	34,037	-3	100.00	2.43	81.4	NA
Nonforest land and other cover	NA	15,247	-1,108	44.79	0.67	3.4	NA
Forest land	100	18,790	1,106	55.21	1.77	78.0	0
Forest land attribute, decreasing in area							
No trash[a]	63	11,794	-838	34.65	1.27	122.2	57
Livestock use	9	1,730	-210	5.08	.27	37.2	-52
No fences ≤1/4 mi	52	9,784	-160	28.75	1.12	87.0	12
Primitive recreation[b]	15	2,803	-96	8.23	.41	35.5	-54
No roads, trails ≤ 1/4 mi	10	1,881	-53	5.53	.29	39.4	-49
Fire evidence ≤ 2 yrs	3	613	-47	1.80	.12	17.5	-78
Forest land attribute, increasing in area							
Forest fragments >2,500 ac	23	4,326	143	12.71	.58	39.5	-49
Urban, built-up land[c] ≤ 1 mi	11	2,005	194	5.89	.32	30.5	-61
Trail, road use ≤ 2yrs	15	2,785	202	8.18	.42	46.2	-41
Permanent water[d] on plot	10	1,911	275	5.61	.30	23.3	-70
Water[e] sources ≤1/4 mi	34	6,330	353	18.60	.79	45.7	-41
Paved roads ≤ 1/4 mi	13	2,467	481	7.25	.37	32.4	-58
Agriculture[e] ≤ 1/8 mi	31	5,773	552	16.96	.73	33.1	-58
No logging activity ≤ 2 yrs.	74	13,815	1,683	40.59	1.42	30.4	-61
Signs restricting[f]	26	4,942	2,300	14.52	.66	-5.6	-107

Rows and columns may not sum to totals due to rounding. NA = Not applicable.

[a] Garbage dump; beverage, food, or other containers; or discarded machinery, etc.

[b] An area with no trash, no recent trail or road use, and part of forest fragments >2,500 acres.

[c] ≥10 acres and defined by Anderson and others (1976).

[d] Swamp, pond, stream, or small creek.

[e] Water bodies ≥0.13 acres or courses ≥40 feet wide.

[f] No hunting, posted, keep out, no trespass, or other activity restricted.

Table 9—Percent forest and area, 1995, and change and value indices, 1988–95, by attribute and ecological subregion, Arkansas

Attribute	Forest area	1995 area	1988–95 change	State	Ecological subregion					
					MAB	WMCP	Arkansas Valley	Mountains: Ouachita	Mountains: Boston	Ozark Highlands
	Percent	*- - 1,000 acres - -*		*- - - - - - - - - - - - - - - - - - Value index - - - - - - - - - - - - - - - - - -*						
Earth cover	NA	34,037	-3	81	57	132	66	38	47	11
Nonforest land use and water cover	NA	15,247	1,108	3	2	5	4	4	3	3
Forest land	100	18,790	1,106	78	55	127	62	33	45	8
Forest land attribute, decreasing area										
No trash[a]	63	11,794	-841	124	81	183	118*	69*	53	33*
No fences ≤1/4 mi	52	9,784	-217	90	74	118	57	63*	57	37*
Livestock use	9	1,730	-206	37	12	26	19	24	26	47*
Primitive[b] recreation	15	2,803	-119	39	9*	21*	75	34	34	20*
No roads, trails ≤1/4 mi	10	1,881	-56	40	11*	25*	52	-4*	43	24*
Fire evidence ≤ 2 yrs	3	613	-44	17	7*	23*	-1*	6*	4*	3
Forest land attribute, increasing area										
Forest fragments >2,500 ac	24	4,326	143	40	17	23*	98	36	32	36*
Urban, built-up land[c] ≤1 mi	11	2,005	194	31	8*	28	31	22	21	19*
Trail, road use ≤2 yrs	15	2,785	202	46	33	63	17	70*	-6*	15*
Permanent water[d] on plot	10	1,911	275	23	9*	28	7*	34	-3*	19*
Water[e] sources ≤1/4 mi	34	6,330	353	46	40	112	11*	51	37	20*
Paved roads ≤1/4 mi	13	2,467	481	32	17	39	5*	42	24	32*
Agriculture[c] ≤1/8 mi	31	5,773	552	33	32	90	30	43	30	7
No logging activity ≤ 2 yrs.	75	13,815	1,683	30	39	73	15	30	34	2
Signs restricting[f]	27	4,942	2,300	-6*	14	-6*	-7*	-11*	-23*	-26*

Rows and columns may not sum to totals due to rounding. NA = Not applicable.
MAB = Mississippi Alluvial Basin. WMCP = Western Mid-Coastal Plains.
* ≥80 percent different relative to subregion forest land value index.
[a] Garbage dump; beverage, food, or other containers; or discarded machinery, etc.
[b] An area with no trash, no recent trail or road use, and part of forest fragments >2,500 acres.
[c] ≥10 acres and defined by Anderson and others (1976).
[d] Swamp, pond, stream, or small creek.
[e] Water bodies ≥ 13 acres or courses ≥ 40 feet wide.
[f] No hunting, posted, keep out, no trespass, or other activity restricted.

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GENERAL SESSION II

Forest Survey Data—
Ownership Implications

B.G. Blackmon, Moderator

SURVEY IMPLICATIONS FOR NONINDUSTRIAL PRIVATE LANDS

James W. Foster[1]

Abstract—The 1995 forest survey data generally indicates that the physical conditions found in the nonindustrial private forests of Arkansas have improved since the 1988 survey. There is nothing in the data to suggest the need for public policy initiatives to correct current trends in the slowly changing conditions in the forests of the State.

INTRODUCTION

In the huge body of data, which we call the forest survey, is there anything of importance to the nonindustrial forest owner? A collateral question is whether there is anything of importance about the private nonindustrial forest.

With respect to nonindustrial private forest owners, I understand a little about how most of them think. In fact, I think along the same lines myself. The reality is that most nonindustrial private forest owner decisions are made in what I call a micro-scale context.

The nonindustrial private forest owner makes short-term management decisions on the basis of what is possible and what seems to be best at the moment. In the longer term, he wants to know that his behavior is in harmony with the actions of other intelligent people. Confidence is gained by observing what other nonindustrial private forest owners do and then judging the results of that behavior. An even higher level of confidence is sometimes achieved by getting help from a competent and independent professional. The nonindustrial private forest owner takes comfort from believing that the free market system will provide a suitable reward for his land management decisions.

Is there anything of great importance to the nonindustrial private forest owner in the forest survey data? Probably not. Few will ever see the data, and most will not even know of its existence. There may be popular articles in newspapers or magazines, but, in the absence of some startling revelations and large headlines, the information will be largely unnoticed by the nonindustrial private forest owner.

Is there anything of importance about the nonindustrial private forest? The answer is an emphatic yes!

For the industrial community, it is important to know what raw materials can be produced from the forest and what will be the likely availability of the various forest products in the future. That information can be found in the forest survey data. We will take a look at some of that information in just a moment.

As a matter of public policy, the data is also quite valuable as it can show, to some degree, how well the nonindustrial private forest is fulfilling economic, social, and environmental needs. To the extent that we can predict future social needs, the data shows the capacity of the private nonindustrial forest to fulfill those requirements. Public policy makers are properly concerned with the question of whether estimated future requirements can be satisfied and, if not, what remedial action would be useful.

There are seven areas of interest in the data that I think are particularly useful to consider in connection with the private nonindustrial ownership: (a) acreage, (b) inventory, (c) condition, (d) growth, (e) removals, (f) land quality, and (g) balance.

I plan to talk a little about each category and then to conclude with a few opinions.

PRIVATE NONINDUSTRIAL FOREST ACREAGE

Table 1 shows forested acreage in nonindustrial private ownership and total forested acreage.

In all regions of the State, private forest ownership is significant, and, only in the Ouachita region where 44 percent of forests are owned by the government, is it not the dominant ownership class. For the State as a whole, 58 percent of forest land is owned by nonindustrial private owners.

An interesting side note can be made by reaching back to the 1988 data. In every region of the State, the nonindustrial private forest acreage has increased, and the percentage of the forest held by nonindustrial private landowners has increased in all but the Delta region.

PRIVATE NONINDUSTRIAL FOREST INVENTORY

There are a number of different ways to look at the quantity and quality of the forest biomass. Cubic feet in live trees does not address many of the qualitative questions, but gross volume information certainly can be useful in some of the environmental and social questions. In fact, volume in live trees is becoming of increased importance in addressing economic questions as well because the commercial acceptability of what we used to call rough, rotten, and cull material has improved considerably. I am

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Table 1—Forested area in nonindustrial private ownerships and total forest area in Arkansas for 1988 and 1995

	1988	1995
	Area in thousands of acres	
NIPF forested acreage		
Ozark	4,417.1	4,689.3
Ouachita	990.8	1,207.0
Southwest	3,018.8	3,277.1
Delta	1,367.9	1,482.6
Total	9,794.6	10,656.0
Total forested acreage		
Ozark	5,729.6	6,010.0
Ouachita	3,172.7	3,413.2
Southwest	6,445.8	6,880.5
Delta	1,899.0	2,110.0
Total	17,247.1	18,413.7
	- - - - - *Percent* - - - - -	
Percent NIPF forested acreage		
Ozark	77	78
Ouachita	31	35
Southwest	47	48
Delta	72	70
Total	57	58

NIPF = nonindustrial private forest.

Table 2—Volume in live trees in private nonindustrial forests in Arkansas for 1988 and 1995

	1988	1995
	- - *Millions of cubic feet* - -	
Softwoods		
Ozark	569.4	765.1
Ouachita	331.3	445.3
Southwest	2,282.9	2,396.8
Delta	175.9	205.1
Total	3,359.5	3,812.3
Hardwoods		
Ozark	3,146.1	3,879.4
Ouachita	614.6	804.4
Southwest	2,161.0	2,197.4
Delta	1,639.0	1,748.0
Total	7,560.7	8,629.2
Totals		
Ozark	3,715.5	4,645.5
Ouachita	946.0	1,249.7
Southwest	4,443.9	4,594.2
Delta	1,814.9	1,953.1
Total	10,920.2	12,441.5

Table 3—Percentages of NIPF forests in Arkansas stocked at 60 percent or greater

Area	Stocking: >60
	Percent
Ozark	67
Ouachita	73
Southwest	82
Delta	75
Total	73

not sure how bad a tree has to be to deserve assignment to the category of economically worthless, but I can tell you that, in every part of the State trees and even stands of trees that have been considered worthless for generations now have significant economic value.

In every region of the State, both for softwoods and for hardwoods, the total volume in live trees on private nonindustrial ownership has increased since the 1988 inventory. Table 2 reflects the increased gross wood volume in our State's private nonindustrial forests. For the State, the total volume has increased nearly 14 percent from 1988 to 1995.

THE CONDITION OF THE FOREST

One important indicator of the condition of the nonindustrial private forests is the stocking level. I have often repeated the fundamental forestry principle that the productivity of a tract of forest land is a function of stocking. To the extent that the land is occupied by suitable growing stock, it will be productive.

Table 3 shows that the nonindustrial private forest is generally well stocked with 73 percent of timberlands having at least 60 percent stocking. The forest survey specifications define optimally stocked stands as those that are between 61 percent and 100 percent stocked. By comparison, the data for all ownerships for the entire State shows 80 percent of the forest area to be stocked at the 60-percent level or higher. Obviously, the nonindustrial forest has lower stocking than public and industrial lands. This is not an unexpected fact. Ownership objectives for the nonindustrial private owners are clearly different from either industrial or government owners, and the condition of the forests should be expected to reflect those differences. There are also some land-quality differences that affect stocking levels, which will be discussed later.

NET TIMBER VOLUME GROWTH

For the State as a whole and for all regions but the Ozarks, the average net annual growth of both growing stock (cubic

feet) and sawtimber (board feet) has increased since the 1988 survey (table 4). In the Ozark region, softwood net volume growth has increased in both growing stock and sawtimber. The only declines in growth have been in the Ozark hardwood categories. Current net volume growth of hardwood growing stock in the Ozark region is down by 15.2 percent whereas net hardwood sawtimber volume growth is down by 21.7 percent.

It is interesting to note that the decline in net hardwood growth in the Ozarks has developed in spite of a 23-percent increase in hardwood live tree volume and whereas growth has exceeded harvest by 39.1 percent. There has been recent concern about some aggressive timber harvesting practices in the Ozark region. In fact, one of the most interesting parts of this symposium is the presentation by Drs. Gray and Guldin tomorrow afternoon when these very questions will be addressed.

Much of the timber harvesting that is causing concern began too late in the cycle to be reflected in the 1995 data, but it is clear that the recent aggressive cutting practices are not the cause of the volume growth decline in the Ozarks. I suspect the opposite may be true.

Table 4—Average net annual growth on private nonindustrial lands in Arkansas or all species

Area	1988	1995
Million cubic feet		
Ozark	140.2	118.9
Ouachita	33.3	48.9
Southwest	199.0	204.2
Delta	53.4	63.8
Total	425.9	435.8
Million board feet		
Ozark	471.9	369.4
Ouachita	126.9	176.6
Southwest	889.2	1,016.9
Delta	249.2	289.9
Total	1,737.2	1,852.8

GROWTH EXCEEDS REMOVALS

A measure of the direction of the changes occurring in the nonindustrial private forests is the growth vs. removal ratios. Softwood growth exceeds the harvest in every region of the State.

Table 5 shows removals and growth volumes in million cubic feet. When the question addresses the more qualitatively meaningful sawtimber growing stock instead of total growing stock, the results are the same: in every region softwood sawtimber growth exceeds harvest.

The hardwood growth/removal ratios are only a little different. When the hardwood growth/removal ratio is in totals measured in cubic feet, growth exceeds harvest in all regions but the southwest region. For the southwest region, the hardwood removals exceed growth by 41 percent and the softwood hardwood combined data indicates removal in excess of growth by 9.8 percent.

The hardwood growth/removal ratio for the higher quality sawtimber shows growth in excess of removals for the State with the overall growth exceeding removal by 15.3 percent. Only in the southwest region where the hardwood sawtimber removals are 4.4 percent over growth does sawtimber removal exceed growth.

It is occasionally useful to refer back to certain milestones to get a clear picture of where we are. In reviewing some old data, I discovered that the 1995 removals in cubic feet were higher than the 1977 removals by 35 percent and that 1995 growth exceeds 1977 growth 3.5 percent for the nonindustrial private forest.

LAND QUALITY

The quality of the forested land in nonindustrial ownership is below average for the State. Approximately 59 percent of private nonindustrial forest land is below site class 85 whereas only 46 percent of all of the other forest lands are in the 85 and lower site classes.

Table 5—Average net annual growth and average annual removal of growing stock on private nonindustrial land, 1995, in Arkansas

	Softwood		Hardwood		Total	
Region	Growth	Removal	Growth	Removal	Growth	Removal
	Million cubic feet					
Ozark	33.9	21.6	85.0	45.9	118.9	67.4
Ouachita	25.3	22.7	23.6	14.7	48.9	37.4
Southwest	141.2	135.2	63.0	88.8	204.2	224.2
Delta	6.5	5.8	57.4	37.8	67.8	43.5
Total	206.9	185.3	229.0	187.2	439.8	372.5

This fact is an important consideration when comparing the condition of the private nonindustrial forests with the conditions found in other ownerships. For example, about 74 percent of the nonindustrial ownership is found to be in either the sawtimber or poletimber size classes, whereas 79 percent of the other ownerships are found in the sawtimber and poletimber size classes.

Both longer time in regeneration stages associated with poorer land and landowner willingness to invest in less productive quality land explain, in part, the fact that there is a lower proportion of the nonindustrial private forest land occupied by the larger size classes.

A similar pattern is found in the sawtimber stocking levels where nonindustrial private owners have nearly 43 percent of their ownership stocked at a level of less than 1,500 board feet per acre whereas other ownerships have only 28 percent stocked below the 1,500-board-feet-per-acre level. Certainly this fact is explained in part by different landowner objectives, but the land quality factor is undoubtedly a part of the explanation as well.

THE BALANCE AND SENSITIVITY TEST

As reassuring as all of the above data is, there is an understandable reluctance to feel secure about the future of the nonindustrial private forest for several reasons:

1. No one is in charge. All of the various landowners, some wise, some not, are proceeding in what may seem to be a helter-skelter fashion. Certainly some of their management decisions seem poorly advised. I am not sure that this characterization is peculiar to private nonindustrial forests. I have seen both industrial and governmental situations where it was difficult to determine if anyone was in charge.

2. Individual cases of aesthetically displeasing landscapes are not difficult to find. Even cases where elevated erosion hazards exist as a result of forest management activities can be found, particularly in hill country.

3. How accurate is the data anyway? I will leave that one to other speakers but do acknowledge, in passing, that some seemingly small changes in definitions could result in significantly different conclusions based upon data differences.

So, what comfort should we take from the data with respect to the private nonindustrial forest of Arkansas? Engineers routinely use a concept called sensitivity testing. My unsophisticated interpretation of their concept is, “How responsive are the results to changes in the inputs?” or “If we are wrong, how much latitude do we have for the results to fall within the safety range?” That same concept can apply to our use of the forest survey data.

Even if we were going the wrong way, a situation not supported by the data, the margin of safety is so great as to cause little concern in the context of the present survey data.

Figure 1 shows that forest growth exceeds timber removals by a significant margin for both pine and hardwood. Granted that the marginal differences seem rather small.

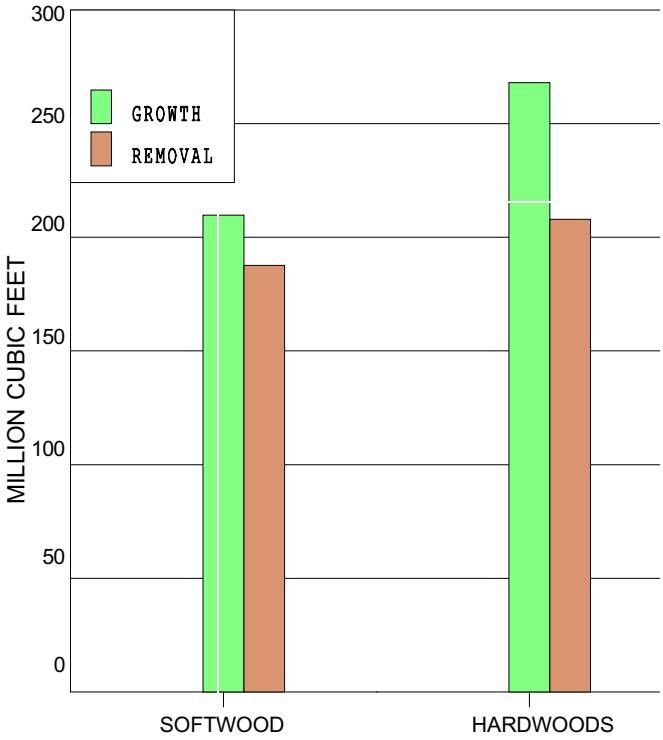

Figure 1—Timber growth and removal for nonindustrial private ownership in Arkansas.

Figure 2 is significant because it shows the timber volume removal from the forest relative to the inventory. The private nonindustrial forest is not in danger from anything that is happening now or likely to happen in the next survey cycle. If the need for change in forestry practices becomes evident at some future time, there will most certainly be ample time in which such changes can be developed with a minimum of risk to the environment or the economy of the State.

Table 6 shows the excess of growth over removals relative to inventory for softwoods and for hardwoods in all four regions of the State. The only negative figure is for hardwoods in the southwest region where the deficit is only 1.17 percent of the inventory.

The hardwood removal data suggests the possibility that some of the hardwood supply requirements from that region may shift to other regions in the future. In the alternative, more intensive culture of the hardwood forests of the southwest region may occur as a result of price escalations associated with a decline in the total regional inventory.

CONCLUSION

The forest survey data indicates that the physical condition of the private nonindustrial forests of Arkansas is improving. There are a few troublesome areas, which merit further analysis such as the growth and removal ratios in the southwest region and the decline in net annual growth in the Ozark region. Neither of these conditions is of sufficient size to indicate a problem or the need for any remedial action.

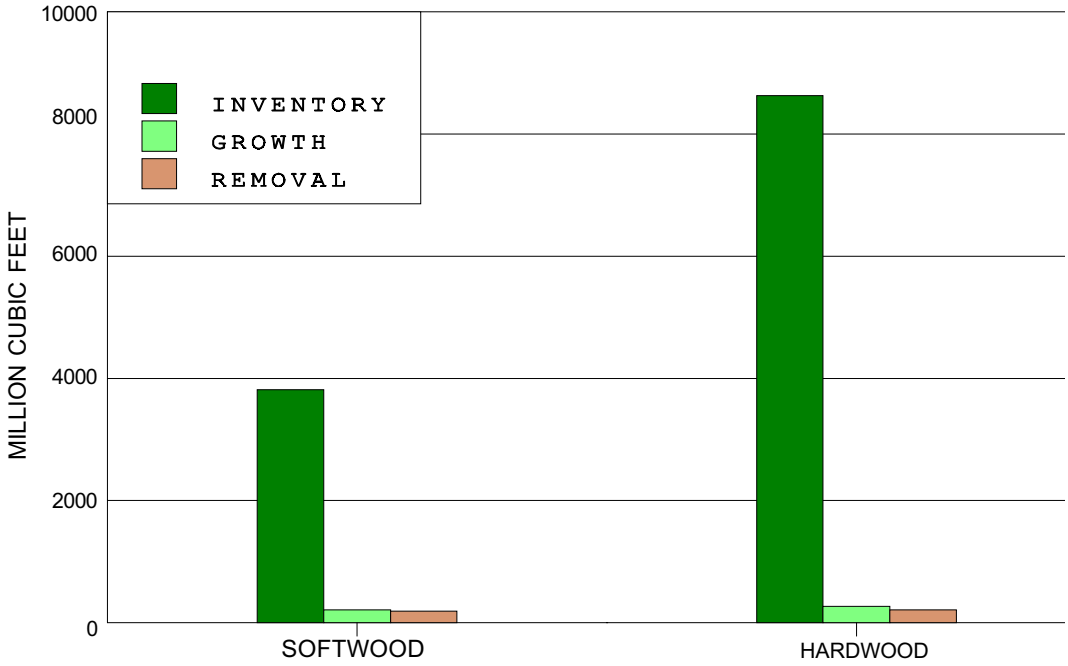

Figure 2—Timber inventory, growth, and removal for nonindustrial private ownership in Arkansas.

Table 6—Excess growth over removals relative to inventory on nonindustrial private lands in Arkansas

Region	Inventory	Excess growth over removals
	Million cubic feet	
Softwoods		
Ozark	765.1	12.3
Ouachita	445.3	2.6
Southwest	2,396.8	6.0
Delta	205.1	0.7
Total	3,812.3	21.6
Hardwoods		
Ozark	3,879.4	39.1
Ouachita	804.4	8.9
Southwest	2,197.4	-25.8[a]
Delta	1,748.0	19.6
Total	8,629.2	41.7
All woods	12,441.5	63.4

[a] 1.17 percent of total hardwood inventory for the region.

Many adverse trends that might develop in the future have self-corrective mechanisms built in. For example, harvest levels that result in reduced inventories and reduced productive capacities will result in increased scarcity and therefore relative value increases. Value increases in turn will result in better stewardship of the forest resource. It is human nature, I think, to take good care of things that have high value and carelessly treat things that have low value.

In view of the mostly positive changes in things addressed by the survey during the last survey period and the size of the resource, there should be a general predisposition against any public policy initiatives having to do with regulation of nonindustrial private timberlands, whether for environmental, social, or economic reasons. The forest survey of 1995 shows the private nonindustrial forest to be in good condition and getting better.

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IMPLICATIONS FOR THE FOREST PRODUCTS INDUSTRY

Richard A. Kluender[1]

Abstract—Major changes have occurred in the Arkansas timber economy in the last 25 years. Global and domestic demand for forest products continues to expand, doubling every 42 years. Additionally, the U.S. per capita consumption rate of forest products is over three times the world average. Production continues to expand to meet rising global demand, but timber supplies have not kept up with demand. Major reductions in public lands harvest have increased pressure on southern nonindustrial lands. Local procurement problems abound in the face of new entrants and existing mill expansions. Procurement costs continue to increase as social legislation forges an increasingly capital intensive harvesting force. Supply of roundwood falls short of rising demand. Consequently, short-term price run-ups have accelerated harvest into marginally merchantable stands. Growth-drain ratios reflect declining nonindustrial timber reserves. Long-term real price appreciation of stumpage will continue, and procurement officers will face increasing problems and expense in wooding mills.

INTRODUCTION

A broad background for understanding the 1997 Forest Inventory and Analysis (FIA) data and its relevance to the Arkansas forest products industry will be provided in this presentation. It does not dwell on dissecting the FIA data itself. Rather, a set of background conditions is presented. Further, this paper does not presume to interpret FIA data that is best analyzed at the local mill level. I do, however, paint a comprehensive picture of the position that Arkansas' forest industry is in as it enters the 21st century.

RECENT HISTORY AND ITS IMPLICATIONS INDUSTRY

Major changes have occurred in the Arkansas timber economy in the last 25 years. These include major changes and complicating factors in timber demand, technology changes in primary forest products milling as well as procurement and delivery systems, and a changing legal climate within which companies must operate. Roundwood production from the Pacific Northwest has decreased by over 4.9 billion board feet per year. Nationally, increasing portions of public lands have been locked up in wilderness or timber sales have been restricted drastically. This has put enormous pressure on the southern wood basket to pick up the slack. Major changes in mill technology and the independent contractor harvesting force have occurred as well as changes in the legal climate in which southern wood procurement takes place.

Increased Demand for Forest Products

Demand for forest products starts with population expansion. The U.S. population has expanded at a rate of 1.3 percent per year. At this rate, the population of the United States will double in 55 years. Populations of many developing counties are doubling in shorter periods. At the same time that population expands, disposable personal income is also increasing at a real rate of 2.4 percent per year or a nominal rate of 7.2 percent per year. Clearly, people have more money to spend on wood-based products. This is driven home by the fact that consumption per person in the United States continues to increase at a rate of about 1 percent, or about 0.5 ft^3, per year. The annual consumption per person in the United States is now about 77 ft^3 per year, which is more than three times that of the world average of 24.7 ft^3 per person per year.

Total U.S. roundwood consumption and production continue to rise, and we continue to consume more than we produce by 8.5 percent per year. Even though production has increased over time, we have been unable or unwilling as a country to close the gap. This is especially true in softwood lumber production and consumption where net imports have continued to exceed exports by 21 percent per year. The margin between domestic pulpwood production and consumption has narrowed over time, but we continue to import 6.4 percent more pulp products than we produce.

Now, when economists consider demand and supply for a product, they think of the traditional supply and demand curves. Normally, through short-term price adjustments, demand will equal supply. The meeting of supply and demand is at the equilibrium point. Ideally, if demand increases there will be an expansion of supply to meet the increase in demand. However, with timber-based forest products, this takes from 15 to 35 years, depending on whether you want pulpwood or saw logs. Therefore, to meet the short-term run-up in demand, price must increase with a corresponding rise in price along the short-term supply curve. What we see in the short run is a series of increases along the supply curve rather than an outward shift of the supply curve. Over time, then, the equilibrium point of log supply and demand will move as quantity demanded and prices increase. The movement, over time, of the equilibrium point leads to real-price appreciation of timber.

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This is a major benefit to the landowner, but a major source of increasing cost to the procurement forester. Long production times for timber work against real price stability in the industry.

The Harvesting Contractor Force

In 1979, only 22 percent of the harvesting force was equipped to haul long wood; but by 1996, 81 percent of the crews were long-wood or tree-length loggers. Additionally, whereas the ratio of roughly 50 percent of the total pulpwood production is being generated by 14 to 15 percent of the producer force has remained constant, the average size of contractor operations has changed significantly. The median production level has shifted from 50 cords in 1979 to 200 cords in 1987 to about 400 cords in 1996. At the same time, a terrific increase in capital investment has been required on the part of an average contractor. A $1-million investment was unheard of 20 years ago, but now it is common.

Perhaps the most astounding changes in the contractor force are shown in a recounting of contractors' demographics (table 1). Average age of the dwindling contractor force is shifting older. Today's contractors are better educated and have significantly more time in business. The force is thinning out, but new, young producers are not being attracted into the force. It is significant, however, that man-week productivity has increased from 25 to 58 cords. This is attributable to the shift in labor-capital mix. Today's producer requires more wood, larger tracts, better financing, and more sophisticated procurement foresters to understand their production problems.

Changes in Mill Technology

An economic theory, survivorship, stipulates that mills can only remain economically competitive if they possess the latest equipment and enjoy the economies of scale consistent with the latest technology. Generally, this means that primary production facilities will get larger over time to take advantage of increasing economies of scale associated with mill size. This is certainly true with the OSB industry, for example. The average size mill, and, hence, economically competitive mill, increased from just over 1 million square feet of production to almost 250 million ft^2 in 20 years. This is an average 7.5-percent increase in production capability and in wood requirements per year, per mill.

The same phenomenon has occurred in the pulpwood industry. In 1980, 52 mills consumed < 500 cords per year. However, by 1995, this number had dropped to 27. At the same time, mills requiring over 1 million cords per year increased from 9 in 1980 to 27 in 1995. These increases came through expansions and new mill construction. Clearly, the problems involved in wooding a mill of over 1 million cords per year are staggering; but the technology of decreasing marginal cost industries encourages this kind of expansion. The weight of the procurement problem in a major expansion falls on those outside the mill profit center. Procurement foresters face a horrendous problem in this atmosphere.

The mill procurement problem is compounded by the fact that yearly consumption across the South has grown steadily over time. When this happens, demand soars, working circles expand, and competition increases with associated short-term price wars and long-term supply problems.

The Changing Legal Climate of Timber Procurement

As American society has evolved from its postwar production mentality of the 1950s, numerous challenges to harvesting and procurement have arisen. Best Management Practices (BMP) and the implementation of Stream-Side Management Zones (SMZ), mandatory in some States, are still voluntary in Arkansas. However, in either fear of regulation or good social conscience, industry has adopted them. A major question arising out of the implementation of BMPs is the cost. Actually, two costs are involved. The first is the one-time loss of productive area tied up in SMZs. The second includes the increased operating costs due to the movement-restricting presence of SMZs.

Table 1—Timber harvesting contractor demographics in 1979, 1987, and 1997 in Arkansas

Demographics	1979	1987	1997
Contractor			
Average age (yr)	42.7	46.4	45.6
Education (yr)	8.8	10.5	11.9
Employees	3.2	5.7	5.4
Time in business (yr)	12.5	16.9	17.0
Median production level			
Cords per week	50.0	200.0	400.0
Average production			
Cords per week	77.1	231.1	310.5
Cords per man per week	24.7	40.6	57.5
Required capital			
investment ($)	96,500	500,000	>1,000,000

In a study at the Arkansas Forest Resource Center, I found that using a one-chain buffer on the streams tied up about 8 percent of a tract's previous timber area. This is a one-time loss to the total land area. The second cost associated with SMZs is the increase in operating cost due to restrictions in skidding patterns. SMZs can lead to suboptimal harvest layout. When we impose the SMZ no-penetration restriction, it becomes more costly to harvest tracts because of increased skidding distances. Some of this increase in cost can be diminished by the judicious use of low cost, portable timber bridges to traverse SMZs. However, not all areas have easy solutions, and operating costs are generally increased when SMZs are present.

In addition to BMPs, a general tightening of harvest regulations by local and State governments threatens to stifle procurement operational patterns. This is perhaps the greatest long-range fear that operating managers have. As a nation, we are clearly schizophrenic. Our manifest market place actions are for avaricious consumption, whereas we also choose to increasingly regulate production for environmental reasons. We may be painting ourselves into a production corner from which we cannot extract ourselves.

Summary of the Prevailing Conditions

Increasing demand alone would present enough problems for forest industry. But, when this is exacerbated by (1) decreased production in the PNW; (2) rising real prices for stumpage; (3) fewer, but more capital intensive harvesting contractors; (4) increasing mill requirements; (5) a decreasing land base; and (6) increasing harvest restrictions, two facts emerge. First, the problems of producing, aggregating, and delivering sufficient quantities of wood to mills will increase exponentially in the future. Second, there will be an associated rise in procurement cost due to economic scarcity of roundwood.

BASIC ECONOMIC QUESTIONS

Market economists are concerned with questions of allocation and distribution. Allocation questions are ones of production: who will produce the goods and at what cost? Distribution questions are ones of the flow of products: who gets the goods and services and at what cost? An additional question is that of *Qui Bono*?, or who benefits?

For society and the forest products industry in Arkansas the questions are

- Who will grow the wood?
- Will quantities be sufficient to provide adequate shelter and other wood-based products?
- How much will it cost?
- Is this production—consumption level sustainable?
- Are existing incentives to invest in forestry sufficient?

THE ARKANSAS FOREST CONDITION

The preamble to this point has been long, didactic, and, perhaps, too abstruse. But, without the background it is hard to appreciate Arkansas' forest industry position. The forest land distribution by ownership in the state shows only slight changes in all categories since 1987 (table 2). The 2-million-ac increase in the nonindustrial ownerships is due to CRP and SIP plantings, as well as improvements in reporting. The important statistic, however, is the approximate percentage of forest land by ownership because this provides some fundamental insights into the problem of production allocation.

