

OLDER STANDS CHARACTERIZED AND ESTIMATED FROM SAMPLE-BASED SURVEYS

Proceedings reprint from:

*Victor A. Rudis, Research Forester, Forest Inventory and Analysis Unit, USDA-FS, Southern Research Station (Mailing address): P.O. Box 928, Starkville, MS 39760-0928
Web page " <http://www2.msstate.edu/~vrudis/index.html>"*

Cite as:

Devall, Margaret S.; Rudis, Victor A. 1991. Older stands characterized and estimated from sample-based surveys. In: Henderson, Douglas; Hedrick, L.D., eds. Restoration of old growth forests in the Interior Highlands of Arkansas and Oklahoma: Proceedings of the conference; 1990 September 19-20; Morrilton, AR; Winrock International and Hot Springs, AR: Ouachita National Forest: 121-138.

Older Stands Characterized and Estimated From Sample-based Surveys¹

Margaret S. Devall²
Victor A. Rudis³

Abstract

Old growth criteria from the literature are applied to existing data from systematic sample-based surveys to obtain estimates of detailed attributes for private as well as public stands in the Interior Highlands of Arkansas and Oklahoma. Approximately 1/4 of the region's forest is mature. With the most stringent old growth criteria applied, less than 2% of the forested land in the region qualify, and less than 1% is undisturbed by fire, livestock, and/or wood production. In addition, stand histories for selected tracts of older growth outside the National Forest are described, including stands in Hot Springs National Park, around several lakes on U.S. Army Corps of Engineers land, on International Paper Company land, on acreage owned by the heirs of James Garrison Clark, on Cossatot River Natural Area in Arkansas, and on Cucumber Creek watershed in Oklahoma. This report makes clear that there are limited areas of older stands, which suggests the overwhelming importance of efforts to manage and restore old growth on National Forests and elsewhere in the region.

Key words: old growth, Interior Highlands, mature forest

Introduction: Characterizing and Estimating Old-growth Stands

Old-growth forests are increasingly scarce throughout the United States. These forests developed undisturbed over a long period of time and occupied much of the presettlement landscape of the Interior Highlands of Arkansas and Oklahoma. Although native Americans used wood, cleared land for farming, and set fires, European settlers increased the pressure on the forests. Forests provided a valuable source of wood to the European settlers and were an impediment to farming.

¹ This paper was presented at the Conference on Restoring Old Growth Forests in the Interior Highlands of Arkansas and Oklahoma, held at Winrock International, Morrilton, Arkansas, September 19-20, 1990.

² USDA Forest Service, Southern Forest Experiment Station, 701 Loyola Avenue, Rm. T-10201, New Orleans, LA 70113

³ USDA Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis Unit, 201 Lincoln Green, Starkville, MS 39759-0906.

European exploration of the region began with DeSoto in the 16th century, followed by Marquette, Joliet, LaSalle, and others. LaSalle claimed the land from the Mississippi River to the Rockies for France in 1682 and called it Louisiana (USDA, 1986). By the early 19th century, Europeans had pushed the Indians of the Ouachitas farther west; by the second half of the century, Europeans had settled the most fertile lands in the major valleys. Little cultivable land was available at the end of the century (Smith, 1986). The Ozarks had similar settlement patterns.

Before the 1900's, laborers and slaves sawed logs into lumber by hand; one man could produce 100 board feet a day. After the invention and development of water and steam power, circular and band saws, and improved sawmill equipment, the crew of a large sawmill could produce 100,000 board feet a day. The development of powerful steam locomotives and the extension of trunk-line railroads allowed sawmill owners to locate mills near large forests. The sawmillers would exhaust the timber at one location and move on. Around 1908, sawmillers arrived at the Interior Highlands. The forests of the eastern United States had been cut and lumber companies had purchased the forests to the north and south of the Interior Highlands. By 1940, much of the virgin forests of the Ouachitas had been cut (Smith, 1986). Considerable naval stores were produced from the forests of the Interior Highlands; the oak and pine forests were used by the railroad (Martin, 1990). Virtually all the forests in the Interior Highlands have been cut at one time or another.

Recently there has been increased interest in old-growth forests, including those in the Interior Highlands. Scientists, land managers, and the general public are interested in managing and conserving the remaining old-growth forests. This interest arises from concerns that the species, communities, and roles of the older forests are endangered and that the older forests may have functions that are not fully understood, but that may be important to other species.

Methodology

The area of mature forest land by ownership class, disturbance type, forest type, and old-growth criteria was estimated based on the Southern Forest Experiment Station's Forest Inventory and Analysis (FIA) database. The systematic, sample-based surveys in the database provided statistical estimates of forested land for the whole Southern region. Old-growth criteria were drawn from the literature and applied to survey data to obtain estimates of detailed attributes for the region.

The Southern Forest Experiment Station's FIA Unit conducts an inventory of private and public forest resources. The sampling frame comprises permanent 1 acre plots located at the intersections of perpendicular grid lines spaced at 3 mile intervals throughout the south-central states. Detailed field observations are obtained in some 17,000 plots classified as timberland (i.e., at least 0.4 ha in size, 36.6 m in width, and capable of producing crops of industrial wood). Since 1987, additional field

observations have been made for forested areas that have been commercially unproductive (less than 1.4 m³/ha/year) or withdrawn from timber production by statute or regulation (productive-reserved areas).

When combined with ground-truth of photointerpretation for counties, states, and regions, field observations were expanded statistically to estimate all forest resources. Field observations are updated every 8 to 10 years. Periodic analytical assessments and tabular summaries report the current status and trends in tree species, density, basal area, forested area, ownership, forest type, and timber productivity.

Older stands

Stand age is relatively easy to measure in undisturbed, even-aged stands with known stand history, but is difficult to assess in uneven-aged stands and those that have undergone changes, such as succession following the absence of fire, livestock use, or partial cutting. Information on stand history from FIA surveys of the Interior Highlands region is limited to comparing tree records of the 1976 and 1986 Oklahoma surveys and the 1978 and 1988 Arkansas surveys. More than two-thirds of the forests sampled are classed as mixed-aged stands and many stands have undergone varying levels of change in condition.

The data presented in this report represent an *a posteriori* classification of forest stands based on recorded field observations. It was not possible to classify "older" or old-growth stands based on the age of dominant trees, the age of stand, history of stand disturbances, the age of older trees in undisturbed stands, or the presence of a multi-layer forest canopy. Characteristics typical of "mature" stands were used to define older stands.