When we look at softwood growing stock by ownership, there have been some subtle, but significant shifts since the 1987 study (table 3). Harvest percentages were not in line with growing-stock inventories in 1987, and the gap between inventory and harvest has grown in the 1997 study. Specific warning signs include the shift in harvest percentage on nonindustrial lands and the continued reduction in harvest on public lands. The softwood growth-

Table 2—Distribution of Arkansas forest land by major landowner group, 1987 and 1997

Landowner group	1987		1997	
	Million acres	*Percent*	*Million acres*	*Percent*
Industry	4.32	27	4.53	25
Nonindustrial	8.64	55	10.65	58
Public	2.88	18	3.20	18

Table 3—Distribution of Arkansas' softwood growing stock, harvest source, and growth-to-drain ratios by landowner group, 1987 and 1997

Landowner group	Growing stock		Harvest		Growth-to-drain ratio	
	1987	1997	1987	1997	1987	1997
	Percent					
Industry	39.0	37.6	51.0	48.4	1.2	1.4
Nonindustrial	40.0	40.0	39.0	43.4	1.5	1.1
Public	21.0	22.4	9.0	8.2	1.3	1.7

drain ratio has improved on industry lands since 1987. This is due primarily to plantations coming on line. However, the increasing heavy reliance on nonindustrial lands for softwood furnish has knocked the growth-drain nonindustrial ratio from 1.5 to 1 (1987) to 1.1 to 1 (1997). Clearly, if this marginal change continues in the same direction, we will soon be mining nonindustrial softwood reserves.

For hardwood growing stock, there have been some major changes since 1987 (table 4). Industry has maintained its position of eliminating upland hardwoods from pine sites. This is revealed in a major shift in growing-stock percentage decrease from 23 to 15.6 percent. This reduction in total hardwood growing stock has in turn shifted the percent hardwood allocation for the nonindustrial lands from 56 percent of the hardwood inventory in 1987 to 59.5 percent in 1997. Specific warnings for hardwood include a growth-drain ratio of < 1.0 on industry land, a reduction of the growth-drain ratio from 2.3 to 1.2 to 1 on nonindustrial lands, and an increase of growing stock, and the growth-drain ratio on public lands.

Total softwood and hardwood growing stock shows the same patterns that were present in the individual components but highlight the problem of falling growth-drain ratios on industry and nonindustrial lands generated by reductions in the public land harvest (table 5). It is difficult to try to balance public harvest reductions by increasing harvest on nonindustrial lands to meet mill needs. The result is obvious in the falling aggregate nonindustrial growth-drain rate.

Questions of allocation will always be present in supply-side economics. Although the Arkansas industry is only a subset of a much larger industry, the problems of increasing demand on a diminishing base are apparent.

The distribution of acres by site class by ownership shows that, in aggregate, the best sites belong to forest industry. The mode for industrial sites is in the 85- to 120- ft^3-per-year class, whereas nonindustrial sites are more heavily concentrated in the 50- to 85-ft^3 class. Part of the explanation for this lies in the concentration of nonindustrial sites in the Ozarks, but, the nonindustrial sites, in aggregate, are just not capable of producing as much timber annually as industrial sites are. This is significant considering the demands being made on nonindustrial sites to replace public land production.

The perennial problem of low stocking on nonindustrial lands continues. Twenty-six percent of nonindustrial lands are 60 percent or less stocked, and 82 percent are at < 100 percent stocking. In contrast, industrial lands are 64 percent < 100 percent stocked. However, the majority of these industry lands is in plantations or young growth and is entering or is on the steepest part of the growth curve. Nonindustrial lands, on the other hand, suffer from the perennial cut and leave syndrome. We know this because

Table 4—Distribution of Arkansas' hardwood growing stock, harvest source, and growth-to-drain ratios by landowner group, 1987 and 1997

Landowner group	Growing stock		Harvest		Growth-to-drain ratio	
	1987	1997	1987	1997	1987	1997
	- - - - - - - - *Percent* - - - - - - - -					
Industry	23.0	15.6	29.0	28.3	2.0	0.6
Nonindustrial	56.0	59.5	62.0	68.3	2.3	1.2
Public	21.0	24.9	9.0	3.4	4.4	7.8

Table 5—Distribution of Arkansas' total growing stock, harvest source, and growth-to-drain ratios by landowner group, 1987 and 1997

Landowner group	Growing stock		Harvest		Growth-to-drain ratio	
	1987	1997	1987	1997	1987	1997
	- - - - - - - - *Percent* - - - - - - - -					
Industry	30.0	25.1	44.0	40.5	1.3	1.2
Nonindustrial	49.0	51.1	47.0	53.1	1.8	1.2
Public	21.0	23.8	9.0	6.4	2.6	3.0

of the concentration of nonindustrial stands in the pole class. Equally apparent, from this figure, is the concentration of sawtimber-sized trees in public ownership. The balance of stocking, size-wise, for nonindustrial lands is not as good as industrial lands. Finally, the aggregate growth rate for nonindustrial softwood is significantly lower than for industry.

Lower growth rates, low stocking densities, a predominance of pole-size timber, and decreased growth-drain ratios for both softwood and hardwood indicate that nonindustrial forests are under extreme pressure. Given continued increases in demand, increasing mill requirements, and the inherently long growing cycles for trees, the aggregate statistics will probably worsen in the future.

IMPLICATIONS FOR THE FOREST PRODUCTS INDUSTRY

Although the changes in acreage categories are not significant, the utilization pattern is. Public demand has all but shut down public lands as an industrial timber base. Regardless of whether you view the long-term effects from an ecological or industrial production standpoint, these forests clearly have been dedicated to other uses. The current production allocation problem is how to replace the loss from public forests. The first response by industry has been short-term price run-ups along the supply curve as we are currently facing. However, this will not answer the long-term challenge of shifting the supply curve to the right to provide more timber at all prices. In the absence of reopening public lands, the challenge clearly is that of bringing the aggregate productivity of all private land to its maximum potential. In most cases, at least when we consider softwood, industry has done, or is doing this. Growth-drain ratio changes are evidence of this. Whereas industrial lands are not yet at the 95 percent percentile, they are nearing their maximum productivity.

The largest area for marginal improvement obviously is raising aggregate productivity on nonindustrial lands. Nonindustrial productivity is much higher in Georgia and Virginia where strong industrial leadership has brought about significant changes in nonindustrial stocking and productivity. Some Arkansans take pride that their nonindustrial lands have been managed on a “harvest and take what God provides” basis. Decreasing growth-drain ratios in the face of ever increasing demand portends the disaster of this thinking in the long run.

New technology, such as OSB, gave the industry some breathing room by using smaller diameter trees to make a panel product that could compete with southern plywood. This is fine as far as it goes. Modern pulping technology can accommodate juvenile wood from short rotations. The only problem, again, is productivity. The challenge is in developing harvesting and mill systems capable of processing multiple low-volume stems in order to maintain high volumes per hour. Finger splicing, laminate construction, and inside-out beams for dimension stock can provide us with new solutions to declining saw-log size. But the basic and most serious challenge remains: how to produce more wood out of fewer acres faster.

Shorter rotations on some industry and responsive nonindustrial lands will help fill this need. But, Arkansas has had a long tradition of providing high-quality dimension stock from its sawmills. As the last of the big pines are cut, this competitive edge will evaporate; and we will be left with fewer and fewer acres of sawtimber growing stock on our nonindustrial lands.

It is a common belief among industrial foresters that most nonindustrial landowners are poor managers. Active nonindustrial landowners counter this challenge and point out that they are following and responding to market forces. They challenge the industry to pay more for stumpage and to provide better management incentives. Perhaps they are correct. It is not hard to sell timber management when log prices are $450 / MBF Doyle, and internal rates of return appear to be 15 percent or so. But, it is surprisingly easy for a landowner to just let things grow at $240 / MBF, as it was in September 1996, if they don’t have a current fiscal emergency.

In order to shift the supply curve to the right for nonindustrial lands, either a significant number of new acres must be planted or regeneration must be keyed to harvest. As industry knows, this is the principal method of increasing productivity of forest land. Industry has been doing this on their own lands for years, strongly believes in it, and would find it anathema to let a 100-ac tract lay out of production for 2 years without regenerating it in some way. Given increasing demand for wood products, perhaps it is time to consider this mentality for nonindustrial lands as well.

SUMMARY AND CONCLUSIONS

World demand for forest products will continue to increase. U.S. consumption will continue to rise as well and at a rate greater than the world average. Arkansas’ forest products industry will be under continuing pressure to increase production to meet this demand. Increasing mill size and increasing capital intensity of harvesting contractors have compounded procurement problems. These requirements, coupled with real price appreciation for forest products, will increase the cost of supplying mills in the future.

Arkansas’ forests have undergone major changes in utilization since the last survey. Public forests have largely been pulled out of the commercial timber base. This has shifted the supply burden to industrial and nonindustrial lands. Sharp declines in industrial hardwood and nonindustrial softwood and hardwood growth-drain ratios reflect extreme pressure on the commercial forest base. Industrial lands are near full productivity, but nonindustrial lands continue to show signs of lack of postharvest regeneration and generally lower stocking levels than industry lands. Baring major changes in nonindustrial management activities, growth-drain ratios will continue to fall, and inventory mining will commence. A major campaign, spearheaded by forest industry, could help in reforestation of nonindustrial lands. A major component of this would be tying regeneration to harvest of forest lands.

SURVEY IMPLICATIONS FOR PUBLIC FOREST LANDS

James M. Guldin[1]

Abstract—Public timberlands represent the smallest of major ownership classes in Arkansas; of the State's 18.38 million ac of timberland, the public owns 3.198 million ac, or 17.4 percent. Of that total, > 85 percent is in Federal ownership (70.8 percent in national forests). State lands account for 12.4 percent, and county and municipal lands, about 2 percent. Compared to other ownerships, public timberlands have higher levels of stocking, more area in sawtimber, and higher per-acre growing-stock and sawtimber volumes. Site quality in the national forests is poor relative to other public lands, where the difference between upland and bottomland physiography is somewhat higher. By total area, hardwood forest types dominate National Forest System lands in the Ozark and Ouachita regions. The archetypal species groups are shortleaf pine in the Ouachitas and hard hardwoods in the Ozarks. In both regions, the archetypal species groups show growth that is slightly less than the State average, removals that are much lower than the State average, and, as a result, a growth surplus that is from two times to three times greater than the State average. As described in the Forest Inventory and Analysis reports, data suggest two elements of concern about timberland conditions on national forest lands in Arkansas: removals exceed growth in the planted pine component of the Ozark region, and stands tend to be overstocked in the Ouachita region. Nevertheless, the data support the hypothesis that the public sector in general, and the national forests in particular, support timberlands with larger trees than other ownership classes in the State.

INTRODUCTION

The public forests of Arkansas are among the State's most valued treasures. Many attribute Arkansas' identity as "The Natural State" to its forested nature and the many resources that its forests provide. Public forests include Federal, State, county, and municipal ownerships. However, management objectives within and among these different ownership categories differ with respect to tract size, management philosophy, and constraints related to social, economic, and legal issues of governance.

Federal forest ownership in Arkansas includes the Ouachita National Forest and the Ozark-St. Francis National Forest, which are managed by the Forest Service, an Agency of the U.S. Department of Agriculture. The U.S. Department of the Interior has jurisdiction over seven national wildlife refuges (managed by the U.S. Fish and Wildlife Service) and several national parks, scenic rivers, historic sites, and military parks (managed by the National Park Service). A third Federal agency, the Department of Defense, manages timberland on several large military installations, including (as of 1995) Fort Chaffee, Camp Robinson, Little Rock Air Force Base, and the Pine Bluff Arsenal. The U.S. Army Corps of Engineers, which is also under the Department of Defense, manages the dozen or so artificial impoundments of Arkansas waterways and the recreational lands that adjoin them.

State ownership includes an extensive system of nearly 50 wildlife management areas that, under the Arkansas Game and Fish Commission, encompass roughly 350,000 ac. The State owns 48 State parks, which are managed by the Arkansas Department of Parks and Tourism. Other significant State holdings include the 10,000-ac Poison Springs State Forest, which is managed by the Arkansas Forestry Commission; lands managed by the Arkansas Natural Heritage Commission; and several forested tracts managed by the University of Arkansas System.

County and municipal forest lands constitute the smallest share of public ownership and provide primarily local outdoor recreation. If such lands qualify as timberland according to Forest Inventory and Analysis (FIA) standards, they would be included in these data.

The author has used results from the 1995 FIA Report for the State of Arkansas to characterize public forest lands. However, the FIA sample design limits the ability to make detailed interpretations across ownership categories. For example, each plot cluster represents, on average, 5,760 ac of forest. At this sampling intensity, the Poison Springs State Forest would be represented by only two plots, which could not accurately characterize current conditions, much less long-term changes in so small a tract. Nor can it facilitate comparison with other ownerships of small aggregate acreage.

Therefore, only the broadest characterizations of ownership are considered in this paper. The author's objectives are to quantify broad attributes of public forest lands in Arkansas relative to both the general conditions of the State's forests and the public sector data from earlier FIA reports.

METHODS

General Attributes of Public Forest Lands

In general, the national forests are the most actively managed public lands in Arkansas. Therefore, the public

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forest database was divided into two ownership classes—national forest and other public. Available FIA data for the State (London 1997) and the four Regions in the State (Rosson and London 1997a, 1997b; Rosson and others 1995, 1997) were used to compare attributes of these two ownership classes with regional and statewide averages. Several comparisons between 1988 and 1995 were possible using the 1988 FIA statewide report (Hines and Vissage 1988) and the 1988 Ozark region and Ouachita region reports (Hines 1988a, 1988b). A few long-term comparisons were made with statewide tables from 1959, 1969, and 1978 (Hedlund and Earles 1970, Staff of Renewable Resources Evaluation Research Work Unit 1979, Sternitzke 1960).

Attributes of National Forest System (NFS) Lands

The FIA regions do not exactly correlate with the national forests' boundaries. For example, national forest land in the 10-county Ouachita region FIA report includes not just the Arkansas portion of the Ouachita National Forest but also the Magazine Ranger District (RD) of the Ozark National Forest. It excludes, however, several thousand acres of Ouachita National Forest land in the southwest Arkansas FIA region, and excludes the entire Oklahoma portion of the Ouachita National Forest. Similarly, the FIA's 17-county Ozark region includes all of the Ozark National Forest north of the Arkansas River, but does not include the St. Francis National Forest, which lies in the Delta region. Thus, Ozark region data used here exclude the Magazine RD and the St. Francis National Forest; Ouachita region data include the Magazine RD, and exclude a fringe of national forest land along the southern border of the Ouachita National Forest as well as all Ouachita National Forest lands in Oklahoma.

Assumptions Made During Data Manipulations

Standard FIA definitions were used throughout this report (Beltz and others 1992). For example, understocking is used to describe stands having < 60 percent stocking; overstocking was used to describe stands having > 100 percent stocking.

The author defines "growth surplus" (called "net change" in FIA publications) as the difference between growth and removals (see core tables 20 and 23, Rosson and London 1997a). For purposes of this paper, growth, removals, and growth surplus were converted from the total region or statewide volume means presented in FIA publications to mean volumes per acre by dividing the total timberland volume data by timberland acreage in the respective sector (see core table 3 in Rosson and London 1997a).

It should be emphasized that transformations from total volume to average per-acre volume data may not reflect the actual per-acre data gathered in the field. Rather, the data reflect an averaging of all forested acres, not the average condition of a typical acre of forest in the State.

RESULTS

Statewide Analysis

Public forest land area—The public lands of Arkansas constitute the smallest of the major ownership groupings in the State. Of the 18.38 million ac of timberland, the public owns 3.198 million ac, or 17.4 percent. Compared to information in the 1988 FIA report, this represents a 122,800-ac increase but a decline of 0.4 percent of total timberland, largely because of increases in nonindustrial private forest (NIPF) timberlands (Foster 2001).

Public lands include those within Federal, State, county, and municipal ownership. Of the 3.2 million ac of public lands, > 85 percent is in Federal ownership—70.8 percent in the NFS and 14.7 percent in other Federal ownership, including the National Park Service, U.S. Fish and Wildlife Service, and the Department of Defense. State lands (State parks, wildlife management areas, and one State forest) account for 12.4 percent of timberland and county and municipal lands, 2.1 percent.

Forest inventory data show that since 1959, the NFS landbase has declined slightly (fig.1). This decrease is not reflected in data kept by the national forests. For example, in its annual end-of-year reports, the Ouachita National Forest showed an increase of just under 48,000 ac between the end of fiscal year 1988 to the end of fiscal year 1995. The difference reflects a change in the way that FIA determined national forest acreage. In 1988, NFS acreage was calculated directly from the FIA sample; in 1995, it was based on enumerated data provided by the two national forests.

Conversely, the other public sector has expanded since 1959 (fig.1), especially since 1978. This reflects the addition of several large national wildlife refuges (Felsenthal and White River) to U.S. Fish and Wildlife Service holdings in the State.

Species composition, stocking, and site quality—Differences in overall forest composition are apparent between the national forest and other public categories (table 1). National Forest System lands have higher percentages of softwood, oak-pine, and oak-hickory than the State as a whole. This reflects the upland geology and forest types common to the Interior Highlands. The other public lands have over 50 percent of their forest area in the oak-gum-cypress forest type, 40 percent in other hardwood types, and only 10 percent in pine. This reflects the bottomland hardwood influence in the Federal wildlife refuges and many of the State wildlife management areas of that sector.

One method that FIA uses to report stand density is by percent stocking, a relative value that assumes an established stocking standard. The higher the number, the more densely stocked the stand; optimally stocked stands fall within the 60 to 100 percent stocking class. Overall, public timberlands have better stocking than is found on other Arkansas timberland (table 1). The national forests have a slightly higher percentage of area in optimal stocking than the statewide average, and other public lands have a slightly lower percentage. The national forests have much less understocked area than the State average, a reflection of the attention that Forest Service professionals and technicians give to proper forest management. Understocked stands in the other public sector exceed the

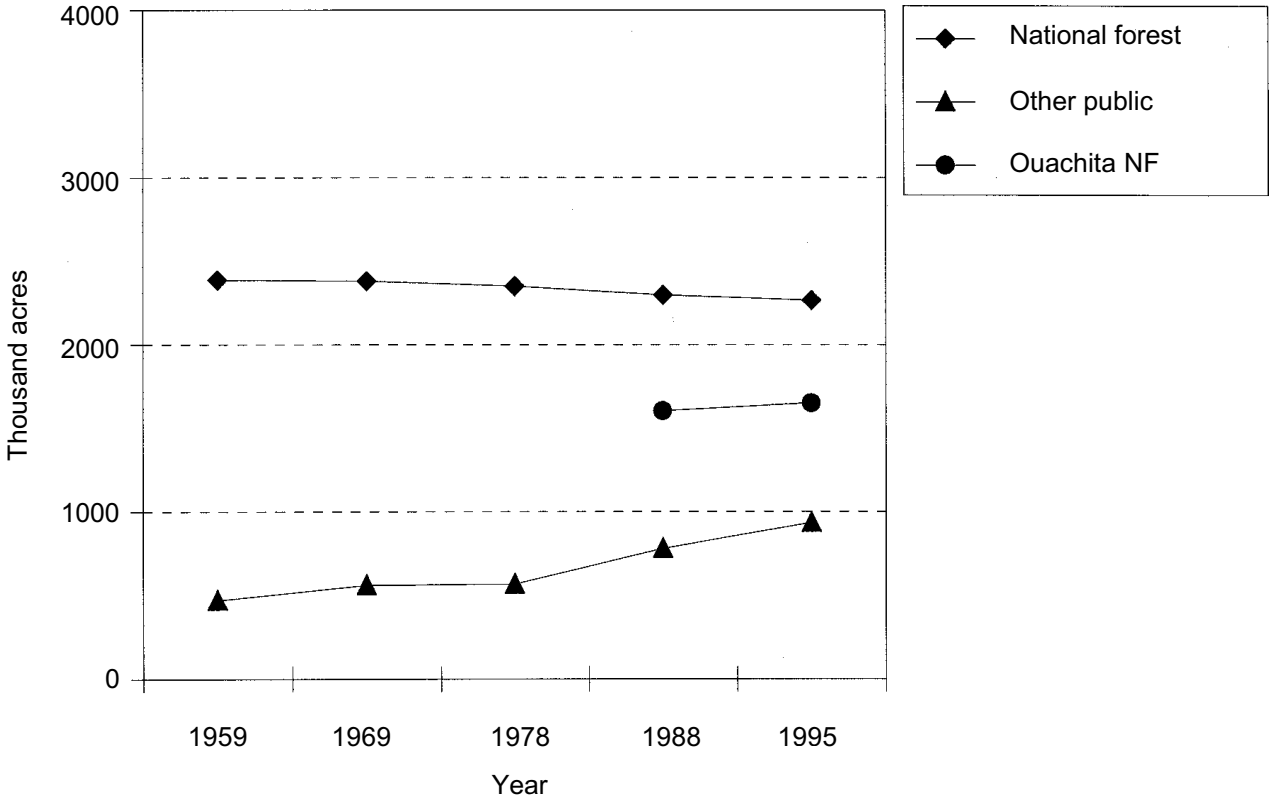

Figure 1—Area of public timberland in Arkansas 1959–1995, for the national forest sector and the other public sector, according to forest survey results, compared with data reported in FY88 and FY99 by the Ouachita National Forest.

Table 1—Species composition, stocking, and site quality for the national forest and other public sectors compared to statewide averages in Arkansas

Stand characteristics	National forest	Other public	Statewide
		Percent	
Species composition			
Loblolly-shortleaf	34.0	10.0	27.5
Oak-pine	19.0	9.9	17.1
Oak-hickory	46.4	21.6	38.8
Oak-gum-cypress	.5	54.0	15.3
Elm-ash-cottonwood	0	4.5	1.3
Stocking			
>130	4.3	1.3	3.4
100–130	30.4	24.6	20.2
60–100	57.5	51.7	55.5
16.7–60	7.8	21.9	19.9
<16.7	0	.6	.9
Site quality (cubic feet)			
>165	0	11.4	4.8
120–165	2.6	13.9	14.0
85–120	16.0	34.9	27.5
50–85	64.0	28.7	38.7
<50	17.4	11.1	15.0

State average only slightly. More than a third of the timberland area in the National Forest System, and 25 percent in the other public sector, is overstocked relative to the statewide average.

Conventional wisdom holds that public timberlands occupy poor-quality sites. Recent FIA data bear this out for national forest lands but not for other public ownership (table 1). Over 80 percent of NFS timberland is classified as capable of growing < 85 ft^3 per acre (about a cord per acre) per year compared with just over 50 percent statewide and only 40 percent on other public timberlands. Conversely, the highly productive bottomland influence is apparent on other public timberlands; 25 percent of the total land area is in the two best site classes, compared with < 20 percent statewide.

Size-class distribution and standing volume—The stand size-class distribution of public timberlands differs from State averages (table 2). Both the national forest category and the other public category have a smaller percentage of timberland in the seedling-sapling and the poletimber-size classes. However, the national forests and the other public timberlands have 15 percent and 20 percent more forest area in sawtimber, respectively, than the statewide average.

Growing-stock volume by species group is consistent with these data (table 2). Compared with the statewide average, the public timberlands have a smaller proportion of growing-stock volume in planted pines and a larger proportion in hard hardwoods (oaks and hickories). Other public

timberlands have more soft hardwood volume and less natural pine volume than the statewide average. Conversely, the national forests have a smaller percentage of soft hardwood growing-stock volume and growing-stock volume that is more natural. Moreover, these data show that both public ownerships have a greater percentage of growing-stock volume in hardwood than in conifers: 51 percent on national forests and over 80 percent in the other public sector.

Sawtimber volume trends by ownership are similar to trends in growing-stock volume (table 2). Both public ownership categories show markedly less than average area in stands with volumes < 1,500 board feet per acre, with other public forests having slightly larger proportions in this volume class than national forests. Both are about the same as the State average in the 1,500 to 5,000 board foot per acre category. Again, both show about 20 percent more area than the statewide average in the category of stands having > 5,000 board feet per acre.

Growth, removals, and growth surplus—Public sector growing-stock volume growth per acre is less than the statewide average in both planted pine and natural conifers (table 3). This is due to the difference in distribution and growth of shortleaf pine (*Pinus echinata* Mill.) and loblolly pine (*P. taeda* L.) across the State. Shortleaf pine is the dominant conifer in both plantations and natural stands on public lands in Arkansas, especially in the Ouachita and Ozark regions. Conversely, loblolly pine dominates the Upper Coastal Plain sites of the Southwest Region, and is also commonly planted in private ownerships statewide.

Natural stands of shortleaf pine in the Interior Highlands grow at roughly two-thirds the rate of natural stands of loblolly pine on the Coastal Plain, and the differences in plantation growth are probably even greater between the species. However, hard hardwood growth per acre in both public ownership classes exceeds the State average.

Growing-stock volume removals per acre on public ownerships are less than the statewide average across all four species groups (table 3). To some extent, it might be expected that removals are less where growth is less. Other reasons for lower removals on Federal lands may be the presence of forest management plans and a more conservative approach to forest management than is generally the case for private lands.

Growing-stock net growth (growth minus removals) in both public sectors markedly exceeds statewide averages, with the prominent exception of the planted pine species group (table 3). Hard hardwood growth in both is four times the statewide average, and natural conifer growth is six times the State average. However, planted pine net growth on public timberlands is < 25 percent of the net growth statewide. This may be due, in part, to the high net growth

Table 2—Size-class distribution by size class, standing growing-stock volume, and standing sawtimber volume for the national forest and other public sectors compared to statewide averages in Arkansas

	National forest	Other public	Statewide
Size-class distribution (percent of ownership)			
Size class			
Seedling-sapling	9.7	14.7	23.8
Poletimber	29.0	17.5	29.8
Sawtimber	61.3	67.9	46.3
All size classes	100.0	100.0	100.0
Growing-stock volume			
Species group (cubic foot per acre)			
Planted pine	69.8	67.3	94.4
Natural conifer	714.5	244.0	409.4
Soft hardwood	128.8	447.0	198.8
Hard hardwood	710.2	804.7	472.9
All species	1,623.4	1,562.9	1,175.7
Sawtimber volume distribution (percent of ownership by sawtimber volume class)			
Volume			
<1,500 bf/ac	17.1	22.9	36.5
1,500–5,000 bf/ac	32.0	23.7	30.6
>5,000 bf/ac	50.9	53.4	32.9
All volume classes	100.0	100.0	100.0

Table 3—Growth, removals, and growth surplus for growing stock in the indicated species group for the national forest and other public sectors compared to statewide averages in Arkansas

Species group	National forest	Other public	Statewide
	- - - - - *Cubic feet per acre* - - - - -		
Growth			
Planted pine	2.7	1.6	8.7
Natural conifers	17.4	12.5	18.5
Soft hardwood	2.7	8.0	5.0
Hard hardwood	17.4	22.0	12.6
All species	40.2	44.2	44.7
Removals			
Planted pine	1.5	.7	3.7
Natural conifers	11.2	6.0	17.6
Soft hardwood	.3	3.5	4.8
Hard hardwood	2.7	6.5	9.2
All species	15.8	16.8	35.3
Growth surplus			
Planted pine	1.2	.9	5.0
Natural conifers	6.2	6.5	1.0
Soft hardwood	2.4	4.5	.1
Hard hardwood	14.6	15.5	3.4
All species	24.4	27.4	9.5

rates of pine plantations in the private sector (18.8 ft^3 per acre).

Trends in sawtimber volume growth per acre parallel those of growing stock per acre, with some exceptions. Sawtimber growth is slightly less than the statewide average in both public ownership classes, with natural conifer growth per acre far greater than plantation sawtimber growth (table 4). Hard hardwood sawtimber growth on national forest lands, and both soft hardwood and hard hardwood growth in the other public ownership class exceeds the statewide average.

Sawtimber removals on public lands are less than statewide averages in all species groups (table 4). In the other public sector, removals are only slightly less than statewide averages for both hardwood groups; in the national forest sector, removals are slightly less for the planted pine group. Natural pine removals are about half the statewide average in both sectors.

Sawtimber net growth is greater on public lands than the statewide average for the hardwood and natural pine groups (table 4). For both public ownership classes, net growth in the natural pine group is about twice the State average, and net growth in the hard hardwood group is about four times the State average. However, planted pine net growth in both classes is less than the State average. On the national forests, planted pine sawtimber removals exceed growth by a small margin. However, this difference is not statistically significant.

Ozark-Ouachita Region Comparisons

Public land area—Recent FIA data show that the total timberland area in public ownership in the 10-county Ouachita region is just over 1.5 million ac, compared with 1.15 million ac in the 17-county Ozark region. However, the total timberland area of the Ozark region, at just over 6 million ac, is nearly double the size of the Ouachita region, at 3.4 million ac. Thus, 44 percent of the Ouachita region is in public ownership, but only 19 percent of the Ozark region (fig. 2). The other ownership classes also show prominent differences.

Conversely, the distribution of timberland by ownership category within the public ownership classes is remarkably similar in both regions (fig. 3). National forests constitute roughly 85 percent of the area, other Federal lands < 10 percent, and county and municipal lands < 1.5 percent. State holdings are larger in the Ozarks than in the Ouachitas, mostly due to a more extensive network of State wildlife management areas.

National forest species composition and stocking—Hardwoods occupy the majority of timberland acres in both FIA regions (table 5). The dominance of hardwoods is not surprising in the Ozark region. Some might consider it surprising that hardwood timberland area exceeds that of conifers in the Ouachita region because the Ouachita

Table 4—Growth, removals, and growth surplus for sawtimber for the indicated species group by ownership compared to statewide averages in Arkansas

Species group	National forest	Other public	Statewide
	- - - - - - Board feet per acre - - - - -		
Growth			
Planted pine	5.5	8.6	19.2
Natural conifer	97.7	73.7	101.2
Soft hardwood	6.8	41.7	19.5
Hard hardwood	59.9	87.3	45.8
All species	169.8	211.2	185.8
Removals			
Planted pine	7.5	2.7	11.5
Natural conifer	52.2	29.0	83.5
Soft hardwood	1.0	11.5	15.5
Hard hardwood	7.1	27.6	33.5
All species	67.8	70.9	144.0
Growth surplus			
Planted pine	-2.0	5.9	7.7
Natural conifer	45.5	44.7	17.7
Soft hardwood	5.8	30.2	4.0
Hard hardwood	52.8	59.7	12.4
All species	102.1	140.3	41.8

Table 5—Species composition, growing-stock volume, and stocking by area for the national forests in the Ozark and Ouachita regions of Arkansas compared to statewide averages across all ownerships

Stand characteristics	Ozark region	Ouachita region	Statewide
Species composition (percent of timberland area)			
Conifer types	14.4	48.1	27.5
Hardwood types	85.6	51.9	72.5
Growing-stock volume (cubic feet per acre)			
Planted pine	43.3	90.9	94.4
Natural conifer	275.6	1,043.9	409.4
Soft hardwood	197.5	71.1	198.8
Hard hardwood	1,096.7	423.2	472.9
All species	1,613.1	1,629.1	1,175.6
Stocking (percent of timberland area)			
>130	1.3	6.6	3.4
100–130	29.6	31.2	20.2
60–100	60.8	55.0	55.5
16.7–60	8.4	7.2	19.9
<16.7	0	0	.9

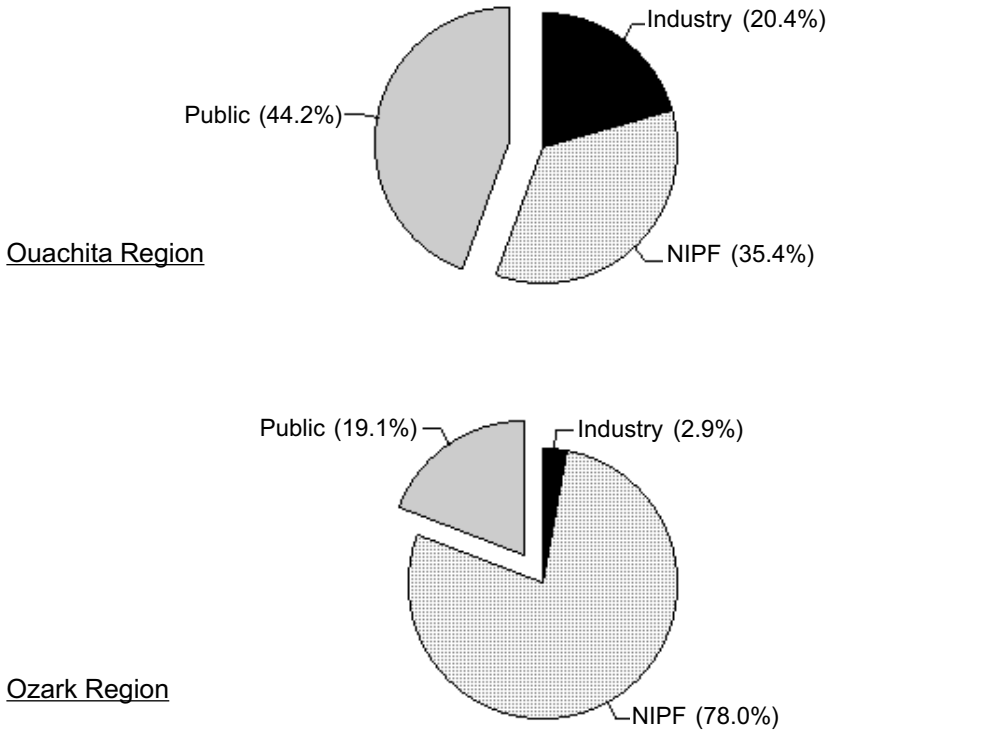

Figure 2—Percent of timberland by ownership in the Ouachita and Ozark regions.

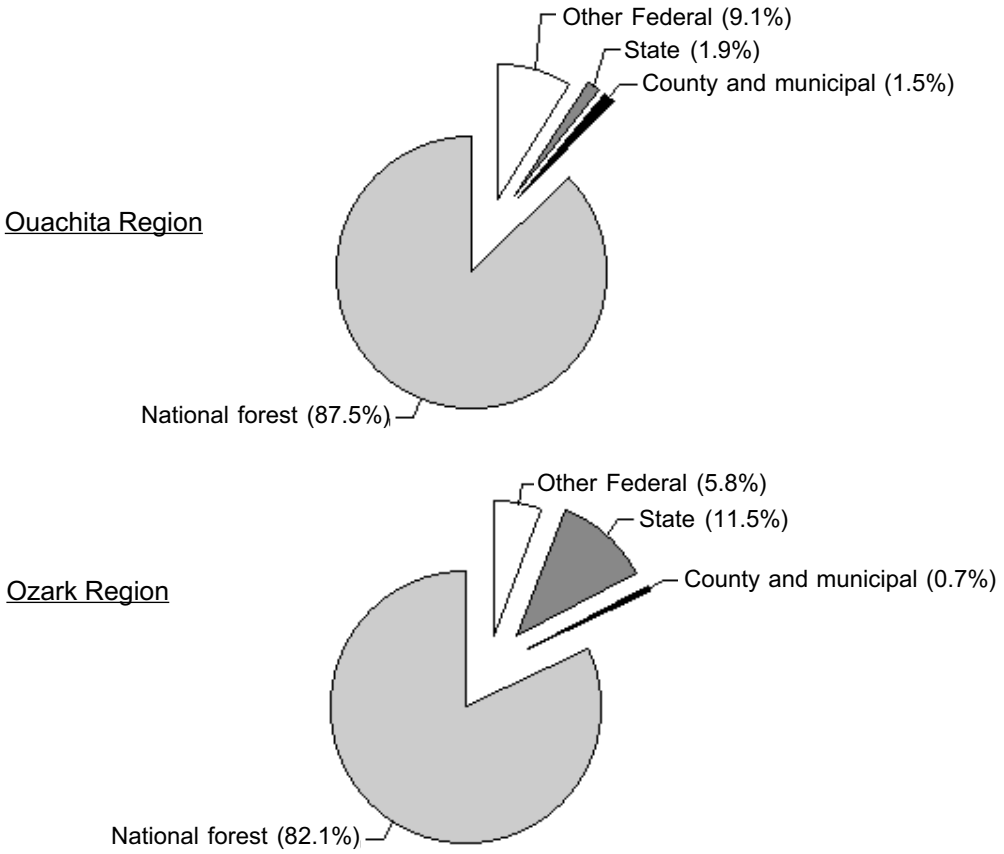

Figure 3—Percent of timberland in several ownership categories within the public sector in the Ouachita and Ozark regions.

Mountains have such a prominent shortleaf pine component. But FIA data from 1988 also show that hardwood timberland area slightly exceeded that of conifers. The total national forest timberland area in the Ouachita region increased from 1.31 million ac in 1988 to 1.32 million ac in 1995. The increase, which is not significant, is the result of a 55,000-ac increase in pine timberland area offset by a 44,000-ac decline in hardwood timberland area.

The total growing-stock volume on national forest lands is similar within the two regions. The average stand has just over 1,600 ft^3 per acre, > 30 percent greater than the statewide average (table 5). However, each region is known for one prominent 'archetypal' species group—oaks and hickories (hard hardwoods) in the Ozarks, and natural (shortleaf) pine in the Ouachitas. The growing-stock volume of these groups is more than double the respective statewide averages (table 5).

Overstocking in both regions exceeds the statewide average (table 5). Thirty-eight percent of acreage in the Ouachita region is overstocked (15 percent greater than the State average), with over 6 percent of timberland in that region highly overstocked. Data do not reveal whether overstocking is in the hardwood component or the pine component.

Growth, removals, and growth surplus—Growing-stock growth on national forest land in both regions is less than the statewide average (table 6), but in each region the growth of the archetypal species group exceeds the State average. Planted pine growth in both regions is less than half the statewide average.

Growing-stock removals on national forest lands in the two regions are also well below the statewide average for all species groups (table 6). No combination of species group by region, including the archetypal species groups, shows removals that exceed State averages. Statewide, and across all species groups, national forest timberlands are being cut at less than half the rate for average timberland on all ownerships statewide.

Thus, the growing-stock growth surplus across all species groups is more than twice the statewide average in the Ouachita region and over three times the statewide average in the Ozark region (table 6). This trend is even more pronounced for the archetypal species; the hard hardwood growth surplus in the Ozarks is more than six times the State average, and natural conifer growth surplus in the Ouachita region is almost eight times the State average. However, data in table 6 also indicate a negative growth surplus (removals exceeding growth) in the Ozark planted pine component.

Sawtimber growth trends in the two region's national forests parallel the growing-stock trends (table 6). Total sawtimber growth is 15 percent less than the State average in the Ozarks and 6 percent less in the Ouachitas. However, hard hardwood sawtimber growth in the Ozarks is more than double the State average, and natural conifer growth in the Ouachitas exceeds the State average by about 30 percent.

Table 6—National forest sector growth, removals, and growth surplus for growing stock by species group in the Ozark and Ouachita regions of Arkansas compared to statewide averages across all ownerships

Species group	Ozark region	Ouachita region	Statewide
	- - - - - - *Cubic feet per acre* - - - - - -		
Growth			
Planted pine	2.0	3.2	8.7
Natural conifers	10.1	22.7	18.5
Soft hardwood	4.2	1.3	5.0
Hard hardwood	25.8	10.8	12.6
All species	42.2	38.0	44.7
Removals			
Planted pine	3.2	.4	3.7
Natural conifers	6.4	14.9	17.6
Soft hardwood	.5	.2	4.8
Hard hardwood	4.0	1.7	9.2
All species	14.0	17.0	35.3
Growth surplus			
Planted pine	-1.2	2.8	5.0
Natural conifers	3.7	7.9	1.0
Soft hardwood	3.7	1.1	.1
Hard hardwood	21.8	9.1	3.4
All species	28.2	20.9	9.5

Sawtimber removals are less than the statewide average in nearly all classes—less than half the statewide average in both the hardwood group and the total group (table 7), with the exception of planted pine removals in the Ozarks, which exceed the State average by > 35 percent.

Total sawtimber growth surplus for all species in both regions is double the statewide average (table 7). Hard hardwood growth surplus in the Ozark region is nearly five times the statewide average; and the natural conifer growth surplus in the Ouachita region is about four times that found statewide. However, as was reported for growing-stock data, removals of planted pine sawtimber in the Ozark region exceeded growth.

Generally, national forests of the Ozark and Ouachita regions are growing slightly less than the statewide average. However, removals are much less, resulting in a growth surplus that is more than double the State average across all species groups. The exception to these trends is found in the planted pine component within the Ozark region, where removals exceed growth, for both growing stock and sawtimber.

Table 7—National forest sector growth, removals, and growth surplus for sawtimber by species group in the Ozark and Ouachita regions of Arkansas compared to statewide averages across all ownerships

Species group	Ozark region	Ouachita region	Statewide
	- - - - - Board feet per acre - - - - -		
Growth			
Planted pine	8.7	3.2	19.2
Natural conifer	43.8	137.4	101.2
Soft hardwood	9.5	3.7	19.5
Hard hardwood	95.3	29.8	45.8
All species	157.4	174.1	185.8
Removals			
Planted pine	15.6	1.7	11.5
Natural conifer	31.9	67.6	83.5
Soft hardwood	2.1	.2	15.5
Hard hardwood	12.7	1.8	33.5
All species	62.4	71.2	144.0
Growth Surplus			
Planted pine	-6.9	1.4	7.7
Natural conifer	11.9	69.8	17.7
Soft hardwood	7.3	3.6	4.0
Hard hardwood	82.6	28.0	12.4
All species	95.0	102.9	41.8

DISCUSSION

Public forests have a more prominent big-tree character than private industry or NIPF ownerships in Arkansas. Both the national forest sector and the other public sector have higher levels of stocking, more area in sawtimber, and greater volume per acre than the private sector, relative to State averages. In the national forests, mortality is less than the State average; in the other public sector, hardwood mortality exceeds the State average, but conifer mortality is less.

National forest lands in Arkansas are found on poor-quality sites. Eighty percent of national forest lands falls within the poorest two site classes, compared to about 55 percent statewide. Such sites are disproportionally poor relative to timberland in all ownership categories statewide. Conversely, lands within the other public ownership class are highly productive—a fact related to the bottomland character of those timberlands. Growing-stock growth on other public timberlands exceeds the State average, both in soft hardwood and in hard hardwood species groups, testifying to the hardwood productivity of those lands.

As reflected in comparisons of current and past FIA data, timber on public lands has matured substantially. Between 1988 and 1995, there was a general decline in national forest seedling-sapling and poletimber stand areas. However, there was a concomitant increase in sawtimber area associated with those declines. This is reflected in declining rates of harvest on the national forests, and the maturation of young stands. In the other public ownership class, sawtimber growth rates are roughly two, three, and five times the statewide averages in natural conifers, soft hardwoods, and hard hardwoods, respectively.

Hardwood forest types are predominant in the Ozark and the Ouachita regions, although only marginally so in the latter. Hardwoods have high rates of net growth, especially the hard hardwood group in the Ozarks. These data contradict a popular opinion that public lands in general, and national forests in particular, are becoming ‘pine tree farms’ at the expense of hardwoods. In fact, as evidenced by the area in pine plantations, the opposite appears to be the case.

National Forest System lands constitute a minority ownership in the Ozark region, where < 20 percent of timberland is national forest. About twice that proportion in the Ouachitas is NFS timberland. This suggests that the vigorous debates about forest management in the Ozarks may be misplaced. Management on private timberlands, which is generally regulated far less effectively than management on public timberlands, undoubtedly has a far greater influence on the overall quality of the timberland resource in the Ozark region.

Survey data show a decline in forest acreage within the national forest ownership class. However, empirical evidence from annual reports by the Ouachita National Forest suggests that NFS acreage is actually increasing. The difference is due to changes in the manner that FIA calculates acreage. In 1988, FIA tabulated national forest acreage directly from its sample plots. In 1995, it used enumerated data, i.e., the known acreage of the NFS timberland base. This accounts for the apparent decline in acreage.

Planted pine sawtimber shows negative net change (removals exceed growth) in the national forests of the Ozark region. Although data from the Ouachita region did not show that planted pine removals exceeded growth, the trend was similar. However, the experimental error of the growth-and-removal estimates exceeds the reported differences. This trend is probably the result of a small sample size. Because there are not many FIA plots in planted pine stands in the national forests of the Ozark region, harvest within one plot may inordinately influence the trends present in the data. On the other hand, the pattern could indicate that some management actions in these planted pine stands contributes to the loss of volume. Despite its lack of statistical significance, this trend should be observed carefully over time.

Data suggest that 35 percent of national forest timberlands and 40 percent of those in the Ouachita region are overstocked. This is well above the State average. Whether or not this is a problem depends on one’s perspective. The term overstocking is used to describe a stand where trees are densely packed to the point where timber growth

declines; thus, overstocking represents a lost opportunity for timber production. Overstocking has also been shown to affect forest health. Two of the most prominent threats to timberlands in Arkansas—the southern pine beetle and the gypsy moth—are both more damaging in overstocked stands. Conversely, dense stands represent a natural condition and provide desirable variation in forest habitat across a landscape. Thus, this observation may trigger debate on whether, and by what methods, Forest Service officials should manage overstocked stands.

The net growth of growing stock and sawtimber on the national forests is double the statewide average for hardwoods in the Ozark region and for natural conifers in the Ouachitas. Growth rates are below average on NFS timberlands, but removals are far below average. The result is a net growth rate for growing-stock volume and sawtimber volume that exceeds statewide averages by three to five times.

Finally, data suggest that Arkansas' public forests are continuing to grow in size and volume over time. Size-class distributions are increasingly of sawtimber size on public lands when compared to State averages. In some ways, this is even more remarkable within national forest timberlands, given their inherently poor sites. Data support the hypothesis that the public sector in general, and national forests in particular, feature mature, big-tree forest lands more than other ownerships in the State. Therefore, if one seeks large trees and mature stands, FIA data suggest that Arkansas' public lands are the best place to find them.

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GENERAL SESSION III

Forest Survey Data—
Implications for Other Resources

John T. Shannon, Moderator

FOREST INVENTORY AND ANALYSIS: WHAT IT TELLS US ABOUT WATER QUALITY IN ARKANSAS

Edwin L. Miller and Hal O. Liechty[1]

Abstract—Forests and forest activities have a significant impact on the amount and quality of surface water in Arkansas. Recognizing this important relationship between forests and water quality, we utilized the Forest Inventory and Analysis (FIA) data from Arkansas to better understand how forest land use in Arkansas has likely influenced the water quality in the State during the past 17 years. Five specific types of FIA information were considered to be important indicators of, or strongly correlated with, water quality: (1) the land area in forest cover, (2) age distribution of forests, (3) amount of harvesting and timber removal, 4) amounts of riparian forests and, 5) health and vigor of the Arkansas forests. Information from the FIA database suggests that water quality attributed to forest land use should have increased or at least remained the same over the past 17 years. These conclusions reflect an increased amount of forest lands within the State, increases in important riparian forest area in the Delta and Southwestern region, a general maturing of Arkansas forests, and increased growing-stock volumes during this time period. Timber removals in the State have increased, but any potentially negative water quality effects of forest harvesting have most likely been offset by increases in forest area and a general maturing of the resource.

INTRODUCTION

To examine what we might learn about the status of water quality or hydrology in Arkansas from what is known concerning the character, quantity, and distribution of forests in the State is the objective of this paper. Information concerning Arkansas forests was derived from the extensive database provided by the Forest Inventory and Analysis (FIA) Unit of the USDA Forest Service, Southern Research Station. Furthermore, it is our objective to discuss ways in which FIA might be implemented to provide more direct information useful for evaluating water quality in Arkansas.

In order to set the stage for the FIA and water-quality discussion, we first briefly review the basic relationships among forests, forest management, forest soils, water quality, and hydrology. While covering these topics could require several textbooks and consume a semester-long course, it is our intent to make some general statements and provide limited scientific support or examples, which will delineate the important issues and data to be covered in the evaluation.

IMPACT OF FORESTS ON SOIL AND WATER RESOURCES

Erosion

Annual soil erosion from forested lands is minimal and is commonly lower than erosion rates under most other land uses. Erosion from undisturbed and carefully managed forest lands in the United States has been reported to range from 0.05 to 0.10 tons per acre per year. Measured erosion rates from minimally disturbed forest lands rarely exceeded 0.25 tons per acre per year (Patric and others 1984). Based on a national survey in 1987, soil erosion from cropland was estimated to average about 3.8 tons per acre per year (USDA Soil Conservation Service 1989).

Research in the Ouachita Mountains of Arkansas reported soil erosion from harvested and undisturbed forests was in line with data reported from forests nationally (fig. 1). Miller and others (1988a) reported erosion from undisturbed forested watersheds averaged about 0.03 tons per acre per year, whereas rates from clearcut areas averaged about 0.10 tons per acre per year during the first 3 years following forest harvest when disturbances are the greatest.

There are a number of reasons why erosion rates are low in disturbed as well as undisturbed forests. Soils in forests, even after normal harvesting, generally have good ground cover in terms of plants and logging debris, which reduces velocity of water movement. Infiltration rates are also high unless the soil has been severely compacted. These characteristics prevent soil detachment and transport, the essential elements of the erosion process. However, if excessive soil exposure occurs and bare soil is exposed for prolonged periods, forest harvesting can increase erosion rates. Excessive compaction or disturbance, often caused by harvesting on saturated soils, will also reduce infiltration of rainfall and increase overland flow of water. The increased exposure of mineral soil and the increased flow of water over the soil surface increase the potential for soil erosion. Silvicultural activities such as burning or windrowing of slash shortly after harvesting reduce debris and plant material, and, thus, can increase erosion beyond what is commonly produced by harvesting alone.

It is generally accepted that differences in erosion rates between undisturbed and harvested forests are relatively small and short lived. Furthermore, land-use conversion

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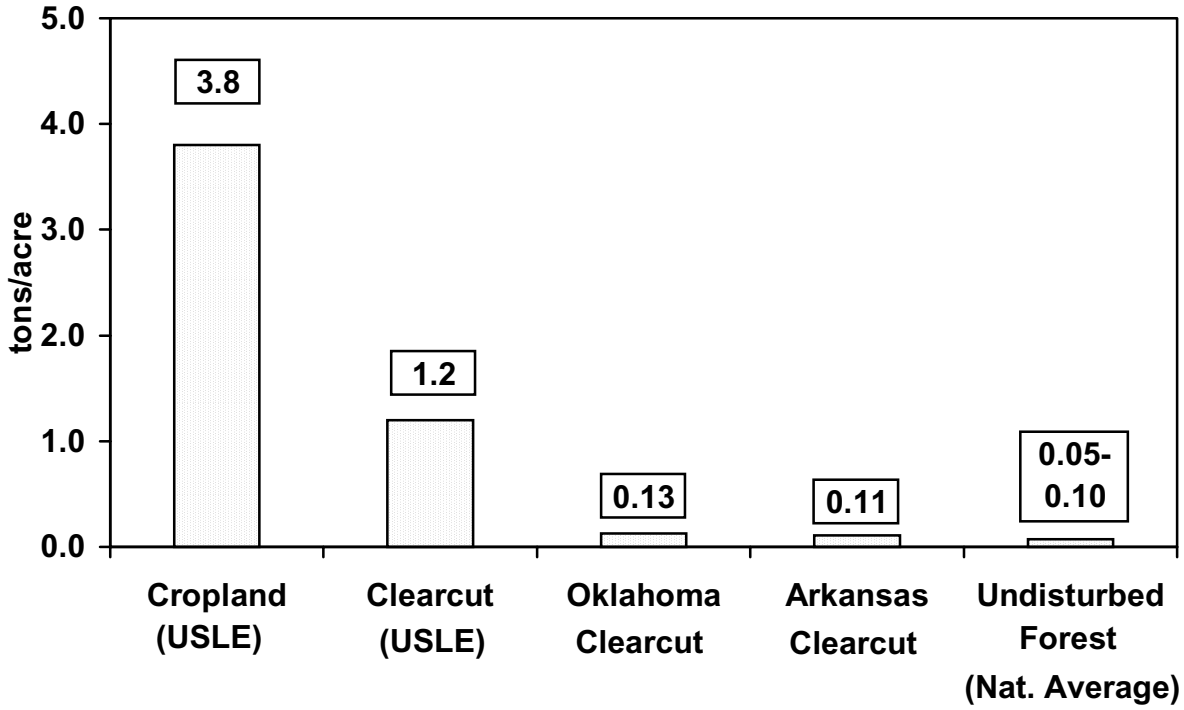

Figure 1—A comparison of annual soil loss from forests and croplands in the United States.

from forestry to cropping or cropping to forestry causes an order-of-magnitude, longer-term change in soil erosion rates. In comparison to forestry/cropping conversion, changes in erosion rates due to forest harvesting when followed by prompt forest regeneration cause relatively small changes in erosion and sedimentation.

Forest Harvest and Nutrient Losses

Undisturbed forests are very conservative regarding nutrient input and output (Jorgensen and Wells 1986). That is, input of nutrients from the atmosphere in the form of precipitation or dry deposition has a strong tendency to remain in the forest ecosystem once absorbed by plants within the ecosystem. Nutrient losses in stream flow from forests are generally small by comparison to the input. Consequently, the concentration as well as total nutrient losses associated with forest streams is usually low. Low levels of nutrients in stream flow are one indicator of high water quality. Low suspended sediment concentrations and cool temperatures are other characteristics of high quality stream flow.

Forest disturbance such as harvesting, burning or a land-use conversion will normally increase the losses of nutrients from forested watersheds through stream flow. Nutrient concentrations as well as the total annual losses of nutrients increase with the level of disturbance. Forest fertilization has also been shown to increase the output of nutrients, primarily nitrogen, in stream flow. Fortunately, the effect of forest disturbance on nutrient losses is relatively small and short lived when rapid forest regeneration occurs. Furthermore, when acceptable application rates and methodologies are utilized, forest fertilization of plantations and mature forests has short-term effects on stream nutrients because forests are effective at retaining added nutrient input.

Nutrients of importance to those interested in water quality and forest productivity include nitrogen, phosphorus, potassium, calcium, and a few others depending on special site characteristics. Nutrient movement in stream flow may occur when soluble nutrients such as nitrate-nitrogen and calcium are in solution and move freely with water through the soil. Other nutrients, primarily phosphorus, are not readily soluble and cannot move in solution with water. Phosphorus is strongly adsorbed onto soil particles. Therefore, the greatest percentage of phosphorus losses in stream flow is found when erosion occurs and sediment moves with stream flow.

Losses of nitrogen and phosphorus, as shown by comparisons of stream chemistry in harvested and undisturbed small forested watersheds in the Arkansas Ouachita Mountains (table 1), reflect these general trends in nutrient movement (Scoles and others 1995). Changes in

Table 1— Nutrient levels in stormflow after harvesting in nine Arkansas watersheds

	Uncut		Clearcut	
Year	Nitrate N	Total P	Nitrate N	Total P
	Pounds per acre			
1981	0.08	0.05	1.18	0.29
1982	.01	.05	.08	.20
1983	.10	.13	.22	.25
1984	.19	.06	.25	.10

nutrient loads were small following the 1981 harvest treatments. Nutrient loads returned to control levels soon after harvest. Changes in nutrient losses following moderate controlled burning or forest fertilization treatments should also be expected to be minor and short lived. However, inclusion of the burning of logging debris with hot fires shortly after harvesting can elevate the nutrient losses above those found with only forest harvesting.

Good comparisons of nutrient losses following conversion of forests to other major land uses are not available. However, conversion from forest to cropping, for example, would involve significant changes in nutrient losses to streams due to a number of natural and management-related factors. These types of changes would likely be large and long term in comparison to those caused by forest management.

Forest Roads and Erosion

Forest roads pose an erosion threat because they are, by default, designed to expedite water movement. First, soils on road surfaces and back slopes may be maintained or remain in a bare or near-bare condition for extended periods of time. Soil particles are therefore continuously exposed to rainfall energy and possible detachment. Second, road drainage systems are specifically designed to efficiently transport water and its suspended sediment load from roads. In many cases, road runoff is directed to natural drains or streams. Where streams and roads cross, sediment can easily be displaced in streams unless diverted to more desirable locations.

Rates of erosion from forest roads are a function of many factors including soils, slopes, back slope design, surfacing materials, amount of road use, timing of use, road maintenance, topographic placement, and the type and placement of water control structures. Research on forest road erosion in Arkansas shows that the amount of sediment delivered to streams from roads can be significantly reduced when best management practices are used (Miller and others 1985). However, the amount of sediment produced and delivered to forest streams from an average forest road system on a watershed can easily exceed the amount of sediment produced as a result of all the silvicultural activities conducted on that watershed.

Because forest roads are a ready source of sediment, the presence or absence of forest roads and the extent of forest road use are good indicators of the potential for road sediments to enter forest streams. The development or existence of forest roads and the extent of forest road use are closely linked to the amount of activity, such as harvesting, which occurs in a specific area. Thus, the levels of harvesting or regeneration activities should also indicate the potential for road sediments to enter forest streams. While the rehabilitation of a poor forest road system might result in a significant reduction in road sediment production and delivery to forest streams, such activities are not necessarily reflected in data descriptive of the condition of forest stands.

Forests and Stream Flow

It is well established that the removal of forest cover increases the amount of stream flow. In the Southern United States, annual water yield as stream flow increases directly in proportion to the percentage of the area of forest cover removed. Bosch and Hewlett (1982), in a review of the literature, found that for every 10 percent of a watershed that is deforested, average annual stream flow increases 1.6 inches during the first year after tree removal. The greatest increases in stream flow due to forest harvest tend to occur during wet years. Conversely, the reforestation of previously cleared watersheds actually reduces total annual stream flow, and, during dry years, forests can significantly reduce stream flow totals.

It is important to understand the difference between total annual stream flow and peak or flood flow because the influence of forest harvest on these variables is significantly different. Total annual stream flow is the total volume of water produced by a stream in a year. Flood flow is the maximum discharge of a stream or river during an individual runoff event. Desert watersheds can produce tremendous flood flows very quickly but yield very low total volumes of water over the period of a year. Streams that maintain low but sustained flows over a long period of time can produce tremendous volumes of stream flow annually but may not produce large flood flows.

Forested watersheds in the Ouachita Mountains are particularly interesting regarding flood flows. With shallow soils, limited capacity to store water, seasons with intense and high amounts of rainfall, and well-developed sloping stream systems, high peak or flood flows are common. Research in the Ouachita Mountains has shown that forest removal does not increase the severity of the larger flood events that occur during the wet seasons when trees are not actively growing (Scoles 1992). During this period of time when soils are saturated they have little ability to store water. Trees that are not actively growing do not remove water from the soil and have little consequence on peak floods.

Forest removal does tend to increase the size and frequency of smaller peak flows of upland streams, especially during the drier portion of the growing season. At these times, forest removal causes soil moisture levels to remain higher than normal due to the reduction in tree interception and transpiration losses of water to the atmosphere.

Bottomland riparian forests play a unique and important role in the hydrology of streams on flood plains. Forest cover not only increases the amount of available water storage in flood plain soils; riparian and flood plain forests slow and spread flood waters and, thereby, attenuate or reduce the magnitude of flood peaks. The effect of flood plain forests is similar to that of a reservoir. The stabilizing effect of forest cover on stream banks and flood plain soils is also well recognized. Tree cover reduces the availability of flood-flow energy available to erode streambeds and banks and flood plain soils. Major changes in bottomland flood plain and riparian forest cover (land use) may therefore have implications for the rates of stream sedimentation, stream stability, and flooding.

Riparian Forest Functions

Riparian forests provide a number of important benefits to their associated stream systems (Miller 1986). We refer to these benefits as riparian forest functions, and they include the following: (1) Streambed and bank stability, (2) Stream temperature regulation, (3) Source of large organic debris, (4) Nutrient and pollutant sink, (5) Sediment reservoir or trap, and (6) Source of food for aquatic organisms.

Excellent technical reports are available detailing the functional relationships between riparian forests and stream ecosystems. These relationships need not be reviewed in this paper, and two of these functions have been briefly discussed previously. However, it is important to note that stream characteristics, for example, size, location, slope, and flow, interact and thereby determine for each stream which riparian functions dominate or are most important to stream health. For example, stream shade for temperature control is particularly important for smaller, cold-water upland streams but not as important for large, shallow and wide bottomland streams. Streambed and bank stability are not as critical for smaller, rocky, well-armored streams as compared to larger, meandering streams with deep unconsolidated bed and bank soils. The streamside management schemes needed for riparian forests to maintain important functions will therefore vary widely from stream to stream and across the landscape.

In Arkansas, upland or mountain riparian forests generally occupy narrow areas of the landscape adjacent to streams and rivers. Upland riparian forest types may or may not be significantly different from adjacent forest types and they often do not represent a large percentage of the total land area. Bottomland riparian and flood plain forests occupy narrow to very broad areas of the landscape. Bottomland riparian forest types are often distinct from adjacent forest types, and they may occupy a large percentage of the landscape. These facts have implications regarding the possible utility of FIA data as a tool for the evaluation of riparian forest functions and stream health.

WHAT FIA INDICATES ABOUT WATER QUALITY

Considering the variety of ways in which forests affect soil and water quality, the degree in which the location of forests with respect to bodies of water contributes to water quality, and the relatively short periods of time that disturbances to forests alters water quality, it is unlikely that FIA data, which was designed to measure large-scale, long-term trends in forest products, health, volume, and acreage, is well suited for indicating water quality within Arkansas. Since numerous nonforest as well as forest factors are responsible for the water quality in the State, FIA data cannot indicate what level of water quality exists in the State. However, due to the temporal nature of the FIA surveys, some information can be gleaned from this database, which can be used to indicate whether the general water quality in the state has improved or declined.

We foresee five areas of information in which FIA data may contribute to our understanding of temporal changes in water quality within the State. These specific areas are: (1) large scale changes in forest cover and land use, (2) changes in age distribution of forests, (3) information concerning harvesting activities as related to forest removals, (4) increases or decreases in riparian or wetland forest communities, and (5) changes in tree health or mortality, which may alter woody debris input to streams and bodies of water. In the following text, we focus on current and past surveys concerning these five attributes and how changes in these forest attributes may denote changes in water quality. It should be recognized that due to the differences in physiography, land use, demographics, etc., among regions within the State, not all of the survey information pertaining to the five attributes will be of similar applicability for indicating changes in water quality for a given region. Thus, examples will be presented or conclusions drawn for each of the five information areas where linkages between FIA data and water quality are strongest.

Large-Scale Changes in Forest Cover

As indicated earlier in this paper and by other sources (Moore 1988, Scoles and other 1995), undisturbed forests generally have low sedimentation rates and nutrient input in streams and other water bodies. Properly managed forests are considered to have less deleterious effects on water quality compared to more intensive land uses such as agricultural or urbanization. Thus, it seems likely that all other factors being equal, water quality in the State would generally be positively correlated with the amount of forest land in the State. Table 2 shows that the amount of forested land has increased from 16.6 million acres in 1978 to 18.8 million acres in 1995. Currently approximately 56 percent of Arkansas is forested compared to 49 percent in 1978. Although FIA data does indicate an increase in forest land, it gives no indication as to the land use of this area prior to afforestation. Considering the large variation of land uses in the State, it is difficult to determine if these increases in the forest land base would appreciably increase water quality in the State as a whole.

However, in the Delta region where the dominant land use is agriculture, increases in forest land would indeed suggest a reduction of agricultural land and, thus, a measurable increase in water quality. From 1978 to 1995, the amount of forest land in the Delta increased from 1.8 to 2.1 million acres, which represents an increase from 19 percent to 23 percent of the total land area in this region. This increase in forested land, presumably replacing agricultural land, would suggest that water quality within this region has either increased or at least stayed at the same level as it was in the prior surveys. It is possible that water quality has decreased if agricultural losses of soil, agricultural effluents, and/or water removals from existing agricultural lands have outpaced gains in water quality attributed to afforestation. Although the problem of assessing the current impact of specific nonforest land uses on water quality hinders our ability to use FIA data as a sensitive indicator of water quality in the State or a region as a whole, it seems likely that the increased amounts of forests in the State have had a positive impact on water quality.

Changes in Age Distributions of Forests

Increased amounts of forest canopy and litter reduce the erosion and nutrient movement from forest land areas to

Table 2—Forested and nonforested land by region during the last three FIA surveys in Arkansas

	Forested			Nonforested		
Region	1978	1988	1995	1978	1988	1995
	- - - - - - - - - - - - - - - - - *Acres* - - - - - - - - - - - - - - - - -					
Delta	1,827	1,899	2,110	7,664	7,592	7,106
Southwest	6,388	6,446	6,886	2,528	2,332	1,901
Ouachita	3,197	3,238	3,486	1,671	1,496	1,272
Ozark	5,205	5,730	6,326	5,507	4,458	4,237
Total	16,617	17,313	18,808	17,370	15,878	14,516

water bodies. Generally, the amounts of canopy and litter are at their lowest levels early in a forest's life after it has been regenerated through natural disturbances or planned manipulation. If a greater portion of Arkansas forests were at this early stage of development now rather than in the past, it would be possible that water quality influenced by forests would be reduced. We compared the area occupied by three broad age/size classes within each region over the last three surveys to evaluate if there had been any major shift in age distribution during this time. Although some variation among regions exists, forests in Arkansas have generally continued to mature during the last three surveys (table 3). The greatest increase in the area classified as sawtimber occurred in the Ouachita and Ozark regions. In 1995, approximately 61 percent and 42 percent of the timberland in the Ozark and Ouachita regions were classified as sawtimber compared to 52 percent and 40 percent in 1978. Increases in the amount of sawtimber acreage have also occurred in the southwest and Delta regions. However, the number of acres in seedlings and saplings has also increased as a result of an increase in reforestation. Thus, the proportion of total timberland classified as sawtimber has remained stable or declined slightly in these two regions.

Overall, there have been no large-scale changes in land area for the younger sapling/seedling-age classes. Instead the acreage of sawtimber has increased by 22 percent whereas the amount of forest land classified as poletimber or sapling/seedlings is similar to the 1978 levels. Consequently, there is no indication water quality has been reduced as a result of a change of stand or forest age in Arkansas.

Extent of Forest Management Activity

Although nutrient and sediment loss from stable, undisturbed forests is low, perturbations such as canopy removal, forest-floor disturbance, or tree removal either from natural or artificial sources, can increase the amount of these constituents in streams and surface water (Swank 1988, Shepard 1994). Research in Arkansas has verified that silvicultural practices such as tree harvesting can increase rates of nutrient and sediment loss. Although these rates are increased, the accelerated rates are generally short lived (Scoles and others 1995). The sediment and nutrient loads in streams from forest management activities have the potential for lowering water quality at least during a short period after forest harvesting. Forest roads are another source of sediment to streams. The amount of soil

Table 3—Timberlands in sawtimber, poletimber, and sapling/seedling size/age classes by region in Arkansas during the last three surveys

	Sawtimber			Poletimber			Sapling/seedlings		
Region	1978	1988	1995	1978	1988	1995	1978	1988	1995
	- *Acres* -								
Delta	1,080	1,181	1,279	465	442	365	245	238	447
Southwest	3,296	3,331	3,428	1,675	1,473	1,422	1,384	1,582	2,019
Ouachita	1,289	1,233	1,454	1,139	1,080	1,235	759	837	725
Ozark	1,319	1,706	2,351	2,194	2,775	2,464	1,659	1,174	1,194
Total	6,984	7,451	8,512	5,473	5,770	5,486	4,047	3,831	4,385

that can be produced and carried into streams from these forest roads can exceed the amount that is produced from silvicultural and harvesting activities (Scoles and others 1995).

FIA data has a limited ability to indicate what type of silvicultural practices is occurring or how many miles of roads are in use in Arkansas forests. The FIA data does report the volume of wood removed from Arkansas forests. Assuming that volume/area harvested was similar among inventory periods, harvested volumes should give an overall indication about the level of management activity in forests and forest road use. Annual net removals increased in all regions except the Ouachita. Removals increased by approximately 50, 9, and 33 percent respectively, in the Delta, Southwest, and Ozark regions but decreased by 32 percent in the Ouachita region (table 4). The increased rates of removals in the Delta and Ozarks should reflect a greater level of forest activities such as harvesting and forest road use. This intensification of forest management has the potential to increase nutrient and sediment yields above those generated at lower levels of forest harvesting and management. The amount of additional nutrients and sediments in water attributed to the actual harvesting activity is probably minimal and short lived if good forest practices are utilized. However, if additional forest road construction or degradation of forest roads have occurred as a result of this increased activity, longer term and larger scale yields would be possible.

It is likely that any deleterious effects either from increased levels of tree removal or road use/construction in the Ozarks or Delta have been offset by the increased forest land (table 2) and growing-stock volumes (table 5) within these regions. If increased removal rates would continue in these regions without a corresponding increase in forest land area and growing-stock volume, concern about a potential for a reduction in water quality might be warranted. However, given the increasing trends of forest land area and growing-stock volume, we do not foresee evidence that a decrease in water quality has occurred during the past 17 years. In the Ouachita region, where removals have decreased (table 4) while forested land area (table 2) and growing-stock volume (table 5) have increased, water quality related to forest management should be improving.

Table 4—Net annual growing-stock removals from 1978–88 and 1988–95 by Arkansas region

Region	1978–88	1988–95
	Million ft³	
Delta	44	66
Southwest	436	476
Ouachita	121	83
Ozark	62	83
Total	663	708

Table 5—Total growing-stock volume during the last three surveys by Arkansas region

Region	1978	1988	1995
		Million ft³	
Delta	2,014	2,535	2,851
Southwest	8,348	8,322	8,833
Ouachita	3,404	3,370	4,108
Ozark	3,482	4,765	5,873
Total	17,248	18,992	21,665

Riparian and Wetland Forest Communities

Riparian and wetland forest communities often have a greater role in influencing and maintaining water quality and associated aquatic functions than do upland forest communities. These communities, due to the close proximity to bodies of water, provide carbon for primary consumers in the aquatic food chain, modify the climate of water, remove sediment/pollutants from water, and provide habitat for aquatic fauna. Thus, these communities deserve special attention in any evaluation of forest influence on water quality. As a result of their influence on water quality, any reduction in these forests or conversion to more upland communities through alteration of hydrology would have the potential for reducing water quality. The two forest types that are recognized and classified by FIA as wetland or riparian forests are the oak-gum-cypress and elm-ash-cottonwood forest types. Due to the small amount of land these forest types occupy in the Ozark and Ouachita regions (<7 percent) discussion concerning these forest types will be limited to the Delta and Southwest regions.

Amounts of forest land during the last three surveys in the riparian/wetland (oak-gum-cypress and elm-ash-cottonwood), loblolly pine, and other forest types are given in table 6 for the Delta and Southwest regions. The amount of forest in the oak-gum-cypress and elm-ash-cottonwood types has increased over the past three surveys in the Delta region. After a decrease in the Southwest region in 1988, the area of riparian/wetland forests has increased. The riparian/wetland forest has comprised between 68-69 percent of the forest land in the Delta since 1978. The increase in riparian/wetland forest acreage along with the maintenance of the proportion of forests of this cover type, again suggests that water quality should have remained the same or increased during the last three survey periods within the Delta region.

In the Southwest during 1978, this forest type comprised 19 percent, decreased to 16 percent in 1988, and finally increased to 17 percent of the forest land during the last survey period. The decrease in the riparian/wetland forests

Table 6—Timberlands in riparian/wetland (oak-gum-cypress and elm-ash-cottonwood), loblolly-softleaf pine and other forest types for the Delta and Southwest regions during the last three surveys

	Riparian/wetland			Loblloly-shortleaf pine			Other forest types		
Region	1978	1988	1995	1978	1988	1995	1978	1988	1995
	Acres								
Delta	1,266	1,295	1,427	68	86	144	491	517	540
Southwest	1,228	1,051	1,171	2,581	2,562	3,018	2,579	2,833	2,692

in the Southwest region between the 1978 and 1988 surveys may indicate a reduction in water quality at that time. It cannot be determined using this information if these forests were converted into agricultural production or upland forest-cover types. It does not appear that they were converted to loblolly pine, which is planted extensively in this region, because there was no increase in the loblolly-shortleaf pine area corresponding to the reductions in oak-gum-cypress or elm-ash-cottonwood forest areas. Regardless, riparian/wetland forest land area increased by 120,000 acres in the Southwest between the 1988 and 1995 surveys. Any potential reduction in water quality from the loss of these forests between 1978 and 1988 appears to have been partially mitigated with the increase in riparian/wetland forest area between 1988 and 1995. Therefore, at least in the short term, water quality in the Delta and Southwestern regions, as indicated by these forests, have remained similar or improved.

Woody Debris and Carbon Input from Forests

A large portion of the carbon input and fauna habitat for streams is derived from forests. Increased levels of mortality or reduction of health may indicate an increase in this input and a resulting change in water quality. We used the average annual mortality of growing stock and volume of rotten wood from each region during the last two surveys to determine if there have been any potential changes in woody input and, thus, water quality (table 7). Trends between the last two surveys are sporadic with mortality and volume of rotten trees each decreasing in three regions and increasing in one. This would appear to indicate, at least on a statewide basis, that the input of wood materials in streams or water bodies may have decreased during the last survey. However, linkages between this information and woody inputs to streams may be poor. The FIA does not indicate if mortality and rotten volumes consist of upland trees or riparian/wetland trees and where these trees occur in relation to the State's water resources. We believe that the changes in tree health and mortality, with the exception of possibly a 63 percent reduction of rotten tree volume in the Southwest, are not of a magnitude to have any immediate, harmful effect on woody input or water quality.

SUMMARY

Recognizing the limitations of FIA data as it concerns water quality, it is inappropriate to make an unequivocal conclusion concerning water quality within the State. However, the majority of the information we considered does indicate that water quality should have improved or remained the same within the State since the last survey. These improvements are directly related to the increase in forest area within the State and, specifically, in the Delta region.

In the Delta and Southwestern regions, modest increases in wetland/riparian forest types have occurred. These forests have a very direct influence on water quality of streams and rivers. Although timber removals and, thus, general forest management activities have increased within the State, the greater growing-stock volumes and the general maturing of the State's forest should minimize or eliminate any potential decrease in water quality related to intensifying of forest management. Thus, we see no decrease in water quality in the State related to the condition, quantity, or quality of the forests during the last survey compared to previous surveys.

Through our review of the FIA data, we recognized several ways in which FIA data could be improved to better evaluate relationships between the condition of the forests

Table 7—Average annual mortality of growing stock, and volume of rotten timber in Arkansas by region

	Average annual mortality		Volume of rotten timber	
Region	1978–88	1988–95	1988	1995
	Million ft^3			
Delta	31.5	29.2	53.6	33.4
Southwest	56.1	68.1	90.8	33.7
Ouachita	22.1	15.9	43.9	27.2
Ozark	32.4	27.9	98.1	101.3

in Arkansas and water quality. First, information concerning water quality could be improved if a more spatially intensive inventory could be initiated. Forests, such as wetland and riparian stands, which occur in close proximity to water bodies, wetlands, or head waters, will have a greater effect on water quality than forests that occur in other locations. Increasing the intensity of sampling would better quantify the character of these important forest types and locations.

It would also be beneficial to spatially link FIA data with other geographical and physiographical databases. For example, linking FIA data with hydrology information or an ecological classification system would increase our ability to delineate forest management/water quality relationships in specific watersheds or ecologically important areas. Linking soil information such as erosion potential or nutrient content with FIA data would better enable us to evaluate the impact of increased removals or forest activities on water quality.

Since effects from forest management and harvesting on nutrient and sediment input in streams are generally short lived, more frequent measurements of plots would also be beneficial. The majority of any water-quality effects from a large-scale increase in forest harvesting occurring within 2 to 3 years after a survey would be greatly reduced by the next survey completion. A decrease in the length of time between surveys would give a "real time" indication of potential changes in water quality related to Arkansas's forests.

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HABITATS AND NATURAL AREAS—SOME APPLICATIONS OF THE 1995–96 FOREST SURVEY OF ARKANSAS ON THE CONSERVATION OF BIODIVERSITY IN ARKANSAS

Douglas Zollner[1]

Abstract—The conservation status and trend of rare species groups should be better in landscapes with more forest cover due to the presence of quantitatively more habitat, and in the case of aquatic species, qualitatively better habitat. Arkansas provides habitat for 97 species of plants and animals considered critically imperiled globally or imperiled globally. These 97 species were grouped by broad taxonomic and habitat affinities. The ecoregional distribution, conservation status, and conservation trends of the species groups were analyzed in light of the 1995-96 Forest Survey of Arkansas.

INTRODUCTION

The status and trend of biodiversity conservation should be enhanced in more forested landscapes in relation to less forested landscapes. This expectation is due to the availability of quantitatively more habitat and the positive impact highly forested landscapes have on water quality. Arkansas currently provides habitat for 97 species of plants and animals that are considered critically imperiled globally or imperiled globally due to their rarity. Eight other species are known to have been extirpated from Arkansas but are still extant outside the State. Aggregated data on the conservation status and trends of these 97 species is used to represent biodiversity. The forest cover data from the 1995-96 Forest Survey of Arkansas is used to represent habitat.

A clearer understanding of the status and trend of rare species by ecoregion in relation to forest cover and trend data may reveal concerns or incipient challenges to the conservation of biodiversity and identify information and research gaps.

METHODS

The following 6 questions were asked:
1. What is the distribution of rare species types by ecoregion?
2. What is the conservation status by species type?
3. What is the conservation status by ecoregion?
4. What is the conservation trend by species type?
5. What is the conservation trend by ecoregion?
6. What is the implication of the Forest Survey data on each of the above questions?

A globally critically imperiled species has 5 or fewer known populations, and a globally imperiled species has 6 to 20 known populations. There are 105 critically imperiled or imperiled species known from Arkansas, although 8 are no longer extant. Extinct species were also excluded from the analysis. The 97 rare species were grouped in 4 broad taxonomic classes and 1 functional habitat class. These classes include plants and animals. Animals were further divided into vertebrates and invertebrates. Due to the high percentage of rare species that have aquatic-based life cycles, this further group was developed and also comprises plants and animals.

The data generated in the 1995-96 Forest Survey of Arkansas has been broken down by generalized ecoregions, the boundaries of which follow county borders. These ecoregions include the Ozark Highlands, Ouachita Mountains, West Gulf Coastal Plain, and Mississippi River Alluvial Plain. Forest cover and trend data expressed as percent cover and percent increase in cover by ecoregion are shown in table 1 (Rosson and others, unpublished data).

Using natural history references, Arkansas Natural Heritage Commission rare species occurrence data (ANHC 1996), and personnel field experience, each species was assigned

Table 1—Summary of species type by ecoregion

Species type	Ozark Uplands	Ouachita Mountains	Coastal Plain	Alluvial Plain
Total	54	45	25	17
Extirpated	5	4	2	2
Plants	9	13	4	4
Animals	45	32	21	13
Vertebrates	8	14	3	5
Invertebrates	37	18	18	8
Aquatics	37	20	14	12
Forest cover (percent)	60	73	78	23
Forest trend (percent)	+2.1	+5.0	+5.0	+2.3

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to ecoregions by known range. Many species inhabit more than one ecoregion.

A conservation status of satisfactory, unsatisfactory, critical, or unknown was developed for each species (Zollner and others, unpublished data) and aggregated by type. A satisfactory status means five or more conserved populations. A conserved population is a species that the landowner knows about and is managing for accordingly. Unsatisfactory means one to four conserved populations and critical none. A table was then developed to compare conservation status and forest cover data by ecoregion.

A conservation trend of stable, improving, declining, or unknown was developed for each species (Zollner and others, unpublished data) and aggregated by type. A table was then developed to compare conservation trend and forest cover data by ecoregion.

RESULTS

What is the Distribution of Rare Species Types by Ecoregion?

Table 2 shows the distribution of rare species by type. More than 80 percent of the rare species are animals, and, of the animals, fully 75 percent are invertebrates. Nearly two-thirds of the species are aquatic and therefore depend on the maintenance of high-water quality and hydrologic regime for the completion of their life cycles. These factors should be enhanced in more heavily forested landscapes. Table 1 shows the distribution of rare species groups and forest cover by ecoregion (Rosson and others, unpublished data). Most of the rare species are located in the Ozark and Ouachita uplands with substantially fewer in the Alluvial and Coastal Plains. Rarity is due to evolutionary history, as well as recent habitat loss and ecosystem process modification. The highlands represent an old landscape with many conservative and endemic species. Conservative species have narrow habitat niches that are very susceptible to alterations due to scarcity across the landscape. The Coastal and Alluvial plains are relatively young landscapes with few conservative species that require unusually narrow habitat niches but have been subject to extensive habitat alteration.

What is the Conservation Status by Species Type?

Table 3 shows conservation status by species type. As can be seen in the table, it is relatively good to be a rare plant. Most rare plants have a conservation status that is satisfactory. Alternatively, it is not good to be a rare invertebrate or a rare species with an aquatic life cycle. Rare invertebrates and species with aquatic life cycles suffer a high proportion of unsatisfactory and unknown conservation status. The conservation status of animals, as a group, is lowered by the high number of rare fish (aquatic life cycle) with unsatisfactory conservation status.

Table 2—Summary of rare species by type

Rare species	Total	Extirpated	Extant	Aquatics
All species	105	8	97	60
Plants	22	2	20	5
Animals	83	6	77	55
Vertebrates	21	2	19	11
Invertebrates	62	4	58	44
Aquatics	62	2	60	—

Table 3—Conservation status by species type

Species type	Satisfactory	Unsatis-factory	Critical	Unknown
Total	36	12	8	41
Plants	13	2	1	4
Animals	23	10	7	7
Vertebrates	7	6	2	4
Invertebrates	16	4	5	33
Aquatics	16	10	6	28

What is the Conservation Status by Ecoregion?

Table 4 shows conservation status by ecoregion and the forest cover and trend data from the 1995-96 Forest Survey of Arkansas (Rosson and others, unpublished data). As could be expected, the conservation status of rare species in the Delta is poor. Massive habitat loss, a low percentage of forest cover, and poor water quality characterize the Mississippi River Alluvial Plain. Of the rare species with a known conservation status, nearly half are unsatisfactory or critical. Forty percent of the species have a conservation status of unknown.

The situation is reversed in the Ouachita Mountains. A large percentage of the landscape is forested, and the water quality is high. Consequently, as could be expected, nearly three-quarters of the rare species with a known conservation status are satisfactory. Only 20 percent of the rare species have a conservation status of unknown. This is most likely due to the large amount of Federal land in the Ouachita National Forest that has been consistently inventoried and studied.

The Ozark Highlands fit somewhere between the Ouachita Mountains and Delta landscapes. Less forested than the

Table 4—Conservation status by ecoregion

Conservation status	Ozark Uplands	Ouachita Mountains	Coastal Plain	Alluvial Plain
Satisfactory	14	24	4	5
Unsatisfactory	5	7	4	3
Critical	4	2	2	3
Unknown	26	8	13	6
Forest cover (percent)	60	73	78	23
Forest trend (percent)	+2.1	+5.0	+5.0	+2.3

Ouachitas but more so than the Delta, 60 percent of the rare species with known conservation status are in satisfactory shape. The large number of unknowns in the Ozarks may be explained by the high proportion that is also troglobytic. It is simply more difficult to study and analyze species that spend their life cycles underground.

The surprise shown by table 4 is the situation on the West Gulf Coastal Plain. More highly forested that the Ouachita Mountains, unexpectedly on the West Gulf Coastal Plain, 60 percent of the rare species have a known conservation status of unsatisfactory or critical. More than half the rare species have an unknown conservation status. The situation can be partially explained by the lack of inventory and research on rare species on private lands. There is relatively little Federal land on the Gulf Coastal Plain.

What is the Conservation Trend by Species Type?

Conservation trend is the direction that the population of a species is moving. Status and trend are both critical but independent variables. A species with a critical status may have an improving trend and a species with a satisfactory status may be declining. Table 5 shows conservation trend by species type. The large number of unknowns provides so much noise that little information can be gleaned from this table beyond the paucity of information about the population trends of rare species. It is somewhat better to be a plant or a vertebrate animal than an invertebrate or aquatic species. This situation may be partially explained by the differences in relative ease of study.

What is the Conservation Trend by Ecoregion?

Table 6 shows the conservation trend of rare species by ecoregion. This table shows that, as may be expected, conservation trends are good in the highly forested Ouachita Mountains. Eighty-five percent of the rare species that have known trends are stable or increasing. The Ouachita Mountains also have a relatively high percentage (65) of rare species with known conservation trends. The conservation trends for rare species are also good in the Ozarks, but the high percentage (78) of unknowns is worrisome. The large number of unknowns in the Ozarks is probably due to the high percentage of rare species that live underground. Conservation trends on the Coastal and Alluvial Plains are mixed with a high proportion of unknowns. On the heavily forested West Gulf Coastal Plain, fully 70 percent of the rare species conservation trends are unknown. This is likely due to the small amount of land in Federal ownership.

Table 5—Conservation trend by species type

Species type	Stable	Improving	Declining	Unknown
Total	29	5	7	56
Plants	11	2	2	5
Animals	18	3	5	51
Vertebrates	7	2	2	8
Invertebrates	11	1	3	43
Aquatics	13	1	4	42

Table 6—Conservation trend by ecoregion

Conservation trend	Ozarks Uplands	Ouachita Mountains	Coastal Plain	Alluvial Plain
Stable	8	21	3	4
Improving	1	2	2	1
Declining	2	4	2	1
Unknown	38	14	16	9
Forest cover (percent)	60	73	78	23
Forest trend (percent)	+2.1	+5.0	+5.0	+2.3

CONCLUSION

The hypothesis that more forest cover may be good for the conservation of biodiversity cannot be confirmed with the data analyzed. Although the predicted pattern holds for the Ozark Highlands, Ouachita Mountains, and Mississippi River Alluvial Plain, the data for Arkansas's most heavily forested landscape, the West Gulf Coastal Plain, is decidedly mixed. This is most likely due to the lack of biodiversity information for large blocks of industrial forest land. The large percentage of rare species with unknown conservation status and trend information overwhelms much of the analysis.

There is an opportunity and challenge here in working with forest industry to determine the effects of good forest management on the maintenance of biodiversity. In 10 years, after the next forest survey, the conservation status and trends of rare species on the West Gulf Coastal Plain should be known. It should be proven that the conservation of biodiversity across the landscape is compatible with industrial forest management when best management practices are used.

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GENERAL SESSION IV

The Sustainability of Arkansas Forests—Three Key Issues

John T. Shannon, Moderator

A CHARACTERIZATION OF THE NONINDUSTRIAL PRIVATE FOREST LANDOWNERS OF ARKANSAS

Tamara Walkingstick, Donald E. Voth, Richard A. Williams, Jeffrey Earl, and Carl P. Hitt[1]

INTRODUCTION

Forest and timber and forest and timberland management are issues of great importance to Arkansas. The timber industry plays a major role in the State's economy and is constantly being transformed as it becomes more capital intensive and as the southern region, including Arkansas, becomes a more important player in the provision of the nation's supply of timber and timber-related products. This transformation is also affected by the globalization of this industry. Nonindustrial private forest (NIPF) landowners, who own and control a large proportion of Arkansas' forested lands, play an increasingly important role in providing these products. At the same time, aesthetic and environmental considerations have become more important. Much of Arkansas has benefited from the in-migration of retirees, as well as others who are attracted—among other things—by the State's "natural" environment, an environment that owes much to its vast forest lands, both public and private. The management of public forest lands is also being transformed, with increasing demands coming from practically all elements of the USDA National Forest's "multi-use" management strategy.

No comprehensive description of the State's NIPF landowners has been done since the studies reported by Greene and Greene and Blatner in the middle to late 1980's. That study, like the one reported here, was based primarily upon a mailed survey, supplemented by 200 personal interviews. It focused primarily upon identifying the characteristics associated with timber management, timber-owner attitudes toward timber production, and the management and policy implications of these. Statistical methods were used to try to classify respondents into two groups: "managers," and "nonmanagers." These were then compared.

The study reported here is based upon another mailed survey, which was sent to 2,400 forest landowners in a sample of 12 counties in Arkansas using standard procedures for mailed surveys, and providing a questionnaire that was designed from the previous one including input received from focus groups held in the four regions of Arkansas. Nearly 870 usable questionnaires were returned. Some of the results have been reported previously, mostly in the form of professional presentations and public meetings (Williams and others 1996). They are presented here in considerable detail. The presentation is more descriptive than analytic, and we follow a pattern throughout of presenting results for the State as a whole and for each of the four physiographic regions of the State, among which are substantial differences on many important aspects of forestry and forest management.

METHODOLOGY

Sample Selection

County selection—Twelve counties were selected, with the probabilities of selection roughly equal to the acreage in private, nonindustrial forest lands in the county, using procedures described for multistage sampling (Sudman 1976). The total acreage of NIPF land in the State was divided by 12 to obtain an appropriate sampling interval, I. The counties were then sorted by region to insure that the sample would be spread across all regions, and the cumulative sum of NIPF acreage in all 75 counties was calculated across the entire list of counties. A random number R was selected between 1 and I as a starting point. Finally, the county in which the Rth acre occurred was selected, then the one in which the R + Ith acre was located, then the one in which the R + 2*Ith acre was located, then the one in which R + 3*Ith acre was located, etc., through the entire list of cumulative acreage values. Then, consideration was given to overlap with the National Private Land Owner Survey (NPLOS) being carried out at the same time by the Southern Forest Experiment Station in Athens, Georgia. In several cases, counties selected by the procedure above were replaced by NPLOS counties that were similar in location, acreage of NIPF, etc. The Arkansas counties finally selected included Fulton, Johnson, Madison, Sharp, and Stone Counties in the Ozark region, Cross and Lincoln counties in the Delta region, Logan and Perry Counties in the Ouachita region, and Bradley, Miller and Ouachita Counties in the Coastal Plain region.

Respondent selection—Two hundred samples were selected from each county using systematic random sampling from the timber landowners on the county real estate tax lists. In each case, an estimate was made of the number of entries on the entire list. Sometimes a number

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was available. At other times several pages were sampled and counted. Then the average was applied to all of the pages of the county tax lists to obtain this number. This number was then divided by 200 to obtain an appropriate interval, I, for systematic sampling. A random number, N, between from 1 to I was selected. Samples were then drawn by identifying the Nth case, the Nth plus I, the Nth plus 2*I, the Nth plus 3*I, etc., through the entire list. The nearest landowner marked on the list for the forest landowner fire tax was then selected for the sample. Thus, all members of the sample should be forest landowners. However, those for whom the records showed acreages of less than 5 were not selected. Uniform county sample sizes were used to make it possible to make estimates at the county level with a relatively small overall sample. Of course, this results in different sampling proportions in each county, and a different expansion factor for expanding the sample to the total population. See table 1 for a detailed description of respondent sampling procedures and returns and for estimates of the number of nonindustrial private landowners represented by the samples in each of the sample counties.

Survey Procedures

Various sources were used to design the survey instrument, including the previous survey by Greene (1988) and Greene and Blatner (1986). Four focus groups were held in Fayetteville, Perryville, Huntsville, Star City, and in Camden (Williams and others 1996). Based upon these results added to previous work, an 8-page survey instrument was designed and pre-tested.

Questionnaires were mailed to the entire sample of 2,400 persons in the first wave. A reminder postcard was then sent to those who had not responded within 2 weeks. A second mail-out with new copies of the questionnaires was done 4 weeks after the first mailing to everyone who had not yet responded at that time. The overall response to the first mailing was 582, for a gross response rate of 24 percent. The reminder and last mail-out resulted in receiving another 288 usable questionnaires for a total of 865 or 866, depending upon which variables are used, for a gross response rate of 36 percent. The response by county and region is summarized in table 1. As is shown in table 1, within the 12 sample counties from which they were selected, the respondents each represent about 14.4 NIPF landowners (the last column). This number is estimated by dividing the acreage held by NIPF owners (first column) by the average. This varies greatly from county to county and region to region, ranging from 5.2 in Perry County to 41 in Fulton County.

SURVEY RESULTS

Demographic Characteristics by Region

Table 2 shows the basic socio-demographic characteristics of the respondents by region. The first row in table 2 shows that the respondents were, on average, older, with an overall average of 56 and a high of 61 in the Delta. This compares with an estimated average age of farmers in Arkansas of (54). Most respondents were male (78 percent), and, overall, about half were employed full time. Full-time employment was higher in the Ouachitas at 58 percent. Nearly the entire remaining half were retired. This ranged from 38 percent in the Ouachitas to 51 percent in the Coastal Plain.

Both the educational levels and income levels of the respondents were relatively high. An overall 32 percent had completed college, and, by far, the majority of respondents reported income levels in the range of from $25,000 to $50,000 per year. The highest educational and income levels were found in the Coastal Plain and the lowest in the Ozarks.

Table 3 shows organizational memberships of respondents. Relatively few were organizational members, and, of course, even fewer held offices. The patterns of organizational membership varied substantially among the regions. The most interesting aspect of organizational memberships is that, among these nonindustrial forest landowners, membership in environmental organizations was higher (4.5 percent overall) than membership in timber organizations (3.5 percent overall). This varies by region, of course, with timber organizational membership higher in the Coastal Plain but lower in the other three regions.

Land Ownership by County and Region

Overall, 807 respondents provided some information about the amount of land they owned, reporting an average landownership of 382 acres, with a high of 598 in the Coastal Plain and a low of 231 in the Ozarks (table 4a). For the State as a whole, they reported an average of 252 acres of forested land, 133 acres of pine, 94 acres of hardwood, and 107 acres of farmland. The average acreage of forested land was much higher in the Coastal Plain, at 574 acres, most of which was pine (422 acres). Most of the land had been acquired between 1970 and 1989. Respondents in the Ozarks appeared to report, on the average, somewhat more recent acquisitions. These acreage figures seem to be quite large. Of course, those with the smallest acreages were not selected for the sample, and there were some very large acreages included, which resulted in very skewed distributions in almost all of the counties. The maximum reported for all land owned is 30,000 acres with one respondent alone reporting ownership of 14,000 acres of forested land.

Respondents were asked where they lived relative to their forest land. Their responses are shown in table 4b. More than half did live on their forest land. The highest percentages were in the Ozarks (64.2 percent) and the Ouachitas (63.2 percent). Of course, this leaves a surprisingly large proportion of landowners who do not live on their forest lands. These were asked to also specify the distance they lived from their forest land. The distance was greatest in the Ozarks Region for an average of 109 miles. This region had 6.3 percent (7 people) who lived 500 miles or more away.

Table 5, figure 1, and figure 2 show the relative distribution of forested land and land owners by size category. Nearly half of the landowners report less than 50 acres. However, for the State as a whole, nearly 68 percent of the land is

Table 1—Summary of sample returns from 12-county study of nonindustrial private forest (NIPF) landowners in Arkansas

Region and county	Acreage held by NIPF	Estimated number of owners	Number of samples selected	No. "not applicable" returns	Number of usable returns	Effective return rate	Reporting forested acreage	Average forested acreage N	Number of NIPF owners
						Percent			
Ozark	1,038.7	6,925	1,000	30	391	40.3	326	150	21.2
Fulton	184.3	2,220	200	6	75	38.7	54	83	41.1
Johnson	107.0	1,216	200	6	79	40.7	68	88	17.9
Madison	333.1	1,609	200	6	81	41.8	69	207	23.3
Sharp	196.9	1,279	200	6	80	41.2	71	154	18.0
Stone	217.4	1,040	200	6	76	39.2	64	209	16.3
Delta	169.4	1,448	400	11	123	31.6	96	117	15.1
Cross	56.2	646	200	5	52	26.7	41	87	15.8
Lincoln	113.2	809	200	6	71	36.6	55	140	14.7
Ouachita	163.8	1,122	400	12	155	39.9	121	146	9.3
Logan	115.0	871	200	6	82	42.3	63	132	13.8
Perry	48.8	303	200	6	73	37.6	58	161	5.2
Coastal Plain	548.4	1,545	600	18	196	33.7	157	355	9.8
Bradley	169.7	465	200	6	72	37.1	64	365	7.3
Miller	124.8	560	200	6	56	28.9	44	223	12.7
Ouachita	253.9	550	200	6	68	35.1	49	462	11.2
Total	1,920.3	10,054	2,400	71	865	37.1	700	191	14.4

Table 2—Demographic characteristics of respondents by region in Arkansas

Demographic characteristics	Total	Coastal Plain	Delta	Ouachita	Ozark
Average age	58.2	59.1	60.9	56.5	57.5
Percent male	78	69	75	80	80
Educational level					
Elem. (percent)	18	14	19	14	22
High school (percent)	50	38	52	58	52
College (incl. Assoc.) (percent)	22	35	20	19	17
Post-grad (percent)	10	13	9	9	9
Total (percent)	100	100	100	100	100
Number	824	187	117	148	372
Employment status					
Full time (percent)	48	40	47	58	48
Part time (percent)	3	3	1	1	4
Retired (percent)	44	51	44	38	43
Other (percent)	5	6	8	3	5
Total (percent)	100	100	100	100	100
Number	833	188	120	146	379
Income levels					
None (percent)	1	0	2	0	2
LT $10K (percent)	8	6	3	4	12
10 to 25K (percent)	27	21	20	30	31
25 to 50K (percent)	31	32	31	34	29
50 to 100K (percent)	25	28	32	24	21
GT 100K (percent)	8	13	12	8	5
Total (percent)	100	100	100	100	100
Number	747	168	102	134	343

Table 3—Organizational membership by organization and region in Arkansas

	State		Coastal		Delta		Ouachita		Ozark	
Organization	Member	Officer	Member	Officer	Member	Officer	Member	Officer	Member	Officer
	Percent									
Farm, commodity, or breed assn.	13.5	0.7	9.3	0.0	15.1	3.2	18.9	0.8	13.0	0.3
Business Org. (e.g., C of C)	8.8	1.4	11.6	1.2	10.8	2.2	7.6	1.5	7.0	1.3
Environmental organization	4.5	.1	4.7	.6	3.2	0	6.8	0	3.7	0
Outdoor recreation organization	6.6	.7	7.6	0	8.6	2.2	5.3	1.5	6.0	.3
Timber organization	3.6	.1	9.9	.6	0	0	2.3	0	1.7	0
Other interest group	12.4	1.6	12.2	0	9.8	1.1	11.4	2.3	13.8	2.3

Table 4a—Land ownership in Arkansas

Item	State	Coastal	Delta	Ouachita	Ozark
			Acres		
Total land owned (averages)	382	598	366	491	232
Forested land	252	574	117	210	150
Pine	133	422	39	125	22
Hardwood	99	112	42	72	108
Farm land	107	60	235	112	93
Number	807	191	109	141	366
When forest land acquired					
<1949 (percent)	9	11	18	9	5
1950–1959 (percent)	9	11	10	7	9
1960–1969 (percent)	13	15	8	15	13
1970–1979 (percent)	24	23	25	25	23
1980–1989 (percent)	28	29	22	28	29
1990 >(percent)	17	10	17	15	20
Total (percent)	100	100	100	100	100
Number	801	184	111	142	364
			Percent		
Reasons for owning land					
Live in rural environment	58.0	44.9	44.8	65.8	65.8
Enjoy own greenspace	53.6	41.8	44.0	58.1	60.9
Wildlife habitat	52.3	45.9	52.0	53.5	5.0
Building estate for heirs	42.6	57.7	47.2	43.5	33.2
Personal recreation	38.5	31.6	33.6	38.1	43.7
Livestock raising for sale	34.5	21.9	24.8	50.3	37.5
Timber to sell	31.9	59.2	29.6	26.5	21.1
Inherited the land	26.7	48.0	32.8	29.7	12.9
Crop or hay farming for sale	16.2	13.8	26.4	20.0	12.6
Second home site	13.2	6.1	8.8	14.2	17.7
Recreation for others	12.8	13.8	11.2	11.0	13.6
Eventually sell at profit	12.6	11.2	8.8	15.5	13.4
Other reasons	6.8	3.6	5.6	8.4	8.3
Tax shelter	5.4	4.1	3.2	7.1	6.2
Renting dwellings/mobile homes	4.2	4.1	7.2	4.5	3.1
Income from recreation (hunting)	3.9	10.7	1.6	1.3	2.3
Landscape shrubbery for sale	.3	.5	0	.6	.3
Nursery or Christmas trees	.3	.5	0	.6	.3

Table 4b—Residence in relation to forest land owned in Arkansas

	State	Coastal	Delta	Ouachita	Ozarks
Do you live on your forest land? (percent)	57.9	47.5	48.3	63.2	64.2
If not, how many miles is it?	68	57	37	33	109
			Percent		
Distance from forest land					
Less than 5 mile	20.3	19.5	30.8	22.0	15.3
5 to 24 miles	35.7	40.2	38.5	30.0	33.3
25 to 49 miles	13.0	9.2	13.5	24.0	10.8
50 to 99 miles	10.3	12.6	3.8	12.0	10.8
100 to 249 miles	13.0	10.3	11.5	12.0	16.2
250 to 499 miles	5.3	8.0	1.9	0	7.2
500 miles or more	2.3	0	0	0	6.3
Total	99.9	99.8	100.0	100.0	99.9

Table 5—Relative distribution of forested land owned and of owners by size categories and regions in Arkansas

Regions	0–49	50–99	100–249	250–499	500+	Total	Number
				Total forested acres			
Coastal Plain	1,421.5	1,790	4,760	5,,497	78,311	91,779.5	160
Delta	1,119.5	634	3,960	3,263.25	2,300	11,276.75	96
Ouachita	1,178.5	2,218	3284	1,960	17,000	25,640.5	122
Ozarks	2,937.5	4,362	11,859	5,907	23,960	49,025.5	326
Total	6,657	9,004	23,863	16,627.25	121,571	177,722.3	704
				Percent forested acres			
Coastal Plain	1.5	2.0	5.2	6.0	85.3	100.0	—
Delta	9.9	5.6	35.1	28.9	20.4	100.0	—
Ouachita	4.6	8.7	12.8	7.6	66.3	100.0	—
Ozarks	6.0	8.9	24.2	12.0	48.9	100.0	—
Total	3.7	5.1	13.4	9.4	68.4	100.0	—
				Forest landowners			
Coastal Plain	60	25	31	16	28	160	—
Delta	49	9	26	10	2	96	—
Ouachita	55	32	23	6	6	122	—
Ozarks	148	64	78	19	17	326	—
Total	312	130	158	51	53	704	—
				Percent of owners			
Coastal Plain	37.5	15.6	19.4	10.0	17.5	100.0	—
Delta	51.0	9.4	27.1	10.4	2.1	100.0	—
Ouachita	45.1	26.2	18.9	4.9	4.9	100.0	—
Ozarks	45.4	19.6	23.9	5.8	5.2	100.0	—
Total	44.3	18.5	22.4	7.2	7.5	100.0	—

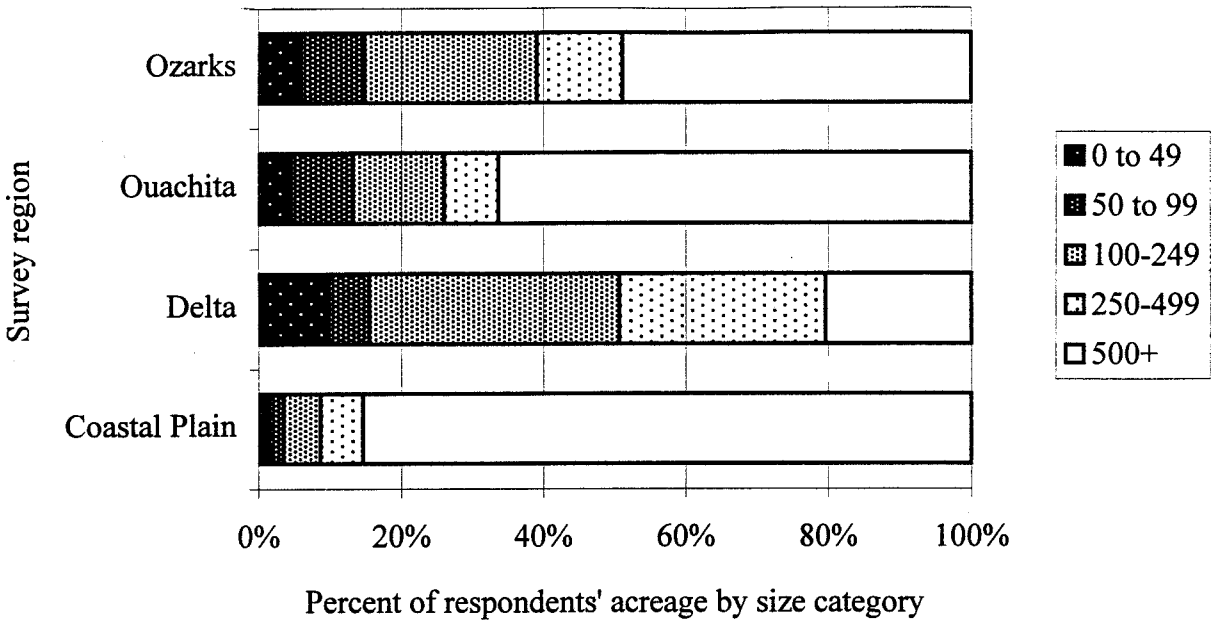

Figure 1—Relative distribution of forested land in Arkansas by size category.

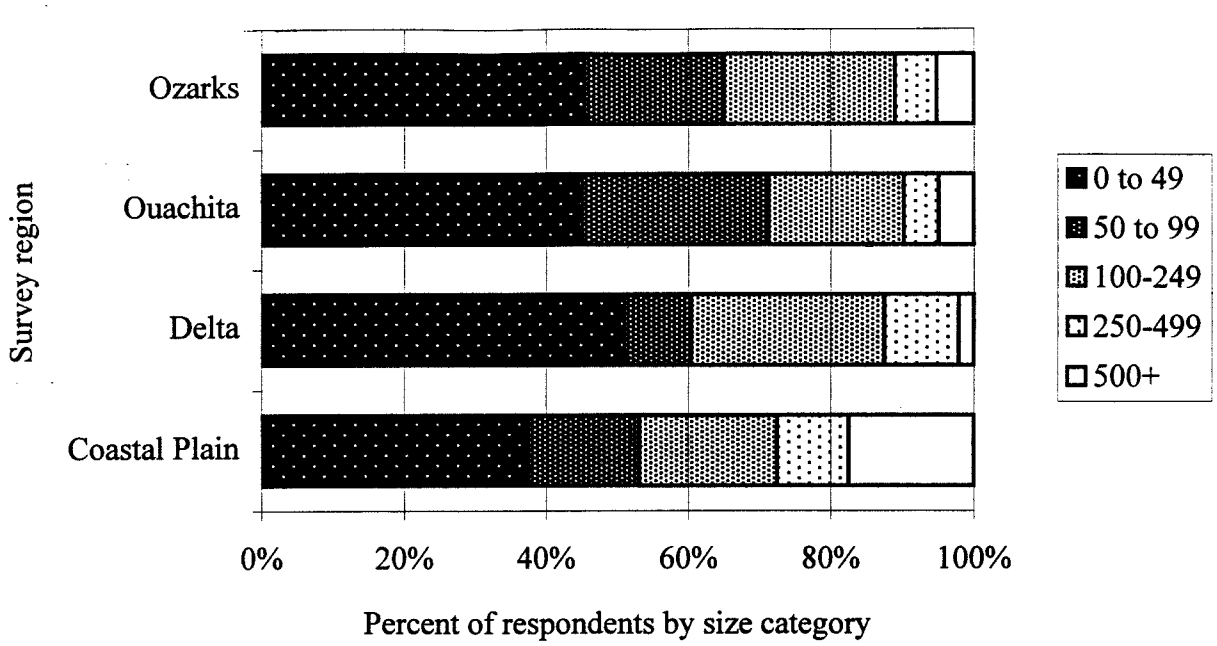

Figure 2—Relative distribution of forest land owners in Arkansas by size category.

owned and managed by those in the largest size category who make up only 7.5 percent of the respondents. For the Coastal Plain region, 85 percent of the land is owned and managed by owners who have 500 acres or more.

Reasons for Owning Land and Intentions for Use of Forest Land

Early in the questionnaire, respondents had been asked to indicate their major reasons for owning land. They were encouraged to mark all reasons that were important to them. The bottom section of table 4a shows the response categories that were provided, which emerged from the focus groups that were performed prior to the survey. The percentage of respondents who selected each item is given, and the reasons have been arranged in descending order of the frequency of selection for the State as a whole.

To "live in rural environment," to "enjoy own greenspace" and "wildlife habitat" are the three most frequently selected motivations, and each was selected by more than 50 percent of the respondents. This is followed by "building assets for heirs," which is followed, again, by "personal recreation." This shows a surprisingly high environmental, aesthetic, and recreational set of motives. And, interestingly, it is relatively consistent across regions, except for the Coastal Plain, where these three items are substantially lower. Selling timber, on the other hand, while not particularly low, was selected by more than 50 percent only in the Coastal Plain (59.2 percent), and overall was selected by only 32 percent of the respondents. Perhaps most interesting, though, is the fourth most frequently selected reason, "building estate for heirs." Professionals working with NIPF landowners have known for a long time that long-term banking and asset building are key factors in forest land ownership and management. "Tax shelter," appeared very infrequently, with an overall percentage of only 5.4 percent.

An exploratory factor analysis was performed on the 17 items in the list of reasons for owning land. Five factors were identified. The rotated factor matrix is shown in table 6. The patterns in the five factors are quite distinct. Those questions with the highest loadings on the respective factors are indicated in bold in table 6. The factors, called "Reason1" to "Reason5" appear to represent the following content:

Reasons1—Greenspace, recreation, and rural environment (Environment and recreation).
Reasons2—Nursery for shrubbery, Christmas trees, and renting out for dwellings and mobile homes (Nursery).
Reasons3—Selling timber, inherited, building estate, hunting (Timber).
Reasons4—Farming and tax shelter (Farming).
Reasons5—Residence, eventually sell at a profit (Residence).

Table 7 and figure 3 show the average factor scores by region for the State on these five factors. This analysis does show a clear distinction among regions, especially on Reasons1, Environment and Recreation, which is relatively high in the Ozarks and quite low in the Coastal Plain, and, conversely, on Reasons3, Timber, which is high in the Coastal Plain and low in the Ozarks. Reasons2, Nursery, which is a reason that occurred infrequently, is hardly distinguishable by region at all.

It might seem reasonable to expect that the value placed upon environment and recreation would be associated with the size and type of landholding, and that higher values on this factor would be found among the smaller land owners. A correlation analysis was performed among the acreage variables and the five factors, and a regression model was estimated in which the factors were the dependent variables and the several acreage measures and region were independent variables. Because of the paucity of

Table 6—Exploratory factor analysis of reasons for owning land in Arkansas

Variable	Reasons1	Reasons2	Reasons3	Reasons4	Reasons5
Renting dwellings or mobile homes	0.141	0.392	0.047	0.033	0.150
Second home site	.256	.095	- .071	- .138	.481
Inherited land	- .227	.103	.596	- .168	- .173
Personal greenspace	.743	.080	- .186	- .031	- .063
Tax shelter	.128	.217	.177	.369	.299
Personal recreation	.732	.039	.117	.042	.180
Eventually sell at profit	- .017	.078	.008	.059	.781
Recreation for others	.501	- .005	.313	.068	.194
Making money from hunting, rec.	.043	.119	.501	.001	.122
Wildlife habitat	.731	.028	.145	- .049	.055
Estate for heirs	.273	- .023	.551	.163	- .053
Live in rural environment	.452	.134	- .320	.344	- .356
Crops or hay for sale	- .064	.078	.055	.770	.043
Livestock for sale	.023	- .037	- .026	.821	- .140
Landscape shrubbery for sale	- .048	.878	.045	.079	.002
Nursery or Christmas trees for sale	.012	.881	.057	.005	.019
Timber for sale	.067	- .011	.661	.071	.012

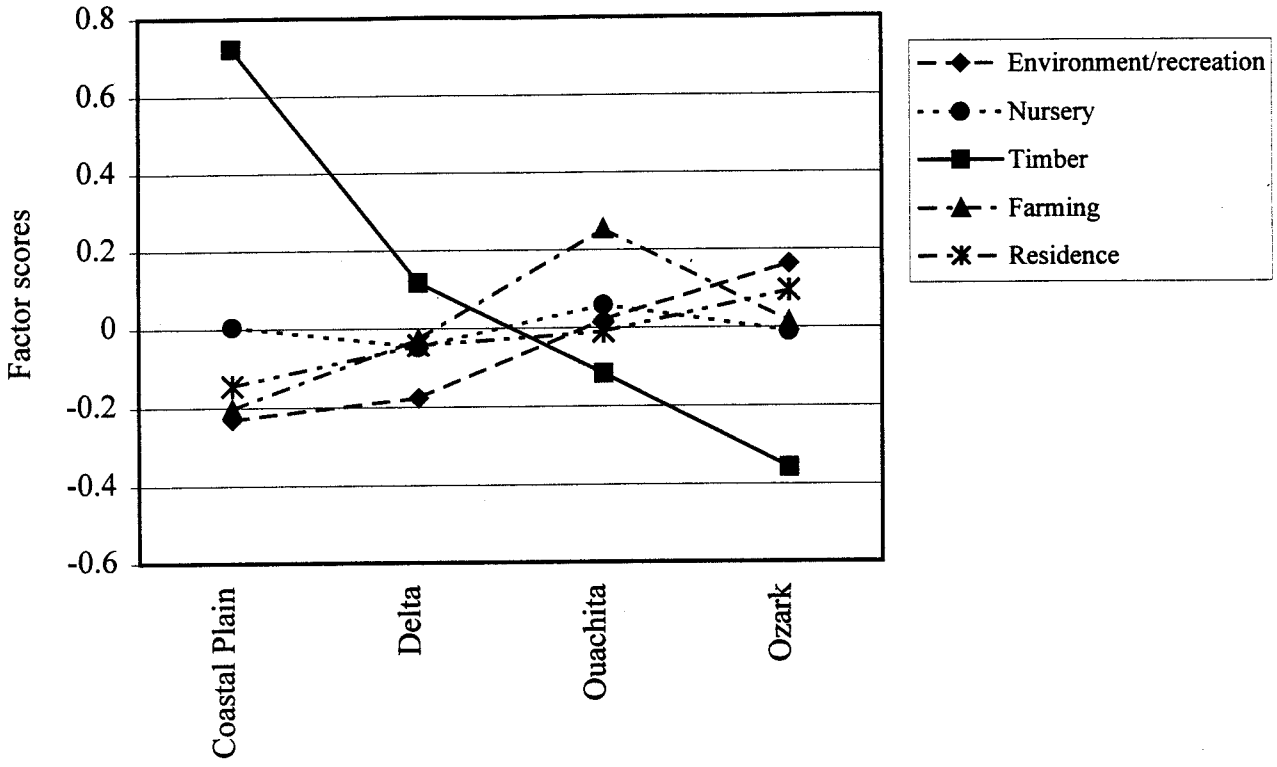

Figure 3—Factor scores for the five reasons landowners identified when asked why they own forest land in Arkansas.

Table 7—Factor scores for the reasons for owning land by region in Arkansas

	State	Coastal	Delta	Ouachita	Ozark
	- - - - Factor scores for "reasons" factors - - - -				
Reasons1	0.000	-0.231	-0.177	0.020	0.163
Reasons2	0	.005	- .047	.058	- .011
Reasons3	0	.723	.117	- .117	- .358
Reasons4	0	- .203	- .027	.254	.013
Reasons5	0	- .145	- .043	- .011	.094

significant correlations, these analyses are not reported here. There is a very slight negative association between size of land holding and environment and recreation, but it is usually not statistically significant. Hence, it is not correct to conclude that the preference for environment and recreation is true only of small land owners, or even that it is limited to a particular region of the State, even though the regions do differ somewhat.

The second question respondents were asked was ". . . how you intend to use and manage your land in the future." The possible responses, together with the summary labels we use, were:

Only Enviro.—I will emphasize improving wildlife, water, beauty or other natural aspects and do not intend on using my land to make money, for example, by growing timber to sell or raising livestock.
Enviro.—I will emphasize improving the natural aspects of my land, but I do intend on using my land to make money, for example, by growing timber to sell or raising livestock.
Money—I will emphasize using my land to make money, but I will also put some effort into maintaining the natural aspects.
Only Money—will mostly use my land to just make money.

The responses to these questions are presented in terms of percentages responding to each option in table 8 and are presented in figure 4. The pattern is similar to that observed above. From the Coastal Plain across to the Ozarks, the proportion selecting "All Enviro" increases, whereas "Money" decreases. "Enviro," and "All Money" do not show a particular pattern. However what is most remarkable is that for the State as a whole, 62 percent of NIPF landowners gives environmental, recreational, and aesthetic answers to this question.

Finally, respondents were asked about specific plans to sell timber in the future. The question was:

Do you plan to sell any timber (check the one best answer)
___ in the next 5 years,
___ 6–10 years from now,
___ sometime, but I don't know when,
___ No plan to sell,
___ don't know.

Table 8—Intentions about use of forest land in Arkansas

Question	Total	Coastal	Delta	Ouachita	Ozark
	- - - - - - - - - - - - - *Percent* - - - - - - - - - - - - -				
All Enviro	23	10	17	22	32
Enviro	39	43	35	47	36
Money	22	32	26	23	16
All money	5	3	11	2	5
Don't know	10	12	11	7	11
Missing	3	3	2	2	4
Total	100	100	100	100	100
Number of persons represented	79,000	10,000	10,000	24,000	36,000

Table 9 shows the answers to this question for the whole State and by region. Nearly 47 percent had no plans to sell timber, but this ranged from 22 percent in the Coastal Plain to 59 percent in the Ozarks, with the Delta and Ouachita regions in-between. Twenty seven and one tenth percent (18.4 + 8.7) indicated some plans to sell timber, either in the next 5 years, or during the next 10 years.

Finally, a question was asked about environmental attitudes in context of property rights. Respondents were asked to respond as to whether they strongly agreed, agreed, were neutral, disagreed, or strongly disagreed with the following statements ("Strongly agree" was coded 5, and "Strongly disagree" was coded 1 for the first panel in table 10):

Q3.1 ___ Private land owners have the right to do as they please with their lands regardless of what it does to the environment.
Q3.2 ___ Private property rights are important, but only if they don't hurt the environment.
Q3.3 ___ Private property rights should be limited if necessary to protect the environment.

Table 10 presents the results in detail. The first panel presents average scores on these three questions for the

Table 9—Plans to sell timber in the future in Arkansas

Plans to sell timber	Total	Coastal	Delta	Ouachita	Ozark
	- - - - - - - - - - - - - *Percent* - - - - - - - - - - - - -				
<5 yrs	18.4	34.1	17.8	15.3	11.4
6–10 yrs	8.7	14.5	9.3	9.9	4.9
Sometime	26.3	29.5	26.2	26.0	24.7
No plans	46.7	22.0	46.7	48.9	59.0
Total	100.0	100.0	100.0	100.0	100.0
Number	735	173	107	131	324

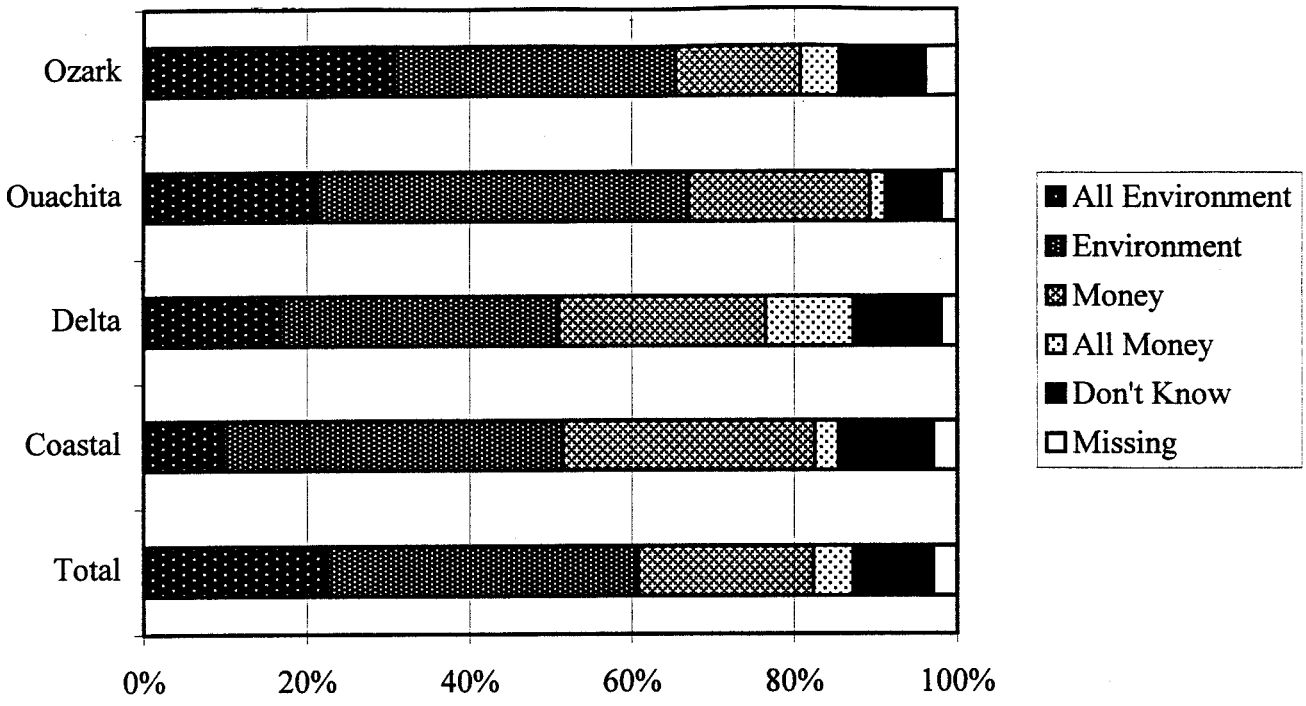

Figure 4—Results of the question asking how Arkansas landowners intend to use and manage their land in the future.

Table 10—Environmental values and property rights in Arkansas

Private property rights	State	Coastal	Delta	Ouachita	Ozark
Q3.1: Do as they please	2.447	2.482	2.706	2.464	2.339
Q3.2: Important but don't hurt env.	3.994	3.961	3.857	4.000	4.050
Q3.3: Should be limited	3.143	3.079	3.000	3.134	3.224
			Percent		
Property rights, Q3.1: Do as they please					
Strongly agree	14.0	12.9	17.4	12.3	14.2
Agree	10.6	12.9	11.0	12.3	8.6
Neutral	9.8	10.0	11.9	13.0	7.7
Disagree	37.3	37.6	44.0	34.1	36.3
Strongly disagree	28.3	26.5	15.6	28.3	33.3
Total	100.0	100.0	100.0	100.0	100.0
Property rights, Q3.2: Important, but don't hurt environment					
Strongly agree	38.0	34.8	21.4	34.3	38.4
Agree	49.6	42.1	56.3	46.4	42.3
Neutral	10.5	11.2	11.6	7.9	8.7
Disagree	8.4	7.9	8.0	7.9	7.3
Strongly disagree	3.8	3.9	2.7	3.6	3.4
Total	110.4	100.0	100.0	100.0	100.0
Property rights, Q3.3: Should be limited					
Strongly agree	11.5	10.3	6.1	12.6	13.4
Agree	38.1	35.8	39.4	35.4	40.1
Neutral	18.4	20.0	20.2	18.9	16.8
Disagree	17.1	19.4	17.2	18.9	15.2
Strongly disagree	14.9	14.5	17.2	14.2	14.6
Total	100.0	100.0	100.0	100.0	100.0

State and for the regions. The other three panels present relative frequency distributions for each of the questions individually. These results are also summarized in figure 5. It seems remarkable that, even in the context of the issues of private property rights, there is relatively high agreement with limitations upon private land rights for environmental purposes and relatively low support for completely unlimited property rights. The differences by region follow the same pattern as above. However, they do not appear to be great.

What we find, then, is what appears to be a relatively low level of interest in the direct economic use of forest land and in the selling of timber from the land; and, conversely, what appears to be preference for environmental, recreational, and aesthetic objectives for use of the forest land. This is, of course, consistent with considerable other research that has been done on NIPF landowners.

Land Management and Land Management Issues

When respondents were asked who actually managed their forest land, they answered as indicated in the top frame of table 11 and figure 6. Most (77 percent for the State as a whole) said they managed it themselves. Fourteen percent said no one did, and a little less that 9 percent said someone else did. Presumably, many of these involve specialized or professional management. This question was followed by a question regarding the kind of land management practices that had been applied during the last year. These are reported in two ways in table 11. The second panel shows the percentage who said they had engaged in this particular practice during the last year. The third panel shows the average number of acres involved for those who engaged in the practice. “Improved habitat for wildlife” was by far the most frequent land management practice reported by nearly 43 percent for the State as a whole, 34 percent in the Coastal Plain, and nearly 48 percent in the Ozarks. The next most frequently mentioned was “Applied fertilizer to rangelands or woodlands” (28.5 percent for the State, 19.5 percent in the Coastal Plain, and 37 percent in the Ozarks). The next in order of frequency were “Provided habitat and/or protection for songbirds” (28.5 percent), “Thinned for better growth” (27.5 percent), “Harvested mature timber” (26.9 percent), and “Planted trees” (25.6 percent). And, as would be expected, the frequency of these various practices varied substantially among the regions. For example, whereas 42.2 percent reported harvesting timber in the Coastal Plain, only 19.6 percent had done so in the Ozarks.

Respondents were asked whether they had encountered any particular problems in the management of their forest lands. The percentages reporting each of a list of possible problems by State and region are reported in table 12 and figure 7. The most frequently reported problem is trash dumping at 45.9 percent. Poaching follows in frequency at 39.9 percent. Land use regulations and restrictions were the least frequently mentioned. At only 3.8 percent overall, 1.1 percent in the Coastal Plain, 14.3 percent in the Ouachitas. It was mentioned by nearly 8 percent in the Ouachita’s and only 1 percent in the Coastal Plain. Timber theft is apparently not uncommon, having been reported by 16.7 percent overall and by 22 percent in the Coastal Plain.

Respondents were also asked about the impact that taxes have upon the management of their lands. The responses are summarized in table 13 and figure 8. Overall, nearly 28 percent said that taxes influenced their management. This was 46.5 percent in the Coastal Plain and 21.3 percent in the Ozarks. Of those who said that taxes influenced how

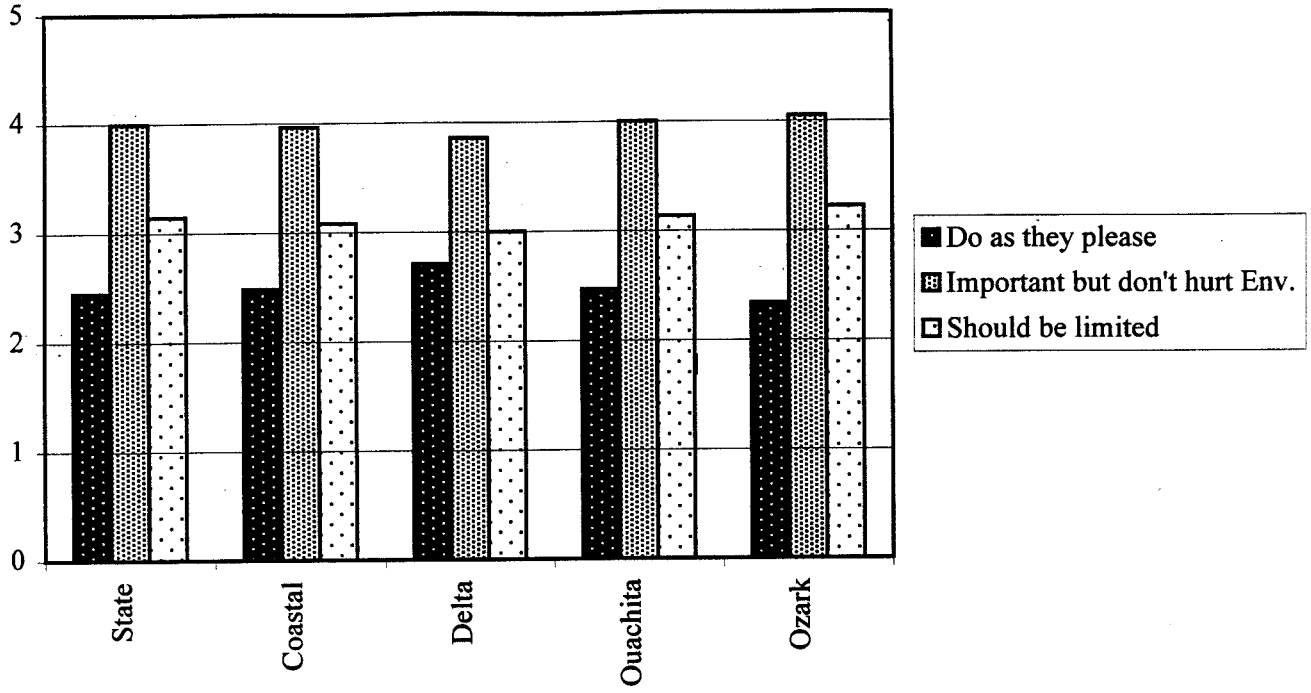

Figure 5—Results of questions raised regarding privacy of forest land ownership.

Table 11—Management of forest lands in Arkansas

	State	Coastal	Delta	Ouachita	Ozark
Who manages forest land?					
Self	77.0%	71.9%	69.0%	80.0%	80.9%
Other	8.9%	18.9%	14.7%	5.5%	3.3%
No one	14.1%	9.2%	16.4%	14.5%	15.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Number	813	185	116	145	367
	Percent who used practice				
Management practices used					
Q6.1: Cleared for pasture/farming	15.6	8.3	7.8	25.0	18.9
Q6.2: Harvested mature timber	26.9	42.2	27.6	23.8	19.6
Q6.3: Thinned for better growth	27.5	39.8	19.6	22.0	25.7
Q6.4: Planted trees	25.6	31.3	20.4	26.2	24.0
Q6.5: Improved wildlife habitat	42.5	34.0	47.5	35.9	47.8
Q6.6: Habitat for songbirds	28.5	20.0	26.9	31.0	32.2
Q6.7: Developed ponds/lakes	18.2	9.9	19.8	23.0	19.9
Q6.8: Stocked fish	22.9	16.0	18.8	29.4	24.8
Q6.9: Developed roads	17.3	17.9	12.6	15.1	19.3
Q6.10: Developed trails	13.7	11.3	20.0	10.9	13.9
Q6.11: Developed boat ramp, etc.	2.2	0.7	2.2	3.4	2.4
Q6.12: Applied fertilizer	31.2	19.5	18.9	40.2	37.0
Q6.13: Used fire to control veg.	10.6	11.4	7.5	12.6	10.4
Q6.14: Controlled wildfire	6.7	4.1	7.6	12.0	5.6
Q6.15: Other	8.5	6.5	8.6	10.6	8.9
	Average acreage				
Management practices used					
Q6.1: Cleared for pasture/farming	23.90	5.60	60.60	16.40	27.80
Q6.2: Harvested mature timber	57.70	71.70	81.40	64.60	37.00
Q6.3: Thinned for better growth	45.70	103.10	64.40	22.10	17.30
Q6.4: Planted trees	40.20	105.00	22.40	34.10	4.20
Q6.5: Improved wildlife habitat	45.80	71.00	104.60	33.50	25.80
Q6.6: Habitat for songbirds	21.40	25.40	29.50	39.60	9.10
Q6.7: Developed ponds/lakes	6.40	1.20	57.70	1.00	.70
Q6.8: Stocked fish	10.90	3.30	56.00	1.80	9.80
Q6.9: Developed roads	12.20	18.40	14.00	0	12.90
Q6.10: Developed trails	20.10	16.50	82.50	3.00	13.50
Q6.11: Developed boat ramp, etc.	8.30	0	62.40	2.30	4.00
Q6.12: Applied fertilizer	38.20	19.50	66.30	36.40	42.60
Q6.13: Used fire to control veg.	21.60	31.20	59.10	20.50	9.30
Q6.14: Controlled wildfire	11.20	.20	53.90	7.40	8.30
Q6.15: Other	5.60	11.30	0	.60	5.70

they managed their forest lands, the most important tax was the Federal income tax at 73.2 percent overall. However, the State income tax was also important (58.9 percent) as were property taxes (55.4 percent). The capital gains tax was mentioned by 35.5 percent, the estate tax by 19.5 percent, investment tax credit by 13.9 percent and the inheritance tax by 11.3 percent. It seems clear, then, that tax management is an important issue to a large proportion of NIPF landowners.

Harvesting and Selling of Timber

A series of questions were asked about the harvesting and selling of timber. Responses to these are presented in tables 14 and 15. A little more than half of those reporting had sold timber in the recent past. This ranged from 39 percent in the Ozarks to nearly 76 percent in the Coastal Plain. The most frequently cited harvest method was “partial cut” at about 61 percent overall.

Those who had not sold timber were asked why. The reasons are given in table 14 and figure 9. The most frequently cited reason was lack of interest, especially important in the Ozarks at nearly 76 percent. The next most frequently mentioned reason was that the timber was too small. This, however, was mentioned most in the Coastal

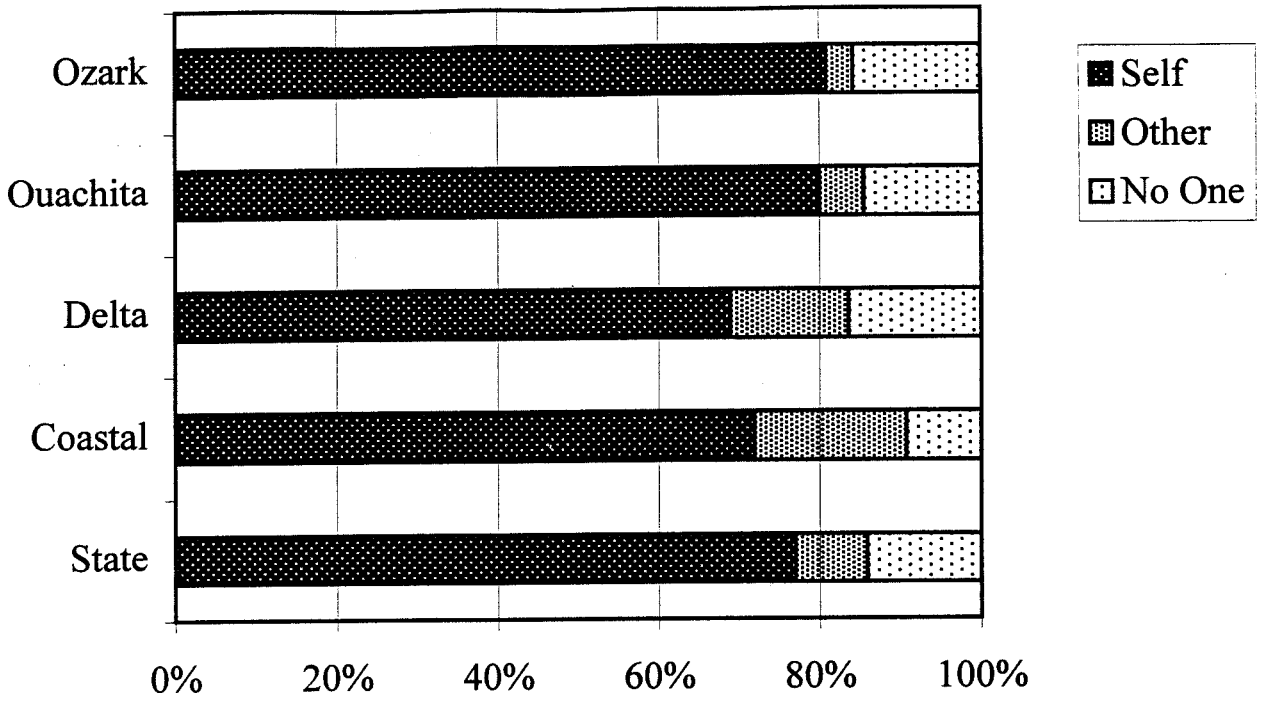

Figure 6—Results of questions raised about who actually managed privately-owned forest land.

Plain at 41 percent, and relatively infrequently in the other regions.

Respondents identified the products they sold. Overall, pine and hardwood sawtimber were the most frequently mentioned products at 54.8 percent and 50.4 percent. Pine sawtimber was, of course, most frequently mentioned in the Coastal Plain and hardwood sawtimber, in the Delta and especially in the Ozarks. Other products were also identified, and by far the most frequently identified was firewood and/or fence posts and other miscellaneous products for personal use.

Most of the respondents reported that they had been satisfied with their sale of forest products. Respondents were also asked whether they had obtained any professional advice when selling timber. The results are reported in the last line of table 14. Overall, nearly 39 percent had done so. However, this varied from 61 percent in the Coastal Plain to only 24.3 percent in the Ozarks.

Awareness of, Preferences for, and Use of Agencies and Programs

Finally, respondents were asked a variety of questions about information sources, agencies, and programs of which they were aware, which they preferred, which they used, and even some, which they would like to have available. The responses to these questions are reported in tables 15 and 16. The question for table 15 was "What are your major sources of information about farm or forest operations? Identify the best one with a '1' and the next best one with a '2.' " These we have recorded in the table as "best" and "good."

Table 12—Problems encountered on forest land (percent who reported the problem) in Arkansas

Problems encountered	State	Coastal	Delta	Ouachita	Ozark
			Percent		
Timber theft	16.7	22.0	17.0	17.9	13.4
Trash dumping	45.9	53.1	47.2	46.4	41.5
Poaching	39.9	31.1	43.4	43.6	41.8
Boundary line encroachment	23.9	36.2	16.0	20.7	21.4
Conflicts with neighbors	12.6	15.3	7.5	14.3	12.2
Land use regs. and restrictions	3.8	1.1	4.7	7.9	3.3
Other	4.3	4.5	1.9	4.3	5.0

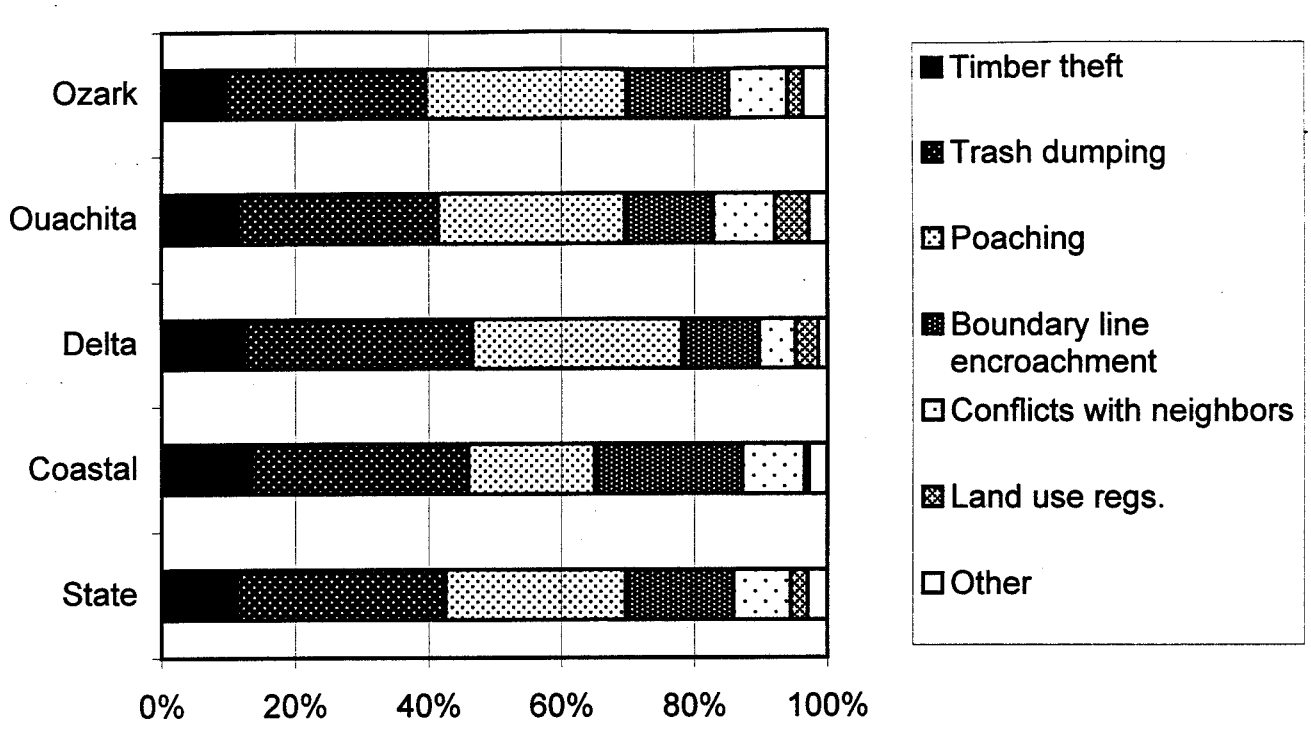

Figure 7—Problems reported in the management of private forest lands.

Table 13—Influence of taxes upon management and use of forest lands in Arkansas

	State	Coastal	Delta	Ouachita	Ozark
			Percent		
Do taxes influence the management and use of your property?					
Yes	27.9	46.5	23.5	24.7	21.3
No	60.2	46.5	60.5	61.0	66.7
Don't know	11.9	7.0	16.0	14.4	12.0
Total	100.0	100.0	100.0	100.0	100.0
			Percent of those reporting "yes" above		
Which tax programs influence management					
Federal income tax	73.2	75.9	79.2	75.7	68.3
State income tax	58.9	59.8	66.7	59.5	56.1
Property tax	55.4	49.4	70.8	56.8	57.3
Estate tax	19.5	21.8	25.0	10.8	19.5
Inheritance tax	11.3	10.5	12.5	8.1	13.4
Capital gain tax	35.5	42.5	33.3	35.1	29.3
Investment tax credit	13.9	17.2	12.5	10.8	12.3
Other	2.6	2.3	0	2.6	3.8

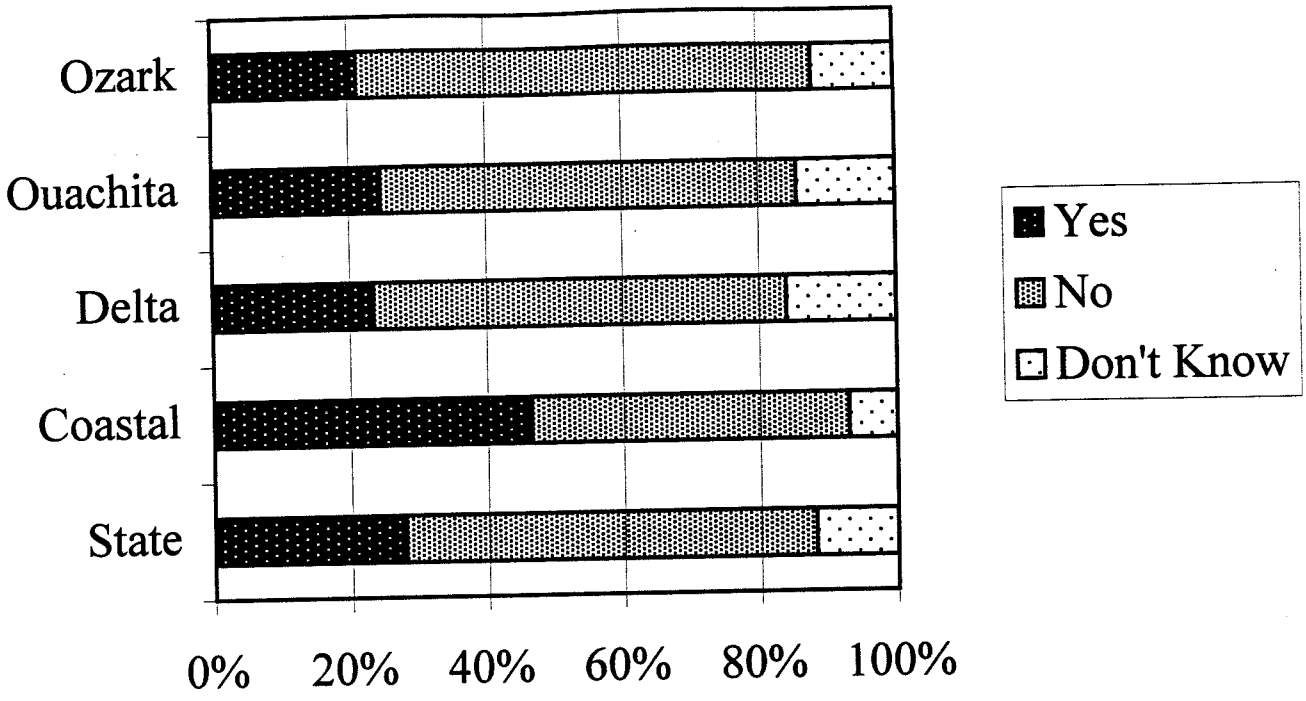

Figure 8—Responses to questions about whether taxes affect the management of private forest lands.

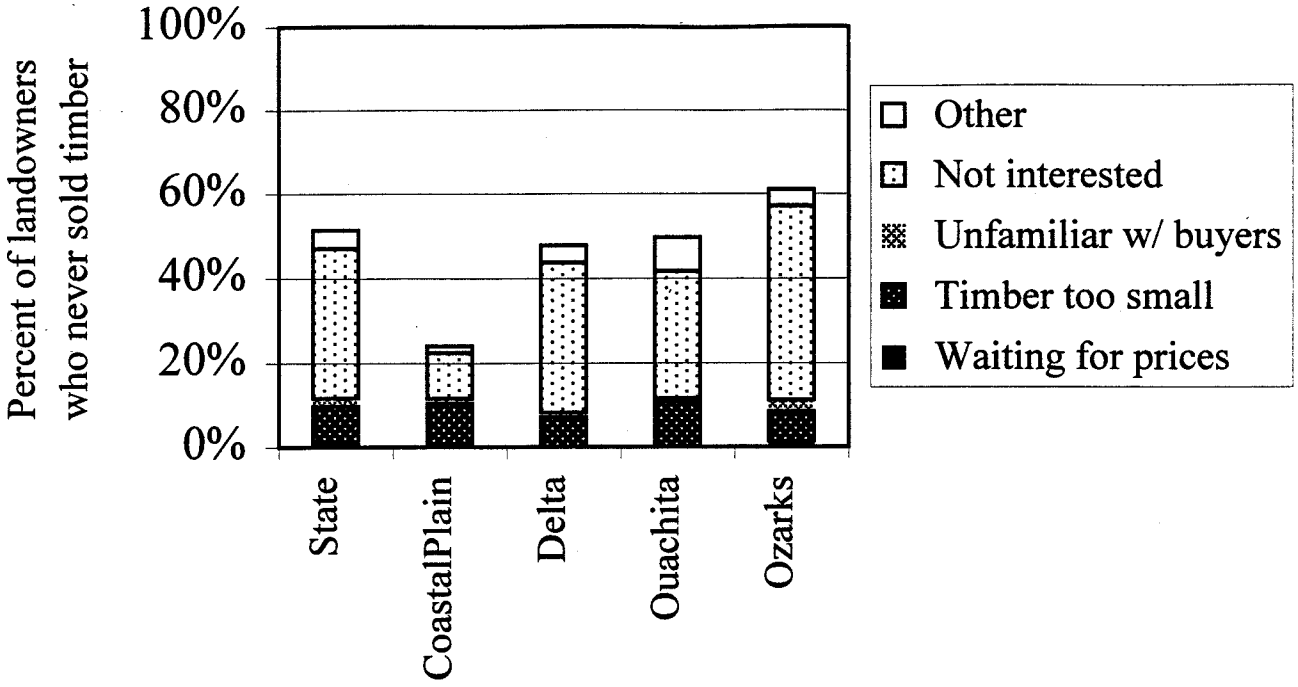

Figure 9—Responses to questions about why private landowners did not sell timber.

Table 14—Harvesting and sale of timber in Arkansas

	State	Coastal	Delta	Ouachita	Ozarks
			Percent		
Ever sold timber (yes)	48.7	75.9	52.2	50.3	39.1
Harvest method					
Harvest or seed tree cut	23.9	22.9	31.5	28.2	20.7
Partial cut	61.3	58.6	57.4	60.6	67.4
Thinning	15.5	23.6	14.8	14.1	8.1
Salvage cut	9.5	18.6	3.7	5.6	5.2
Reasons for not selling					
Waiting for prices	1.4	2.3	0	0	2.0
Timber too small	17.6	40.9	14.9	21.7	11.8
Unfamiliar w/buyers	3.6	4.5	2.1	1.4	4.4
Not interested	69.0	45.5	74.5	60.9	75.5
Other	8.5	6.8	8.5	15.9	6.4
Total	100.0	100.0	100.0	100.0	100.0
Products from last sale					
Pine sawtimber	54.8	79.9	44.3	69.9	25.7
Hardwood sawtimber	50.4	41.7	55.7	19.2	73.5
Pine pulpwood	41.3	68.3	39.3	38.4	16.2
Hardwood pulpwood	27.9	47.5	29.5	24.7	8.8
Pine veneer	1.7	2.9	3.3	1.4	0
Hardwood veneer	3.7	1.4	8.2	2.7	4.4
Other	7.3	2.9	4.9	4.1	14.7
Other products sold					
Firewood for personal use	69.9	53.4	56.6	81.9	84.2
Fence posts, etc., personal use	34.4	9.2	15.1	50.0	57.6
Firewood for sale	8.9	1.5	3.8	9.7	17.3
Posts, etc. for sale	6.1	8.4	5.7	6.9	3.6
Christmas trees for sale	.3	0	0	0	.7
Pinestraw, bark, mulch for sale	0	0	0	0	0
Other	4.1	3.1	1.9	7.0	4.3
Satisfied with the sale?	79.0	81.6	78.9	71.0	80.5
Get professional advice?	38.8	61.0	37.3	25.4	24.3

Table 15—Sources of information identified as "best" and as "good" by respondents in Arkansas

	State		Coastal		Delta		Ouachita		Ozark	
	Best	Good	Best	Good	Best	Good	Best	Good	Best	Good
					Percent					
Cooperative Extension Service	27.8	6.7	19.1	5.3	38.5	8.3	33.3	8.0	27.0	6.5
NRCS (Formerly SCS)	12.1	6.8	9.0	4.3	15.6	9.2	10.1	9.4	13.5	6.5
State forestry commission	11.9	4.6	14.4	3.7	12.8	5.5	11.6	3.6	10.4	5.1
Farm or forestry suppliers	3.0	2.9	3.2	3.2	3.7	3.7	3.6	5.8	2.5	1.4
Farm, forestry, etc. magazines	10.1	6.7	8.5	5.3	6.4	8.3	17.4	8.0	9.3	6.5
Radio or television	8.7	4.7	5.3	4.8	8.3	4.6	10.1	5.1	10.1	4.5
Friends and neighbors	28.2	12.8	28.2	10.6	20.2	9.2	22.5	21.7	32.9	11.5
Universities	1.6	1.0	3.2	1.6	.9	0	.7	.7	1.4	1.1
Others	12.0	.9	21.3	0	10.2	0	6.5	0	9.9	2.0

Table 16—Use, awareness of, and desire for government programs in Arkansas

	State	Coastal	Delta	Ouachita	Ozarks
			Percent		
Any government agency help?	16.1	23.9	22.9	13.3	11.4
Aware of tax credits?	15.1	21.7	16.2	19.7	9.7
Aware of amortization methods available for regeneration?	14.5	26.1	14.4	14.0	9.3
Ever used incentive programs?	11.6	20.7	15.2	12.9	5.6
Which programs?					
Forestry incentive programs	5.4	12.2	4.8	5.8	2.1
Conservation reserve program	2.7	4.6	5.6	4.5	0
Stewardship incentive program	1.0	1.0	.8	1.3	1.0
Other	.9	0	1.6	.6	1.3
What were funds used for?					
Reforestation	8.0	16.3	8.0	9.0	3.3
Site preparation	4.0	6.6	3.2	6.5	2.1
Wildlife habitat improvement	2.9	3.1	3.2	2.6	2.8
Timber stand improvement	2.5	6.1	1.6	0	2.1
Water quality protection	1.4	1.5	.8	1.9	1.3
Setting aside land	1.2	.5	2.4	1.9	.8
Wetlands	1.2	.5	5.6	0	.5
Precommercial thinning	.7	1.0	0	1.3	.5
Road maintentance	.7	1.0	.8	0	.8
Other	.6	1.0	0	0	.8
Use regeneration at removal?	51.4	65.8	52.8	49.0	44.6
Does regeneration idea interest you?	54.2	48.2	56.0	50.3	48.2

Friends and neighbors come out as both “best” and “good” most frequently, but they are closely followed by the Cooperative Extension Service, which is “best” for 27.8 percent and “good” for 6.7 percent for the State as a whole. The Extension Service’s reputation, however, varies considerably by region. It is lowest in the Coastal Plains (19.1 percent “best”) and highest in the Delta (38.5 percent “best”). Universities as separate from the Cooperative Extension Service were identified very infrequently.

Help from government agencies was reported by only 16.1 percent overall, but by as many as 23.9 percent and 22.9 percent in the Coastal Plain and Delta, respectively. And, consistent with this, awareness of tax credits, amortization methods for regeneration, and the use of incentive programs were all substantially higher in the Coastal Plain, though even there they were in the 20’s.

Forestry Incentive Programs were the most frequently used programs but were reported by only 5.4 percent overall and 12.2 percent in the Coastal Plain. CRP was reported by 2.7 percent overall, none in the Ozarks, and around 5 percent in the other three regions. Use of the Stewardship Incentive Program was almost nonexistent. The major use of the funds from these programs was for forest regeneration at 8 percent of all respondents, followed by site preparation at 4 percent.

CONCLUSIONS AND RECOMMENDATIONS

About 866 forest landowners from 12 counties of Arkansas, representing its 4 physiographic regions, were surveyed to determine their characteristics, some of their attitudes and opinions, their experiences with forest management, and their expressed needs. A return rate of about 37 percent was achieved with a mailed survey. Samples were of uniform size for the 12 counties, allowing for separate county-level estimation even though very little analysis has yet been performed at the county level. Each respondent to the survey, it is estimated, “represents” about 14 NIPF landowners in the sample counties alone, and this varies from 41 in Fulton County to only 5 in Perry County. The information is presented for the State as a whole and separately for the four physiographic regions.

Arkansas’ NIPF landowners are, on average, advanced in age, and nearly half are retired. Their educational and income levels are, compared to the rest of the State, relatively high. Although most live on or near their forest acreage, there is a significant number who live long distances away, especially in the Ozarks.

Respondents reported owning, on average, about 250 acres of forest land, 133 acres of pine forest, 94 acres of hardwood forest, and 107 acres of farmland. These acreages, of course, vary greatly among the four regions. Among the respondents, 68.4 percent of the land is owned by the 17.5 percent of owners who have more than 500 acres, whereas 3.7 percent of the forested land is possessed by the 44.3 percent who reported having less than 50 acres.

On a variety of questions that dealt with reasons for owning land, intentions with respect to use of the land in the future, and opinions about land regulations two patterns emerged. One is a concern about and/or interest in environment, recreation, wildlife, etc., and the other is the intent to use and manage the land primarily as a means of generating income through timber production. The latter, which it does not by any means dominate, is remarkably high, frequently mentioned, and widespread among these respondents. The survey results also show the obvious distinctions among landowners and among regions concerning the types of forest land they own. In the Coastal Plain, of course, pine dominates, whereas in the Ozarks, hardwoods are the major issue.

Without going into detail here, the research suggests several things: First, careful targeting is needed, when discussing programs, policy, or even the project impacts of various developments, like the emergence of the chip mills and the chip mill issue. A number of elements need to be taken into consideration in targeting, including the types of forest resources the owner has, which will be closely associated, of course, with the region of the State; the amount of forested land owned; the owners goals and objectives with respect to his or her forest land; and, finally, the characteristics of the owner himself or herself. Elderly landowners, who may reside in California, and own hardwood forests in the Ozarks, will clearly have different objectives and different needs from a resident (or even nonresident) landowner with substantial pine acreage in the Coastal Plain. So, the next step really is to perform some analyses of these very data looking at the size and type of the forest land owned, the objectives of the landowner, the characteristics of the landowner, and, of course, what is technically and economically feasible at a given point in time. Moving in the direction of improved management of hardwood resources is likely, for example, to involve very different considerations, time frames, etc., from trying to accomplish the same in the Coastal Plain with pine.

Another thing that is seriously needed is the development of a better data base. Periodic surveys like this and the one done earlier by Greene and his associates are valuable but limited, partly by their very periodicity. What is really needed is the development of a minimal, on-going population data base or list, which can be used both for sampling purposes for surveys such as this, but, perhaps even more importantly, for periodic, highly targeted surveys to deal with specific issues. Such a list, if kept up to date, properly protected, and appropriately organized, would also be an extremely valuable resource to those responsible for providing services to forest landowners. Finally, given the existence of the fire tax, it should, in fact, be possible to build such a list.

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Appendix 1—Detailed acreages by types of land, region, and county in Arkansas

Variable	Mean	Std Dev.	Minimum	Maximum	Number
Coastal Plain					
Total acreage	645	1835	5	14000	160
Forested acreage	574	1785	2	14000	160
Acreage in pine	422	1408	0	11000	160
Acreage in hardwood	112	479	0	5400	160
Acreage in farmland	60	270	0	3050	160
Bradley County					
Total acreage	399	929	10	6000	64
Forested acreage	365	876	5	5400	64
Acreage in pine	277	765	0	5000	64
Acreage in hardwood	41	116	0	700	64
Acreage in farmland	31	84	0	600	64
Miller County					
Total acreage	388	987	5	6250	44
Forested acreage	223	547	2	3200	44
Acreage in pine	143	426	0	2200	44
Acreage in hardwood	53	161	0	1000	44
Acreage in farmland	156	496	0	3050	44
Ouachita County					
Total acreage	1167	2864	5	14000	52
Forested acreage	1127	2875	2	14000	52
Acreage in pine	837	2244	0	11000	52
Acreage in hardwood	251	806	0	5400	52
Acreage in farmland	14	27	0	113	52
Delta Region					
Total acreage	398	701	2	5500	96
Forested acreage	117	189	1	1500	96
Acreage in pine	39	161	0	1500	96
Acreage in hardwood	42	75	0	400	96
Acreage in farmland	235	518	0	4000	96
Cross County					
Total acreage	441	508	10	2000	39
Forested acreage	87	101	4	400	41
Acreage in pine	3	16	0	100	41
Acreage in hardwood	67	101	0	400	41
Acreage in farmland	282	394	0	1600	41
Lincoln County					
Total acreage	365	821	2	5500	52
Forested acreage	140	233	1	1500	55
Acreage in pine	65	209	0	1500	55
Acreage in hardwood	23	40	0	185	55
Acreage in farmland	200	595	0	4000	55
Ouachita region					
Total acreage	561	2882	5	30000	117
Forested acreage	210	845	2	8000	122
Acreage in pine	125	635	0	6000	122
Acreage in hardwood	72	223	0	2000	122
Acreage in farmland	112	216	0	2000	122
Logan County					
Total acreage	270	643	6	5000	62
Forested acreage	132	382	2	3000	63
Acreage in pine	75	317	0	2500	63
Acreage in hardwood	49	80	0	500	63
Acreage in farmland	125	270	0	2000	63

(continued)

Appendix 1—Detailed acreages by types of land, region, and county in Arkansas (cont.)

Variable	Mean	Std Dev.	Minimum	Maximum	Number
Perry County					
Total acreage	890	4143	5	30000	55
Forested acreage	294	1150	3	8000	59
Acreage in pine	179	853	0	6000	59
Acreage in hardwood	97	310	0	2000	59
Acreage in farmland	97	140	0	800	59
Ozark region					
Total acreage	244	490	0.5	6000	323
Forested acreage	150	432	0.5	5800	326
Acreage in pine	22	239	0	4300	3
Acreage in hardwood	109	294	0	3500	326
Acreage in farmland	93	196	0	2020	326
Fulton County					
Total acreage	219	243	5	1169	54
Forested acreage	83	88	1	500	54
Acreage in pine	4	19	0	130	54
Acreage in hardwood	63	83	0	480	54
Acreage in farmland	127	209	0	1000	54
Johnson County					
Total acreage	155	155	2	700	67
Forested acreage	88	86	2	400	68
Acreage in pine	23	44	0	210	68
Acreage in hardwood	43	51	0	200	68
Acreage in farmland	52	71	0	300	68
Madison County					
Total acreage	317	606	3	4000	68
Forested acreage	207	524	3	3500	69
Acreage in pine	1	4	0	30	69
Acreage in hardwood	199	526	0	3500	69
Acreage in farmland	100	187	0	1300	69
Sharp County					
Total acreage	242	326	4	1758	70
Forested acreage	154	257	3	1520	71
Acreage in pine	2	6	0	40	71
Acreage in hardwood	116	202	0	1250	71
Acreage in farmland	129	296	0	2020	71
Stone County					
Total acreage	285	793	0.5	6000	64
Forested acreage	209	750	0.5	5800	64
Acreage in pine	79	537	0	4300	64
Acreage in hardwood	113	277	0	1500	64
Acreage in farmland	58	124	0	600	64

Appendix 2—Details of land ownership in Arkansas by size categories (total acreage, numbers and percentages)

County	0–49	50–99	100–249	250–499	500+	Total
Bradley	19	9	21	14	9	72
(percent)	26.4	12.5	29.2	19.4	12.5	100
Cross	8	3	11	10	12	44
	18.2	6.8	25	22.7	27.3	100
Fulton	19	13	18	13	6	69
	27.5	18.8	26.1	18.8	8.7	99.9
Johnson	29	11	20	13	3	76
	38.2	14.5	26.3	17.1	3.9	100
Lincoln	21	9	14	9	10	63
	33.3	14.3	22.2	14.3	15.9	100
Logan	21	15	17	15	6	74
	28.4	20.3	23	20.3	8.1	100.1
Madison	15	13	27	11	10	76
	19.7	17.1	35.5	14.5	13.2	100
Miller	23	8	11	5	8	55
	41.8	14.5	20	9.1	14.5	99.9
Ouachita	19	8	14	5	18	64
	29.7	12.5	21.9	7.8	28.1	100
Perry	23	10	10	19	5	67
	34.3	14.9	14.9	28.4	7.5	100
Sharp	23	9	20	11	11	74
	31.1	12.2	27	14.9	14.9	100.1
Stone	37	9	10	8	9	73
	50.7	12.3	13.7	11	12.3	100
Column	257	117	193	133	107	807
Total	31.8	14.5	23.9	16.5	13.3	100
Region						
Coastal Plain	61	25	46	24	35	191
	31.9	13.1	24.1	12.6	18.3	100
Delta	29	12	25	19	22	107
	27.1	11.2	23.4	17.8	20.6	100.1
Ouachita	44	25	27	34	11	141
	31.2	17.7	19.1	24.1	7.8	99.9
Ozark	123	55	95	56	39	368
	33.4	14.9	25.8	15.2	10.6	99.9
Column	257	117	193	133	107	807
Total	31.8	14.5	23.9	16.5	13.3	100

(continued)

Appendix 2 (cont.)—Details of land ownership in Arkansas by size categories (forested acreage, numbers and percentages)

County	0–49	50–99	100–249	250–499	500+	Total
Bradley	23	7	17	9	8	64
(percent)	35.9	10.9	26.6	14.1	12.5	100
Cross	23	5	8	5	—	41
	56.1	12.2	19.5	12.2	—	100
Fulton	25	11	16	1	1	54
	46.3	20.4	29.6	1.9	1.9	100.1
Johnson	29	16	19	4	—	68
	42.6	23.5	27.9	5.9	—	99.9
Lincoln	26	4	18	5	2	55
	47.3	7.3	32.7	9.1	3.6	100
Logan	29	19	10	2	3	63
	46	30.2	15.9	3.2	4.8	100.1
Madison	26	18	15	5	5	69
	37.7	26.1	21.7	7.2	7.2	99.9
Miller	20	9	7	3	5	44
	45.5	20.5	15.9	6.8	11.4	100.1
Ouachita	17	9	7	4	15	52
	32.7	17.3	13.5	7.7	28.8	100
Perry	26	13	13	4	3	59
	44.1	22	22	6.8	5.1	100
Sharp	30	11	17	8	5	71
	42.3	15.5	23.9	11.3	7	100
Stone	38	8	11	1	6	64
	59.4	12.5	17.2	1.6	9.4	100.1
Column	312	130	158	51	53	704
Total	44.3	18.5	22.4	7.2	7.5	99.9
Region						
Coastal Plain	60	25	31	16	28	160
	37.5	15.6	19.4	10	17.5	100
Delta	49	9	26	10	2	96
	51	9.4	27.1	10.4	2.1	100
Ouachita	55	32	23	6	6	122
	45.1	26.2	18.9	4.9	4.9	100
Ozark	148	64	78	19	17	326
	45.4	19.6	23.9	5.8	5.2	99.9
Column	312	130	158	51	53	704
Total	44.3	18.5	22.4	7.2	7.5	99.9

(continued)

Appendix 2 (cont.)—Details of land ownership in Arkansas by size categories (pine acreage, numbers and percentages)

County	None	0–49	50–99	100–249	250–499	500+	Total
Bradley	13	21	6	12	5	7	64
(Percent)	20.3	32.8	9.4	18.8	7.8	10.9	100
Cross	37	3	—	1	—	—	41
	90.2	7.3	—	2.4	—	—	99.9
Fulton	48	5	—	1	—	—	54
	88.9	9.3	—	1.9	—	—	100.1
Johnson	34	23	6	5	—	—	68
	50	33.8	8.8	7.4	—	—	100
Lincoln	28	14	3	7	2	1	55
	50.9	25.5	5.5	12.7	3.6	1.8	100
Logan	26	23	4	8	1	1	63
	41.3	36.5	6.3	12.7	1.6	1.6	100
Madison	61	8	—	—	—	—	69
	88.4	11.6	—	—	—	—	100
Miller	18	14	3	4	2	3	44
	40.9	31.8	6.8	9.1	4.5	6.8	99.9
Ouachita	13	13	7	5	1	13	52
	25	25	13.5	9.6	1.9	25	100
Perry	27	18	7	3	2	2	59
	45.8	30.5	11.9	5.1	3.4	3.4	100.1
Sharp	59	12	—	—	—	—	71
	83.1	16.9	—	—	—	—	100
Stone	38	21	1	3	—	1	64
	59.4	32.8	1.6	4.7	—	1.6	100.1
Column	402	175	37	49	13	28	704
Total	57.1	24.9	5.3	7	1.8	4	100.1
Region							
Coastal Plain	44	48	16	21	8	23	160
	27.5	30	10	13.1	5	14.4	100
Delta	65	17	3	8	2	1	96
	67.7	17.7	3.1	8.3	2.1	1	99.9
Ouachita	53	41	11	11	3	3	122
	43.4	33.6	9	9	2.5	2.5	100
Ozark	240	69	7	9	—	1	326
	73.6	21.2	2.1	2.8	—	0.3	100
Column	402	175	37	49	13	28	704
Total	57.1	24.9	5.3	7	1.8	4	100.1

(continued)

Appendix 2 (cont.)—Details of land ownership in Arkansas by size categories (hardwood acreage, numbers and percentages)

County	None	0–49	50–99	100–249	250–499	500+	Total
Bradley	29	24	6	2	1	2	64
(Percent)	45.3	37.5	9.4	3.1	1.6	3.1	100
Cross	13	14	4	6	4	—	41
	31.7	34.1	9.8	14.6	9.8	—	100
Fulton	14	18	8	13	1	—	54
	25.9	33.3	14.8	24.1	1.9	—	100
Johnson	21	22	15	10	—	—	68
	30.9	32.4	22.1	14.7	—	—	100.1
Lincoln	27	20	4	4	—	—	55
	49.1	36.4	7.3	7.3	—	—	100.1
Logan	13	31	12	5	1	1	63
	20.6	49.2	19	7.9	1.6	1.6	99.9
Madison	11	22	12	14	5	5	69
	15.9	31.9	17.4	20.3	7.2	7.2	99.9
Miller	22	14	3	2	2	1	44
	50	31.8	6.8	4.5	4.5	2.3	99.9
Ouachita	16	18	4	6	3	5	52
	30.8	34.6	7.7	11.5	5.8	9.6	100
Perry	18	23	10	4	1	3	59
	30.5	39	16.9	6.8	1.7	5.1	100
Sharp	17	23	8	12	7	4	71
	23.9	32.4	11.3	16.9	9.9	5.6	100
Stone	21	24	4	9	1	5	64
	32.8	37.5	6.3	14.1	1.6	7.8	100.1
Column	222	253	90	87	26	26	704
Total	31.5	35.9	12.8	12.4	3.7	3.7	100
Region							
Coastal Plain	67	56	13	10	6	8	160
	41.9	35	8.1	6.3	3.8	5	100.1
Delta	40	34	8	10	4	—	96
	41.7	35.4	8.3	10.4	4.2	—	100
Ouachita	31	54	22	9	2	4	122
	25.4	44.3	18	7.4	1.6	3.3	100
Ozark	84	109	47	58	14	14	326
	25.8	33.4	14.4	17.8	4.3	4.3	100
Column	222	253	90	87	26	26	704
Total	31.5	35.9	12.8	12.4	3.7	3.7	100

(continued)

Appendix 2 (cont.)—Details of land ownership by size categories (pine acreage, numbers and percentages)

County	None	0–49	50–99	100–249	250–499	500+	Total
Bradley	33	19	6	4	1	1	64
(percent)	51.6	29.7	9.4	6.3	1.6	1.6	100.2
Cross	6	6	4	12	4	9	41
	14.6	14.6	9.8	29.3	9.8	22	100.1
Fulton	11	19	5	11	5	3	54
	20.4	35.2	9.3	20.4	9.3	5.6	100.2
Johnson	20	25	9	11	3	—	68
	29.4	36.8	13.2	16.2	4.4	—	100
Lincoln	19	17	5	6	2	6	55
	34.5	30.9	9.1	10.9	3.6	10.9	99.9
Logan	9	21	8	18	5	2	63
	14.3	33.3	12.7	28.6	7.9	3.2	100
Madison	16	22	10	16	2	3	69
	23.2	31.9	14.5	23.2	2.9	4.3	100
Miller	19	13	2	5	1	4	44
	43.2	29.5	4.5	11.4	2.3	9.1	100
Ouachita	33	14	3	2	—	—	52
	63.5	26.9	5.8	3.8	—	—	100
Perry	14	18	8	11	7	1	59
	23.7	30.5	13.6	18.6	11.9	1.7	100
Sharp	22	20	5	12	10	2	71
	31	28.2	7	16.9	14.1	2.8	100
Stone	20	26	6	8	2	2	64
	31.3	40.6	9.4	12.5	3.1	3.1	100
Column	222	220	71	116	42	33	704
Total	31.5	31.3	10.1	16.5	6	4.7	100.1
Region							
Coastal Plain	85	46	11	11	2	5	160
	53.1	28.8	6.9	6.9	1.3	3.1	100.1
Delta	25	23	9	18	6	15	96
	26	24	9.4	18.8	6.3	15.6	100.1
Ouachita	23	39	16	29	12	3	122
	18.9	32	13.1	23.8	9.8	2.5	100.1
Ozark	89	112	35	58	22	10	326
	27.3	34.4	10.7	17.8	6.7	3.1	100
Column	222	220	71	116	42	33	704
Total	31.5	31.3	10.1	16.5	6	4.7	100.1

THE SUSTAINABLE FORESTRY INITIATIVE OF THE AMERICAN FOREST & PAPER ASSOCIATION

Chris Barneycastle[1]

Abstract—The Sustainable Forestry Initiative (SFI) is a comprehensive program of forestry and conservation practices designed to ensure that future generations of Americans will have the same abundant forests that we enjoy today. The SFI was developed by the American Forest & Paper Association (AF&PA), the national trade group that represents forest and paper companies. The SFI was implemented on October 14, 1994, and consists of forest principles that spell out five broad elements of sustainable forestry and 12 implementation guidelines that translate the principles into action by providing forest managers with the means to achieve sustainable forestry. The principles and guidelines, which include requirements for sustainable forestry practices, long-term forest health and productivity, prompt reforestation, protection of water quality and the promotion of sustainable forestry on private nonindustrial lands, are mandatory for continued membership with AF&PA. Since the SFI was implemented approximately 2 years ago, the industry has made tremendous progress toward achieving sustainable forestry. Examples include a reduction in the average size clear-cut to 61 acres for AF&PA member companies, reforestation of 2.4 million acres, expenditures of $114 million on research related to forestry, wildlife, and the environment, the training of some 37,000 loggers, and an information and education program that has reached 41,000 private nonindustrial landowners. An independent panel of forestry experts, who review industry's compliance with the SFI each year, summed up industry's progress to date by stating: There is a significant change underway in America's forests—a change for the better in the forest products industry, through the SFI as a leader of that change. This change will not occur overnight, but through incremental progress, it will occur.

INTRODUCTION

The American Forest & Paper Association (AF&PA) is the national trade association for the forest products and paper industry. Its some 200 members represent about 84 percent of the country's paper production, 50 percent of solid wood production (which includes lumber, plywood, etc.) and 90 percent of the industrial timberland. AF&PA is headquartered in Washington, DC.

The close of 1994 marked the end of one era and the start of another for members of the American Forest & Paper Association and many other members of the forestry community. This new beginning was ushered in by AF&PA's members when they established a major industry goal: to enhance the environment by visibly changing the practice of forestry on industrial forest land, especially as it pertains to water quality, wildlife, and biodiversity. Equally important, AF&PA members set out to work with loggers and private nonindustrial woodland owners to encourage reforestation, the use of environmental Best Management Practices (BMPs), and to improve the appearance of harvesting operations, particularly in highly visible areas.

This is called the Sustainable Forestry Initiative, a program of forestry and conservation designed to ensure that future generations of Americans will have the same abundant forests that we enjoy today. This goal is based on the premise that AF&PA members could integrate responsible environmental policy and sound business practice to the benefit of companies, shareholders, customers and the people they serve. The Sustainable Forestry Initiative is the product of more than 2 years of deliberations among hundreds of professional foresters, State officials, academics from leading forestry schools, leaders of conservation groups, and scores of loggers and small woodland owners.

Since the SFI's inception on October 14, 1994, AF&PA members and the forestry community are on their way toward meeting the goal of sustainable forestry. Members are dedicated to practicing responsible environmental stewardship of the forest they own or manage, as well as the wildlife and water resources those forests support. These members are also promoting the same stewardship ethic among the entire forest products industry as well as nonindustrial private landowners.

THE SUSTAINABLE FORESTRY INITIATIVE—DEFINED

Before reviewing the highlights of the forest industry's accomplishments under the SFI during the past 2 years, sustainable forestry must be defined and the Sustainable Forestry Initiative and SFI principles and guidelines described.

First, the definition: "Sustainable forestry means managing our forests to meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic, which integrates the growing, nurturing, and harvesting of trees for

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useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and aesthetics." This definition was spelled out by AF&PA to ensure that it was both complete and scientifically correct. It was based largely on the Bruntland Commission on sustainable development adopted by the International Earth Summit held in Rio de Janeiro in 1992.

SFI FOREST PRINCIPLES AND IMPLEMENTATION GUIDELINES

Now I would like to briefly explain the SFI forest principles and implementation guidelines. The forest principles spell out five broad elements of sustainable forestry. These principles are:

1. Meet the needs of the present without compromising future generations by practicing a land stewardship ethic, which integrates the reforestation, managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air, and water quality, fish and wildlife habitat, and aesthetics.

2. To use in its own forests, and promote among other forest landowners, sustainable forestry practices that are economically and environmentally responsible.

3. To protect forests from wildfire, pests, diseases, and other damaging agents in order to maintain and improve long-term forest health and productivity.

4. To manage its forests and lands of special significance, (e.g., biologically, geologically, or historically significant) in a manner that takes into account their unique qualities. (Examples include wetlands, Native American sites, old-growth stands, special eco-systems, etc.)

5. To continuously improve the practice of forest management and also to monitor, measure, and report the performance of AF&PA's members in achieving their commitment to sustainable forestry.

While the principles lay out the broad elements of the Sustainable Forestry Initiative, the implementation guidelines translate these principles into action by providing forestry professionals with a specific road map for the best way to achieve sustainable forestry. I will briefly review the details of the 12 implementation guidelines starting with the objective and performance measures for AF&PA members' forests. For a detailed description of the guidelines, please pick up a copy of the booklet the *SFI Principles and Implementation Guidelines.*

Throughout the document, beginning with Guideline One, is a call for member companies to document their programs, policies, and plans. This documentation is not intended for AF&PA, but rather to ensure that member companies clearly define and communicate to their employees what their own company's programs, policies, and plans are for each objective.

The guidelines call for reforestation by a time certain after final harvest—2 years for example, if replanting is used. Natural regeneration will occur within 5 years of final harvest. Protecting water quality is an opportunity to get third parties involved in the performance measure. Member companies may collectively or individually consult experts in water quality protection to identify forest management measures needed to better protect perennial lakes and streams. Some companies are cooperating at the state level to conduct water quality workshops to help fulfill this objective.

Guideline Four is a call for members to enhance wildlife habitats by developing and implementing measures that promote habitat diversity and the conservation of plant and animal populations found in forest communities. Minimizing impact on visual quality was one of the most hotly discussed issues throughout the development of the implementation guidelines. The performance measures identify a maximum average clear-cut size for AF&PA member companies of 120 acres. The document also incorporates a 'green-up' requirement so that adjacent clear-cuts do not create significant visual impacts. The green-up provision states that clear-cuts adjacent to past clear-cuts will not be undertaken until the previous harvests have trees that are at least 3 years old or 5 feet tall. The purpose is for aesthetics so the public can see a new forest established before the adjacent forest is harvested.

Protecting special sites involves companies' commitment to identify sites that have special significance, such as those with unique historic or biologic values. This also creates an opportunity to involve independent experts. Many members already have good working relationships with The Nature Conservancy, the Conservation Fund, and similar organizations. Guideline Six involves the protection of special sites where companies will manage lands of ecologic, geologic, or historic significance in a manner that accounts for their special qualities.

Finally, in the area of objectives or performance measures on AF&PA members' lands, the guidelines identified biological diversity, good wood utilization, and prudent use of chemicals as necessary objectives and performance measures.

Since 59 percent of the forest land in the United States is owned by nonindustrial landowners, it is important that we reach these landowners, both directly and through the loggers who harvest their timber. The guidelines ensure that each landowner who sells timber directly to a member company receives information from the member on the advantages of BMPs (Best Management Practices) and reforestation. The guidelines require logger training and education programs to have been in place by January 1, 1996, and that progress be reported annually.

Guideline Eleven commits AF&PA members to an annual report that identifies collective membership performance in implementing the principles and guidelines. This is another area where AF&PA is involving third parties, namely, an independent expert review panel on the SFI annual report. The National Forum of Loggers, Landowners, and Member Companies is a very important component of public and forestry community participation, which is Implementation Guideline Twelve. The suggestion for a National Forum was

made by the loggers as a means to ensure that landowners and loggers can communicate with industry leaders.

To demonstrate that AF&PA is serious about the Sustainable Forestry Initiative, the organization made compliance with the principles and guidelines mandatory for continued AF&PA membership. AF&PA's member companies are required to file an annual progress report to AF&PA regarding compliance with the principles and guidelines. During the first reporting year (January 1, 1995, to January 1, 1996), 17 companies were suspended from membership in AF&PA for failure to confirm their participation in the SFI. Again, this demonstrates that AF&PA is serious about compliance with the SFI.

INDUSTRY PROGRESS

Now that the principles and guidelines of SFI have been reviewed, it is time to report on the progress that has been made since SFI was implemented 2 years ago.

Recently, the second annual progress report on the SFI was published. Some highlights of the report include:

1. A drop in the average size of clear cuts from 66 acres in 1995 to 61 acres in 1996 (remember that the maximum average under the SFI guidelines is 120 acres). Thinning and salvage harvests account for half of the total acreage that the companies harvested whereas clear cuts accounted for slightly less than 40 percent, and shelterwood and selective harvesting made up the balance.

2. Some 2.4 million acres have been reforested during the past 2 years. Member companies on average completed planting or seeding within 1 year after the final harvest on 60 percent of the acres harvested, compared with 57 percent in 1995. Within 2 years of harvesting, reforestation was completed on 97 percent of the acres in 1996 (same for 1995).

3. AF&PA member companies spent $62 million on research last year alone, bringing the 2-year research expenditures to more than $114 million. This research was related to forestry wildlife and the environment. An example is an amphibian survey that has been underway since 1995 on industrial forest lands in the Southeastern Coastal Plain (Georgia, Florida, and Alabama). Scientists are surveying these forest lands for new populations of flatwoods salamanders, striped newts, and gopher frogs. All of these species are being reviewed by the U.S. Fish and Wildlife Service regarding their population status.

4. To ensure that AF&PA member companies are aggressively promoting sustainable forestry on lands other than their own, hundreds of workshops nationwide have been conducted to train thousands of loggers. About 11,000 loggers have completed training and some 37,000 have received partial training during the past 2 years.

5. Here in Arkansas we are particularly proud of our logger-training program, where over 100 workshops have been held, and more than 5,000 participants have attended the workshops including loggers, procurement foresters, and others. Four modules or courses are offered including Timber Harvesting and Transportation Safety, Best Management Practices, Business Management, and Environmental Considerations. Arkansas' logger education and training program is currently the number one logger-training program in the country in numbers of loggers trained. To date, about 90 loggers have completed all four modules of the program. This is impressive in light of the fact that the program is just over 1 1/2 years old.

6. Almost 41,000 private nonindustrial landowners received information from foresters and loggers on economically and ecologically sound sustainable forestry. This compares to 35,500 in 1995. Here again, Arkansas is taking an active lead in the area of landowner education, having conducted several landowner information clinics and having published a landowner education brochure entitled *Your Land Your Options: What You Should Know Before You Sell Your Timber.* In addition, AFA has established a toll-free number (1-888-MY TREES) through which landowners can request information on how to get on-the-ground assistance, as well as information on planting trees, wildlife and forest management, use of Best Management Practices, the Tree Farm Program, and other items.

Since about 60 percent of the nation's forest land is owned by some 9 million nonindustrial private landowners, it is critical that we take measures to ensure that sustainable forestry is practiced on these lands as well as industry lands. This is Arkansas Forestry Association's primary role in the Sustainable Forestry Initiative, and we are committed to reaching loggers and individual landowners with the sustainable forestry message through our educational efforts.

CONCLUSION

Although the Sustainable Forestry Initiative is still in its infancy, the forest industry has made tremendous progress in the 2 short years that the SFI has been in existence. I'll leave the final words to the AF&PA independent panel of forestry experts—public and private officials and academicians—who each year review industry's compliance with the SFI and make their evaluation public. Here's what the panel said about the progress to date: There is a significant change underway in America's forests—a change for the better—in the forest products industry, through the SFI, as a leader of that change. This change will not occur overnight, but through incremental progress, it will occur.

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HARDWOOD CHIP EXPORT MILLS IN ARKANSAS—IMPLICATIONS FOR SUSTAINABILITY

John L. Gray and James M. Guldin[1]

Abstract—Two new hardwood chip export mills (HCEM's) recently began operating in west-central Arkansas, and a third is planned. Together, they will require 1.1 million tons of nonhickory hardwood roundwood annually, primarily from the nonindustrial private sector. Overall, total physical and operable growth surpluses could support the new sector, but purchasable surpluses are barely adequate now and may be less than adequate by 2005. The HCEM's will generate about 630 direct and indirect jobs and $16.75 million in yearly wages and stumpage payments. However, if all of the new demand is met by unsightly harvesting methods, tourism-related job losses after 15 years could offset HCEM-generated employment. Because HCEM's will increase competition for hardwood, some small sawmills may go out of business, although the turnover of small sawmills was high even before HCEM's entered the market. The HCEM market for small hardwoods is less than ideal, but these mills can process "rough" and "rotten" trees. HCEM harvesting is generally not good forestry; to date, it has tended to take the best trees and leave the worst. This could improve if landowners were better informed and willing to reinvest following harvest. The effects of HCEM's on Arkansas hardwood forests as a whole are not expected to be great. Although protection of soils and water quality has been inconsistent, the new sector appears to be committed to provide such protection on lands they harvest. The authors present six recommendations designed to promote a positive effect of new sector operations on the sustainability of timber resources and other forest values.

INTRODUCTION

In 1995, a new market for hardwoods of pulpwood size and quality, primarily from the Arkansas and Oklahoma highlands, opened along the Arkansas River. In that year, two major hardwood pulp chip production mills—Guthrie Wood Fiber at Van Buren and Canal Wood Corporation of Arkansas at Menifee—began operations. In addition, the Corps of Engineers granted a permit to the Weyerhaeuser Company to build a third mill at Dardanelle, which is scheduled to start operations in 1998. Initially, all will produce hardwood pulp chips for export to the Pacific Rim—primarily Japan.

According to mill officials (Barfield 1996, Cooley 1996, Poor 1996a), 37 Arkansas counties are in the planned wood supply area (WSA) of one or more of the three facilities (fig. 1). When all three hardwood chip export mills (HCEM's) are in full production, they will require approximately 1.1 million tons of hardwood pulpwood per year. Relative to 1994 levels, this represents a 53-percent increase in hardwood pulpwood production statewide, a 15-percent increase in the total hardwood harvest in Arkansas, and a 34-percent increase in the total hardwood harvested from within the WSA (Levins 1996).

All three mills will be using hardwoods only; conifers will not be taken. In addition, the mills will not use hickory, which is difficult to debark. The facilities will take trees as small as 5 inches in diameter at breast height (d.b.h.)—6 to 8 inches in diameter at the stump. They will also be able to process trees in the Forest Inventory and Analysis (FIA) "rough" and "rotten" quality category (Barfield 1996, Cooley 1996, Poor 1996b).

An expanded demand for low-grade hardwoods provided by the HCEM's could be welcomed as a positive contribution to Arkansas' timber-based economy. The new market might also offer nonindustrial private forest (NIPF) landowners an opportunity to improve hardwood forest health, productivity, and personal income by selling the worst and keeping the best.

Instead, however, the market's arrival has been highly controversial. The chip export mill issue has been a subject of critical newspaper stories, organized opposition, petitions to the Corps of Engineers to reconsider permits for mill operations, and attempts to restrict expansion of the sector through legislation. The environmental community has voiced its concern and, less publicly, so have some individuals in the forestry and forest industry communities.

The new sector relies entirely on hardwoods, especially oaks. Oak is the most valued and valuable component of upland hardwood forests in the Interior Highlands and dominates Coastal Plain hardwood stands as well. The large-tree character of Arkansas hardwood forests is due mainly to the oak genus. Oak mast is among the most flexible food sources for wildlife. It is generally used by a broad array of species and an even broader array of game species than any other soft or hard mast in the State's forests.

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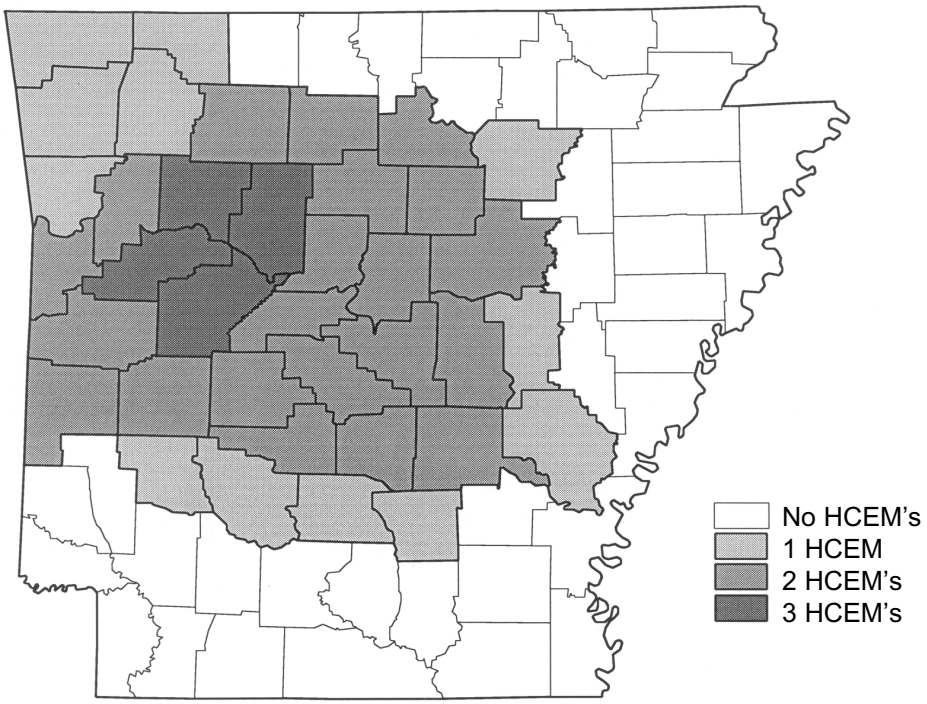

Figure 1—Counties in Arkansas in the wood supply area of the new sector. Shading indicates the number of the three hardwood chip export mills (HCEM's) that have identified a county in their procurement area.

In addition, leisure travel and tourism are big business within the WSA. The area includes seven of the top 10 total-travel counties in Arkansas (Arkansas Department of Parks and Tourism 1995) and 32 of the 42 prime leisure-travel counties (Shiflet 1996). This is particularly true for the 10 Ouachita and 17 Ozark Highland counties. The main reason that out-of-state tourists visit Arkansas is "scenic natural beauty" (Davies 1997); autumn has become a major tourist season, and the Ozarks rank second only to New England for fall color (Davies 1997).

Wood chipping and chip mills are not new in Arkansas. The first pulp and paper mill facility with mill-drum debarker and chipper went into operation at Camden in 1928. Since 1956, sawmills have used log debarkers and chippers to process sawmill and veneer waste. Free-standing, stationary, satellite chip mills (similar to the three export mills but producing chips primarily for use by domestic pulp and paper mills) have been in place since 1971. Arkansas now supports seven such mills with a combined total annual chip production of nearly 1.8 million tons, 63 percent of which is hardwood (Edwards 1996).

Similarly, increases in hardwood demand and harvesting in Arkansas are not new. Between 1985 and 1995, total hardwood tonnage harvested for all products increased over 12 percent statewide and over 10 percent within the WSA (Levins 1996). Between 1954 and 1994, statewide production of hardwood pulpwood increased by 630 percent (Levins 1996). In spite of these increases, the three most recent FIA reports (Staff: Renewable Resources Evaluation Research Work Unit 1979, Hines and Vissage 1988, London 1997) have shown continuing, statewide increases in total hardwood inventories on all timberland ownerships for growing stock of both pulpwood size and of sawtimber size (fig. 2).

The 1.1-million-ton requirement of the three mills could come from any of three sources. The first is forest industry lands. Two of the three mills do not own forest lands within the WSA. The third is operated by a major forest industrial landowner, which expects to draw about 5 percent of its hardwood pulpwood requirements from its own holdings (Cooley 1996). In this analysis, the third mill's probable tonnage requirement was reduced by that percentage.

The second possible source is national forest timber. Two mills do not plan to purchase such timber because of potentially negative public opinion; the third would do so "if offered" (Barfield 1996, Cooley 1996, Poor 1996b). However, the Ouachita National Forest is not offering hardwood in its regular sales program, nor does it intend to do so (Hammond 1997). Between now and 2005, the Ozark National Forest plans to sell 102,000 tons of hardwood timber annually: 63,000 tons of sawtimber, but only 39,000 tons of pulpwood. So far, there have been no sales to either of the two functioning HCEM's (Minehart 1997).

The authors assume that the 1.1-million-ton annual requirement will be met by hardwoods removed from NIPF

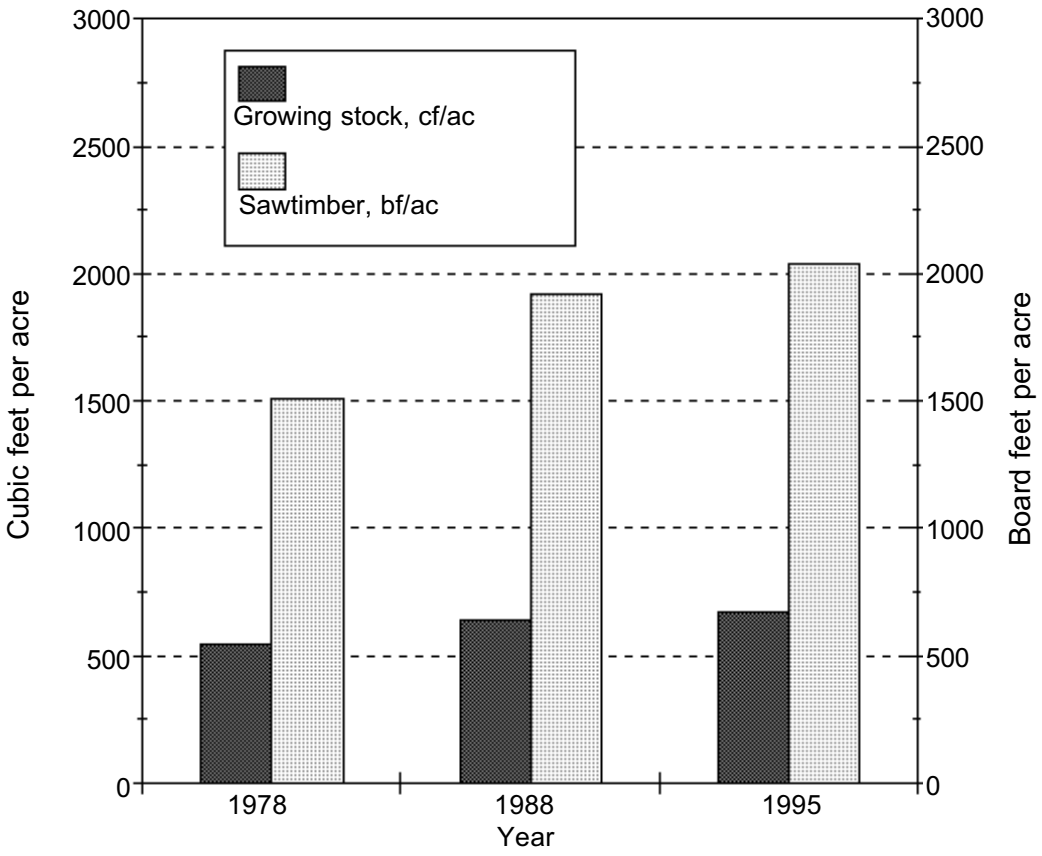

Figure 2—Changes in hardwood growing stock and hardwood sawtimber from 1978 to 1995 in Arkansas.

lands within the WSA. A major concern about the new sector is that its increased demand and harvest will, over time, produce a hardwood growth deficit with resulting declines in both inventory and growth on NIPF lands. Over the long term, this would reduce supply both for the new sector and for the 228 hardwood mills now operating within the WSA that currently depend on NIPF owners for all or part of their timber supply.

The objectives of this analysis are to quantify the hardwood resource sustainability of HCEM sector operations; examine job benefits and impacts that the new sector provides; discuss the silvicultural characteristics of the new sector; and review the new sector's commitments to protecting soil and water resources.

METHODS

Data from the recently completed FIA report for the State of Arkansas (London 1997, Rosson 1997) were used to evaluate sustainability relative to the new sector's operations. The authors analyzed other available data provided by Arkansas forest industry sources, Arkansas government officials, and others. Two broad categories of questions were addressed—economic and environmental.

Economic Questions

Sustainability of timber supply—FIA data from the 1995-96 survey were used to calculate existing rates of growth and removals in nonhickory hardwoods within the WSA; sustainability was evaluated by comparing net growth and removals (London 1997, Rosson 1997). Total physical supply was calculated as the nonhickory hardwood growth and removal levels for all timberland ownerships. Operable supply was calculated as the annual nonhickory hardwood growth and removal levels for all NIPF timberlands, subject to constraints imposed by steepness and wetness. Lands with 33 percent or greater slope were excluded, as were lands within the wetland elm-ash-cottonwood and cypress-tupelo types and the oak-gum-cypress subtype. These three limitations-ownership, steepness, and wetness—eliminated 53 percent of the total timberland area in the WSA. Annual growth and removals on the remaining 5.1 million acres form the basis for "operable supply."

However, not everyone who owns forested acreage is willing to sell. In a recent survey of the opinions and attitudes of Arkansas NIPF owners, Williams and Voth (1996) found that 7 percent of NIPF land statewide and 19.3 percent of such land in the Ozarks were owned by those who had sold no timber nor had any plans to do so. The "purchasable supply" was, therefore, based on either 93 percent or 80 percent of operable growth.

Growth surplus was defined as the difference between growth and removal. But in table 1, growth surplus includes 75 percent of the nonhickory hardwood "rough" and "rotten"

Table 1—Timber supply sustainability on NIPF-owned forest land in the 37-county wood supply area. Supply is nonhickory hardwood. Growth surplus is hardwood growth minus hardwood removals, and includes 75 percent of "rough" and "rotten" nonhickory hardwood growth surplus. Hardwood removals are for existing industry, not HCEM's

Type of supply	Hardwood growth	Hardwood removals	Rough and rotten	Growth surplus
		Million tons		
1995				
Operable supply	3.4	1.8	0.3	1.9
Purchasable supply				
93% level	3.2	1.8	.3	1.7
80% level	2.7	1.8	.2	1.1
2005				
Operable supply	3.4	2.0	.3	1.7
Purchasable supply				
93% level	3.2	2.0	.2	1.4
80% level	2.7	2.0	.2	.9

growth surplus because HCEM's are capable of using such material. The authors assumed that the two functioning HCEM's had no impact on growth and removals reported in the latest FIA report since they did not begin to accept pulpwood until 1995. Therefore, all removals were attributed to the current hardwood industries.

The data also were projected to the year 2005, when the next FIA report is expected. Three assumptions followed: (1) there would be no change in hardwood growth rate; (2) there would be no expansion of the 1.1-million ton yearly wood requirement of HCEM's; and (3) removals attributed to the preexisting hardwood industry would increase by 10.2 percent. This increase was based on the percentage increase in hardwood severance tax receipts between 1985 and 1996 within the WSA (Levin 1996).

Economic benefits of the new sector—Direct economic benefits of the new sector were assessed by interviewing mill officials. Direct employment included all mill workers and company procurement personnel and all loggers (whether under contract to the mill or working independently). Employment data included office staff and others whose jobs are directly linked to the mill. Direct payroll was then calculated according to standard rates of compensation per worker in the appropriate lumber and wood products industrial code category (U.S. Bureau of the Census 1994). Indirect employment data were obtained by applying the 1.7 Type 1 all standard industrial classification multiplier for Arkansas' primary forest products industry to the direct employment data (Kluender and others 1991), and the average annual wage from that same category was applied to indirect employees to determine indirect payroll generated (U.S. Bureau of the Census 1994).

Economic effects on tourism—The effect of increased unsightly hardwood harvesting on tourism will be highly variable, depending on the size of area harvested, the pattern of harvests, the distance from the viewer, and the presence or absence of hickory, cedar, pine or other kinds of trees remaining after harvest. Location is critical. Unsightly harvesting can be especially serious in the viewsheds of scenic corridors, along approach routes to local, State, and Federal outdoor recreation areas, or along scenic and recreational stretches of streams. Depending on location and adjacent land use, unsightly harvesting may or may not have a serious negative effect on real estate values. The visual effect also will depend on what the landowner does with the cutover areas following harvest. For this reason, a detailed analysis of tourism effects would require spatially explicit information on sale locations, which FIA data do not provide.

In lieu of having such information, the authors have sought to link job loss in the tourism industry directly with increases in unsightly harvest. McLemore (1997a) suggested that the following formula be used to estimate the percent loss over time in jobs and payroll due to the effects of increased hardwood harvesting.

$$\text{Percent loss} = \frac{(\text{Area harvested annually})\,(\text{Recovery time})}{\text{Total hardwood forest area in the WSA counties}}$$

The annual HCEM harvest requirement, at 1.1 million tons, will be produced by a combination of clearcutting and other harvest methods. However, the proportions by harvest method are not known. Therefore, three levels of clearcutting were considered—20 percent, 50 percent, and 100 percent. Williams and Voth (1996) reported that 20 percent of the forest land area sold by NIPF landowners

Statewide was sold on an "all-merchantable tree" basis; the other levels were based on statements by mill officials (Barfield 1996, Poor 1997).

The duration of visual effects depends on "recovery time"—time required to "green up" and lose its unattractive appearance, and the time required to recover full fall color attractiveness. Experts identified two recovery times for clearcut areas—10 years to "green up" and 30 years to recover fall colors (Davies 1997, McLemore 1997a). Both time frames were used to assess potential negative impacts.

To simplify the analysis, the authors assumed that all trees harvested, of both pulpwood and sawlog size, would be chipped. This approach does not consider the possibility that purchasers would sort sawlogs from pulpwood and sell them to sawmills ("merchandising") because there were no data available to quantify that effect. Ignoring the impact of merchandising, the harvested material results in a conservative estimate of the possible effects on tourism. Merchandising would require the HCEM's to harvest a larger area in order to meet the 1.1-million-ton annual requirement.

Effects on existing industry—The new sector's requirements will produce a market over and above that which currently exists for hardwoods in Arkansas. Will the new mills have an adverse effect on the existing hardwood-using? To examine this, the authors calculated changes in the hardwood industry within the WSA between 1984 and 1994, based on comparing listings in the directories of the Arkansas Forest Products Industry (Arkansas Forestry Commission 1984a, 1994). Recent changes in existing hardwood mills were used as a basis for estimating possible effects of the new HCEM sector.

Environmental Effects

Resource attributes of new sector—Foresters often say that hardwood management options are limited by the lack of a market for hardwood pulpwood. Thus, the first thought of many foresters is to welcome the expanded hardwood pulpwood market created by HCEM's since it should make selling hardwood pulpwood easier. However, the ideal market for small hardwoods and the market provided by HCEM's may not be the same.

An ideal market for hardwood pulpwood would:

1. Take large trees not suitable for sawlogs, e.g., culls, "rough" and "rotten" trees, and others of poor form and condition that could not be sold as sawlogs regardless of size.

2. Have no limitations on acceptable species; all hardwoods, not just certain kinds, would be merchantable.

3. Take the material otherwise wasted—pulpwood from small trees and tops from sawtimber trees—during thinnings in sawtimber-sized hardwood stands.

4. Take the pulpwood and tops from pulpwood-sized trees within hardwood stands that are not yet of sawtimber size, or stands that are of a marginal sawtimber size.

The authors used observations, experience, and interviews with mill officials to subjectively determine the degree to which the new sector will provide an ideal market.

HCEM harvesting and good forestry—Scientists and others in the professional community have speculated about the impact of HCEM harvesting on the hardwood resource. Based on field observations of stands subject to HCEM harvest and current knowledge about oak regeneration, the authors have identified possible combinations of harvest and followup treatment associated with HCEM operations on NIPF lands:

1. Thinning from below, to improve existing poletimber or sawtimber stands. No immediate followup treatment is needed. Such stands will remain dominated by oaks after harvest and should continue to be dominated by oaks over time.

2. Clearcut the merchantable hardwoods; conduct site preparation to remove the unmerchantable trees and regenerate the stand using seedling sprouts and stump sprouts. Regeneration should have a prominent oak component, and over time, should develop into an oak-dominated hardwood stand.

3. Clearcut the merchantable hardwoods; conduct site preparation to remove the unmerchantable trees and plant pine seedlings. Regeneration should be dominated by pines with some hardwoods, and, over time, should develop into a fully stocked pine or pine-hardwood stand.

4. Harvest all desired species of commercial size, with no followup treatment. Regeneration should have some oaks, but these may be suppressed by hickory, cedar, and other unmerchantable trees that were not cut. Over time, this stand will probably develop into a marginally stocked, poor-quality hardwood stand with a low percentage of oak.

5. Following harvest, convert the land to a nonforest use, such as pasture. The area would, therefore, be removed from the forest land use category.

Areas harvested by the new sector will be compared to conditions described in this subjective classification, based on field observation.

Loss of hardwood forests under new sector harvesting—There is concern that HCEM harvest of upland hardwoods will lead to a major decline in hardwood forest area in the WSA. Recent FIA data (London 1997, Rosson 1997) were used to calculate the average volume of nonhickory hardwood on NIPF land within the WSA. This statistic was then used to determine the annual area harvested, given the 1.1-million-ton demand of the new sector. Comparing this to the total forested area within the WSA provided a realistic percentage of possible hardwood forest loss.

Protection of soil and water resources—Passage of the Federal Water Pollution Control Act of 1972 (Public Law 92-500) codified national water quality goals and the process required to reach them. That process led to the identification and approval in 1981 of a set of Best Management Practices (BMP's) for silviculture in Arkansas

in conformance with guidelines established by the Environmental Protection Agency. BMP's are designed to control nonpoint sources of pollution at a given site such as a harvesting operation.

Arkansas' silvicultural BMP's are voluntary, not regulatory (Arkansas Forestry Commission 1984b). The guidelines apply to soil and water protection, location of log landings, skid trails, drainage, road construction, treatment of waste and chemical materials, stream protection, maintenance of productivity, and related values. As stated in the "Best Management Practices Guidelines for Silviculture" issued by the Arkansas Forestry Commission, application of BMP's is "directed toward the prevention of water quality problems" (Arkansas Forestry Commission 1984b).

The authors conducted a subjective evaluation of compliance with BMPs based on visits to four sites harvested by chip mill operators. Interviews with company officials provided information about the direction that companies will follow with respect to future BMP compliance.

RESULTS

Economic effects

Timber supply sustainability—Findings are shown in table 1. Data show operable growth surpluses of 1.9 million tons now and 1.7 million tons in 2005, exceeding the HCEM's 1.1-million-ton need. In other words, growth of the operable hardwood resource on NIPF lands within the WSA exceeds the demand of both the current industry and the new sector, both now and in 2005.

However, this does not take into account owner willingness to sell. Purchasability is the key. If 93 percent of the growth and inventory is purchasable, growth surpluses are reduced to 1.7 million tons now and 1.4 million tons in 2005. These volumes also exceed HCEM needs. If only 80 percent of the growth and inventory is purchasable, the 1.1-million-ton growth surplus barely equals the current HCEM demand. In 2005, at 0.9 million tons, the growth surplus would fall 200,000 tons short.

Thus, for industries within the WSA that will depend on NIPF timber for all or part of their supply, landowner willingness to sell is the key factor for purchasable supply sustainability now and in any plans for future expansion. If purchasability falls below 80 percent, supplies will not be sustainable from growth alone.

Economic benefits of the new sector—Table 2 lists the direct and second-round indirect effects of the new sector on Arkansas' economy. The HCEM's will directly employ 370 people, and the need to fill indirect or support positions will create 263 additional jobs. Therefore, 633 total new jobs will be generated.

In terms of new annual payrolls, earnings of direct new employees will be about $6.7 million, and the indirect payroll about $5.2 million, for a combined total of nearly $12 million.

Table 2—Positive annual economic benefits of the new HCEM sector in Arkansas

Category	Number of jobs	Yearly dollar value
Employment and payrolls		
Direct new jobs	370	$ 6,663,000
Indirect new jobs	263	$ 5,253,000
Total	633	$11,916,000
Payments to landowners		
Purchase of standing timber		$ 4,750,000

A second positive effect will be the income landowners receive from timber sales to the new sector. In 1996, the average Statewide price paid for standing hardwood pulpwood was $4.46 per ton (Timber Mart-South 1996). When this price is applied to the new sector's 1.1-million-ton yearly wood requirement, annual payments to landowners will total $4.75 million. In a number of counties, this represents a market for hardwood pulpwood that did not exist before.

Economic impact on tourism—Table 3 shows that the tourism industry supported approximately 11,250 direct and indirect jobs in 1995 within the WSA (Arkansas Department of Parks and Tourism 1996, McLemore 1997b). This includes full- and part-time jobs. Direct and indirect annual payrolls totalled $161 million (McLemore 1997b, U.S. Bureau of the Census 1994). Total direct expenditures by leisure travelers and tourists were about $460 million annually.

Table 4 shows annual, 10-year, and 30-year potential cumulative job and payroll losses that would be expected under various rate levels of clearcutting. At the 20-percent level, cumulative job and payroll losses under either the 10-year "greenup" period or the 30-year fall color recovery period are relatively minor (except for the affected employees). At the 50-percent or 100-percent levels, cumulative effects are more dramatic. For example, at the 50-percent level with a 30-year recovery period, the loss of

Table 3—Jobs, payroll and expenditures for recreational travel and tourism in the WSA

Category	Number of jobs	Yearly dollar value
Tourism jobs and payrolls		
Estimated direct jobs	7,600	$ 88,100,000
Additional indirect jobs	3,648	72,900,000
Total	11,248	$161,000,000
Annual expenditures		
Recreational travelers and tourists		$460,000,000

Table 4—Potential negative impact on leisure travel and tourism yearly direct and indirect jobs and payrolls in the 37-county sourcing area in Arkansas of different rates of increase in annual pulpwood-type clearcutting and recovery periods

Rate of clearcutting	Acres clearcut annually	Potential job losses		
		Annually	After 10 years	After 30 years
		- - - - - - Number of jobs - - - - - -		
		Potential job impact		
220,000 tons (20%)	5,300	7.6	76	227
550,000 tons (50%)	14,600	20.8	208	625
1,100,000 tons (100%)	29,200	41.7	417	1250
		- - - - - - - Million dollars - - - - - - -		
		Potential payroll impacts		
220,000 tons (20%)	5,300	0.11	1.08	3.25
550,000 tons (50%)	14,600	0.30	2.98	8.94
1,100,000 tons (100%)	29,200	0.60	5.96	17.89

direct and indirect jobs is nearly equal to those created by the new sector, and payroll losses are nearly 75 percent of the new sector's payroll. At the 100-percent level, the cumulative job loss is nearly double that of the new sector, and payroll losses are 50 percent greater than payroll gains.

Effects on the current hardwood industry—In 1994, there were 536 primary and secondary wood product manufacturing concerns in Arkansas (Arkansas Forestry Commission 1994). Within the WSA, 228 were identified that required hardwoods or hardwoods and other species as their raw material. One hundred and thirty-eight accepted hardwoods only. Table 5 lists the 228 facilities by category and type. Sawmills and sawmill-planing mills predominate the list with a total of 146. One hundred and fifteen of this total were in the two smallest production capacity categories (processing less than 3 million board feet of logs annually).

Unlike the leisure travel and tourism sector, no source of data is available to tie employment and payroll to hardwood-using manufacturers within the WSA. Nor is there a rational way of using any available data to quantify the impact of the new sector's effect, positive or negative, on the current industry.

As shown in table 1, operable growth and purchasable growth at the 93-percent availability level would support the

Table 5—Hardwood-using manufacturers in the WSA in Arkansas

Category	Type	Number of facilities
Primary	Sawmill	123
	Sawmill-planer mill combination	23
	Handle blank	3
	Pulpmill (and paper)	1
Subtotal		150
Secondary	Furniture	32
	Furniture parts	4
	Pallets	19
	Finished lumber and millwork	12
	Flooring-panelling	3
	Wood treating	3
	Containers	2
	Handles	1
	Musical instruments	1
	Picture frames	1
Subtotal		78
Total		228

combined needs of current and new sector mills that depend wholly or partly on NIPF-owned timber. In 1995, the combined needs could be met with purchasable growth at the 80-percent availability level, but not in 2005, when it would fall short.

However, small sawmill survival was volatile before the introduction of HCEM's. From 1984 to 1994, 141 hardwood mills, or 38 percent of the 1984 total in WSA counties, went out of business, and 82 of them were small sawmills (Arkansas Forestry Commission 1984a, 1994). So, increased competition for the purchasable supply, coupled with likely increases in timber prices and wood costs, may simply reinforce the existing downward trend in small sawmill survival.

Environmental Effects

Resource attributes of the new sector—A subjective assessment of how HCEM's would address the four criteria used to describe the ideal hardwood pulpwood market led the authors to the following conclusions:

1. The new market can use large trees that do not have sawlog potential. Mill officials, as well as evidence in several recently cut areas, suggest that HCEM's process about three-quarters of the "rough" and "rotten" trees, which are often the unmerchantable sawtimber-sized component not removed in earlier selective sawtimber harvests.

It follows that the new sector provides a market for larger trees of poor form and quality. As discussed in the section on timber availability, FIA data show that this market could provide 200,000 to 300,000 tons annually. However, the poorest of the "rough" and "rotten" trees, such as those that are hollow within a significant portion of the bole, may not be taken. Nonetheless, leaving some of these could help maintain or enhance wildlife habitat.

2. The new market does not use all species of hardwoods. The HCEM's prefer oaks but also take most other hardwoods. However, they do not take hickory because of the physical difficulty in removing its bark. The FIA data show that for the typical NIPF stand within the WSA hickory accounts for 16 percent of all live hardwood trees per acre and 12 percent of the growing stock volume (Rosson 1997). Thus, HCEM harvest is "selective" by species. If necessary followup treatments are not carried out, the remaining forest is likely to become dominated by hickory and other unmerchantable trees.

3. The HCEM's can use pulpwood and tops left following harvest of hardwood sawtimber. However, mills will not actively solicit this material. Instead, they will accept it as "gatewood", delivered to the mill by independent loggers who are not under contract with them. In the past, opportunities to use hardwood pulpwood resulting from sawlog harvests were limited. The expanded pulpwood market will allow delivery of small volumes of pulpwood and tops which, if sold separately, might not be marketable.

4. In the authors' opinion, pulpwood thinning in pulpwood-sized hardwood stands is impractical. Company officials reported that they require a minimum harvest of between 15 and 25 tons per acre. According to FIA data, an average NIPF hardwood stand within the WSA contains between 30 and 37 tons per acre. A thinning operation would yield only about 12 tons per acre from the pulpwood-sized trees (6 to 10 inches in d.b.h.) Additional harvest and use of some sawtimber-sized trees for chips would be needed to yield the minimum tonnage per acre.

The authors feel that HCEM's meet only the first and third criteria for an ideal market, and that the third would not deliver the required volume. Therefore, the prospect that HCEM's might fill an ideal hardwood pulpwood market in Arkansas is limited.

HCEM harvesting and good forestry—Of the five possible outcomes of HCEM harvesting, one converts the site to nonforest use. A second does nothing to ensure future stocking with desirable and productive hardwood stands dominated by oaks. Two restore productive forests—one in hardwoods and the other in pine—but only at substantial followup cost to the owner. They both require a classic silvicultural clearcut and, because of the followup treatment, will appear to the public to be even more intensively disrupted than by the initial harvest. The fifth alternative improves stand growth and development but requires a well-stocked stand initially, which is relatively rare.

Unfortunately, the easiest thing for the landowner to do, which provides the greatest income in the short run, is to perform no followup treatment. Such harvest would constitute little more than a high-grading to a pulpwood diameter limit. This is not good forestry.

Loss of hardwood forests under new sector harvesting—The FIA data show that an average acre of NIPF hardwood type forest land of commercial size within the WSA contains 37.6 tons of nonhickory hardwoods per acre, including 5.7 tons of "rough" and "rotten" material (Rosson 1997). To meet the 1.1-million-ton requirement, and assuming all of the volume on an average acre is harvested, HCEM's would have to carry out approximately 29,200 additional acres of commercial timber harvests each year.

The same data show that hardwood-type forests in all ownerships within the WSA total 7.9 million acres (Rosson 1997b). Assuming that the total HCEM need is met through clearcutting NIPF hardwood forests of commercial size, the area clearcut annually (cf. table 5 at the 100-percent level) would amount to 29,200 acres, or 292,000 acres in 10 years. If all this acreage was taken out of forest use, the 10-year loss of forest would amount to 3.7 percent within the WSA, and 1.6 percent Statewide. This is a relatively minor reduction. Also, because some landowners will reforest their harvested lands using natural or artificial regeneration, the actual loss should be less.

Protection of soil and water resources—Of four sites visited by the authors that were harvested by chip mill operators, two did not meet BMP standards. One company, however, provided a written policy statement, and officials

of a mill not yet operating pledged to take positive steps to improve BMP compliance. Two of the three have indicated they will not accept wood from sites where BMP's are not followed. One has hired a BMP staff person whose primary duty will be to ensure compliance with BMP provisions.

DISCUSSION

In the previous sections we have considered four economic and four environmental concerns associated with the installation and operation of three hardwood chip export mills within a 37-county wood supply area in west-central Arkansas. These issues and concerns reflect the vital interests of individuals, industries, and communities statewide.

The following questions address these issues and concerns, and the discussions summarize evidence presented in the previous sections.

Is HCEM harvesting sustainable? Yes, if only the total physical and operable supply of nonhickory hardwoods on NIPF lands is considered. However, assuming the more realistic purchasable supply premise, sustainability may be marginal now and submarginal in the future. If owners of 20 percent or more of the NIPF operable hardwood timber growth and inventory within the WSA are not willing to sell at any price, the harvest of purchasable timber, by both existing mills and the HCEM's, exactly balances growth in 1995; harvest may exceed growth by 2005.

What will HCEM's contribute to the economy? They will provide about 630 direct and indirect new jobs, with a combined $11.9 million annual payroll, and $4.75 million in payments annually to landowners who sell their timber.

Will HCEM harvests hurt the tourism industry? The analysis is simplistic and inconclusive. However, rough calculations indicate that if all of the HCEM requirements are met by unsightly harvests, cumulative tourism-related job losses after 15 years could offset the employment generated by these mills.

Will the big new mills drive small sawmills out of business? This is unlikely. A large number of small sawmills in the WSA went out of business in the 10 years preceding the arrival of HCEM facilities. Greater competition for purchasable timber and possible price and cost increases will have an added effect on less efficient operations.

Do the new mills provide an ideal market for small hardwoods? Not exactly. They fall short of the ideal by being unable to take hickory or to thin pulpwood profitably from below in immature stands. However, they do take "rough" and "rotten" trees that were not salable before.

Is HCEM harvesting good forestry? Probably not, as it is being applied in a majority of cases. Empirical observations suggest that it is more oriented to cutting the best trees and leaving the worst, rather than the other way around. Nonetheless, there is potential for improvement if landowners are better informed and willing to maintain productive trees for additional growth or invest in regeneration following harvest.

Will harvesting by the new sector lead to a major loss of hardwood forests? Not to any great extent. In the most extreme situation, in which 100 percent of the new sector's need is met by unsightly harvesting with all of the cutover area converted to pasture or cropland, total hardwood forest area within the WSA would be reduced by only 3.7 percent. The actual decline should be considerably less.

Will soil and water resources be protected? The jury is still out on this one. Empirical evidence suggests that some sites are harvested in compliance with BMP's, others are not. Apparently, the HCEM owners are convinced that BMP's are important and are committed to working with landowners and loggers to apply them. Two of the three interviewed indicated that they would decline to buy from landowners unwilling to do so.

RECOMMENDATIONS

Based on these discussions, the authors developed six recommendations which, if implemented, would considerably improve the likelihood that the new sector will be a positive influence in the economy and environment within the WSA.

HCEM Responsibilities

The new sector's mill owners cannot harvest a single acre in the WSA without the landowner's signature on a contract. Clearly, the landowner has a legal right to disregard BMP standards and sell every tree, right down to the edge of the creek. However, no law forces a responsible forest products company to buy from an irresponsible seller. The public, fairly or unfairly, is more likely to blame the buyer. The buyer also has rights, which include the right to "walk away" from dealing with landowners who disregard appropriate forestry practices.

We suggest that HCEM's should be prepared to "walk away" from landowners unwilling to implement BMP standards. One company official has indicated that it is now doing this and a second says they plan to do so. The HCEM's also should consider "walking away" from clearcutting immature stands and from unsightly harvests in visually sensitive areas.

NIPF Owner Education

Within the WSA and statewide, NIPF owners hold title to two-thirds of the hardwood forest area. Yet, as a group they have the least knowledge of forest management and marketing options that fit their individual situations and goals. A major educational program in hardwood forest management and marketing options would help landowners make better decisions.

As much as possible, public agencies like the Arkansas Forestry Commission, the Cooperative Extension Service, and the Natural Resources Conservation Service should concentrate educational resources on these themes and within this area of the state. For example, the Arkansas Forestry Commission might refocus its current educational emphasis from public affairs to landowner education. The new Landowner Education and Assistance Initiative of the

Arkansas Forestry Association should give it a high priority as well.

NIPF Professional Advice and Assistance

Although owner education is important, helping the individual landowner decide specifically what to do on "the back forty" and how best to get it done is also important. One-on-one professional advice and assistance are often the key to a landowner's success. Primary providers of such advice and assistance are the Arkansas Forestry Commission's county foresters (33 statewide) and private consulting foresters (28 individuals or firms statewide). Landowners should be made aware of who they are and how to contact them.

Landowners who are looking for a more impartial source of professional advice and assistance than they feel is available from HCEM procurement foresters should be referred to their county forester before making a decision on whether or not to sell timber.

In addition, many professionals would benefit from state-of-the-art factual information on the latest practical advances in hardwood management. Research scientists and extension specialists can help by developing field guidelines for upland hardwood regeneration and by training county foresters, consulting foresters, and HCEM procurement foresters in their use. A "manager's handbook" for Arkansas' upland hardwood forests, including photographs of representative forest situations, which would help landowners visualize harvesting options and their outcomes, also would be helpful.

Focus Programs on More Than Just Timber

As Williams and Voth (1996) brought out, educational and professional assistance programs should be tailored to help landowners reach a variety of goals, ranging from cattle grazing to improving wildlife habitat and recreational values, particularly in the Highlands. A program that emphasizes timber production and marketing only, to the exclusion of other resources and goals, will be ignored by owners with nontimber goals.

Programs should also focus on getting the biggest resource impact per dollar spent on education and professional assistance. A special effort should be made to communicate with landowners in the largest ownership size category. In the Ozarks and the Ouachitas, the 11 percent who hold 250 forest acres or more account for 55 percent of all nonindustrial private forest land.

Explore Ways to Use Hickory

The new sector should explore every possibility for utilizing hickory. Companies should ask whether increasing yield by 12 percent from harvested areas would, over the long term, be worth the additional cost of sorting out, treating, and storing hickory.

Although it is easy to recommend that mills harvest hickory, it will be difficult to make such harvest technologically feasible. One step would be for the hardwood fiber-using sector as a whole to ask the Technical Association of the Pulp and Paper Industry (TAPPI), in partnership with the American Pulpwood Association and the USDA Forest Service Forest Products Laboratory in Madison, Wisconsin, to convene a select group of scientists, wood technologists, and manufacturers throughout the South for a state-of-the-art analysis of debarking and chipping hickory.

Survey of NIPF Owners Who Have Sold Timber to HCEM's

The authors recognize that this analysis has many shortcomings. A major one is the lack of input from NIPF owners within the WSA who have sold hardwood pulpwood to the new sector. What was their goal in doing so? Was it met? If not, why not? Would they recommend that other NIPF owners sell to this sector? Why or why not? What information did they not have that other NIPF owners should have before making such a decision? Did they know where to turn for information and assistance? What help did they need that they did not receive? Were they made aware of BMP standards? Were these followed? If not, why not?

The Arkansas Forest Resources Center of the University of Arkansas has recently funded a formal study of the economic and socio-economic effects of the HCEM's in the Ouachita and Ozark regions. The study should include a survey of NIPF owners who have sold timber to HCEM's. Without such input, efforts to improve the use of this new market opportunity to the advantage of all involved, and to the resources, could fail.

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In preparing this paper, the authors visited, conferred, and corresponded with scientists, HCEM officials, former chip mill managers, professional colleagues in forestry, tourism, and recreation, and certain members of the environmental community. We are grateful to all who shared their knowledge and opinions with us. We express special thanks to Bob Levins, Paul Dahl, Jim Rosson, Charles McLemore, Rick Williams, and Dick Kluender. Our charter was to summarize, on as factual a basis as possible, the sustainability of the new sector. Any errors in fact or interpretation are ours alone.

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SUMMATION OF THE SYMPOSIUM ON ARKANSAS FORESTS

B.G. Blackmon[1]

This brings us to the conclusion of a wonderful 2 days together—the culmination of the symposium on Arkansas Forests. We heard from a wide range of speakers who presented details of the forest survey and those who interpreted that information in light of the important resource issues in Arkansas and the region. My task here is to summarize and possibly interpret the information we've been given. And that is a difficult, if not impossible, assignment.

The presentations by John Kelly and Jim Rosson gave us a lot of details about the survey itself. We heard about a net increase in softwood volume, unlike the 1988 survey, that showed a decrease. The hardwood resource is also on the positive side statewide, with growth exceeding removals, yet less than in 1988. Perhaps this should be watched carefully in the upcoming annual measurements as demands (e.g., the new chip export market) on the hardwood resource intensify in the future.

Several times during the symposium there were questions about error and accuracy of the FIA data. The survey publishes sampling errors, but generally speakers presented mean data without error bars—understandable as that would have required speaker access to original data. Nevertheless, the scientific community should follow up on that issue and better define the statistical parameters on the data. We should know if there is reason to be concerned about error in sampling and/or analysis.

Vic Rudis shared some of the wealth of nontimber and spatial information in the survey. Most of us didn't know that data existed. Apparently they are in huge and intricate data sets, available on the Internet. I encourage the Forest Service to offer some training sessions for users who want to access this important information.

Rick Williams' presentation was encouraging. He told us that Arkansas has more forested acreage than 30 years ago. He pointed out that statewide, we are growing more softwoods and hardwoods than are being harvested. He also sent up a caution flag when he pointed out that in several counties in south Arkansas removal is exceeding growth, if only by a small amount—raising questions about sustainability in that region. Someone mentioned that many of the pine plantations in that area are just now beginning to "come on line" and produce the kind of volume growth that potentially could make up the deficit. Chris Barneycastle reviewed the industry's Sustainable Forestry Initiative. That program is only about a year old and, in my opinion, has a great deal of potential for addressing the sustainability issue in south Arkansas.

Dick Kluender raised a rather significant flag when he said that if current trends continue we may be mining forests on nonindustrial private lands. His presentation included a lesson on fundamental economics and told us that demands on the resource will continue in a major way. Dr. Kluender mentioned some possible solutions, such as new technology (presumably including better utilization), increased productivity, and shorter rotations, but, unfortunately, offered little optimism that trends would reverse. Does this portend the need for at least some discussion of statewide forest practices legislation? Perhaps the topic should not be ignored.

On the other hand, Jim Foster raised the point that even if removals exceed growth, one should interpret the severity of the trend by relating the amount of removals to amount of standing crop. Food for thought. During the discussion period following Kluender's paper, recycling was mentioned, and I would like to take the liberty of jumping on my soapbox about that issue. According to Dr. Kluender, recycling will help the resource supply issue, but not a lot, and I believe that to be true. But there are other compelling reasons to support recycling. Recycling lengthens the life of landfills, reducing society's costs of waste disposal. Additionally, many areas of the "Natural State" are badly littered, and recycling offers us the opportunity to improve the quality of our landscape. So let's support recycling; it's good for us! In his presentation, Bryan Kellar cited litter as a problem in terms of tourism, and he is correct.

Philip Tappe pointed out that we don't know much about populations of many wildlife species, e.g., neotropical birds. Dr. Tappe mentioned that the survey was not designed to inventory wildlife. As mentioned above, some of these data may be available on the Internet, but generally the public is unaware of its availability.

The paper by Ed Miller and Hal Liechty gave us good news about the relationship between forest management and soil and water. They also made some helpful suggestions about how FIA might be altered to improve its utility—a message to which we hope the Forest Service will give some attention.

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Jim Guldin reviewed the survey relative to public lands and gave us the top 10 things the FIA tells us about the public forest lands of the State. Among other things, he talked about the “sawtimberization” of public forests, a tendency for public lands to be overstocked relative to other ownerships, the negative growth/removal ratio in the planted pine component in the Ozark region, the inherently poor site quality on the national forest land base, and the big-tree character of public forests.

In her paper on socioeconomic assessment of private nonindustrial lands, Tamara Walkingstick helped us understand why private landowners hold their forest lands. These reasons included greenspace, preference for a rural style of life, and wildlife. It is interesting that income from timber was not in the top three reasons, even in the Coastal Plain region of the state. One of her messages was that we should listen to and honor the wishes of the landowner. With this I agree, except in cases where the landowner’s objectives violate principles of sustainability.

The long-awaited chip mill paper by John Gray and Jim Guldin reviewed the chip industry and its implications for sustainability. An attempt to answer eight important questions about that activity was made in their paper. Although most of the information was encouraging, some raised important questions. This is the first instance in the debate about chip mills where hard data supplemented rhetoric in analyzing potential benefits and costs to the state. Reading this paper in its entirely is a must.

So, what does all this mean? Perhaps the question is “can we have a ‘working forest’ in the “Natural State?” Can we have profitability, preserve property rights, protect critical species and habitats, maintain scenic and pastoral vistas? The list could go on and on. “Can we have our cake and eat it too?” is what we are really asking.

Our forests and ecosystems are sustainable, and they can remain sustainable if all of us with varied interests, values, and paradigms are willing to work together and make it happen. But we have to make it happen, recognizing that compromise will most certainly be necessary.

We are the stewards of the land today. To be treated well by history, we must leave the land and its forests, water, and animals in as good or better shape than we found them. That’s what sustainability is all about. Generally I think we are practicing sustainability, but let’s make sure we are. Surely we would want no other alternative.

The planners of this symposium hope that this event has contributed in a positive way. We thank our speakers, our generous sponsors, and, finally, we thank you, our audience, for making this conference a success.

Guldin, James M., tech. comp. 2001. Proceedings of the symposium on Arkansas forests: a conference on the results of the recent forest survey of Arkansas; 1997 May 30–31; North Little Rock, AR. Gen. Tech. Rep. SRS–41. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 125 p.

The proceedings include 14 papers on the status of Arkansas forests, based on data from the 1995–96 Forest Survey of Arkansas conducted by the Southern Research Station of the USDA Forest Service. Authors reviewed the State's forest history, current conditions and changes over time, implications for different resource values and ownerships, and current issues that affect the sustainability of Arkansas' forests.

Keywords: Arkansas, chip mills, Coastal Plain, Delta, forest survey, inventory, Ouachita, ownership, Ozark.

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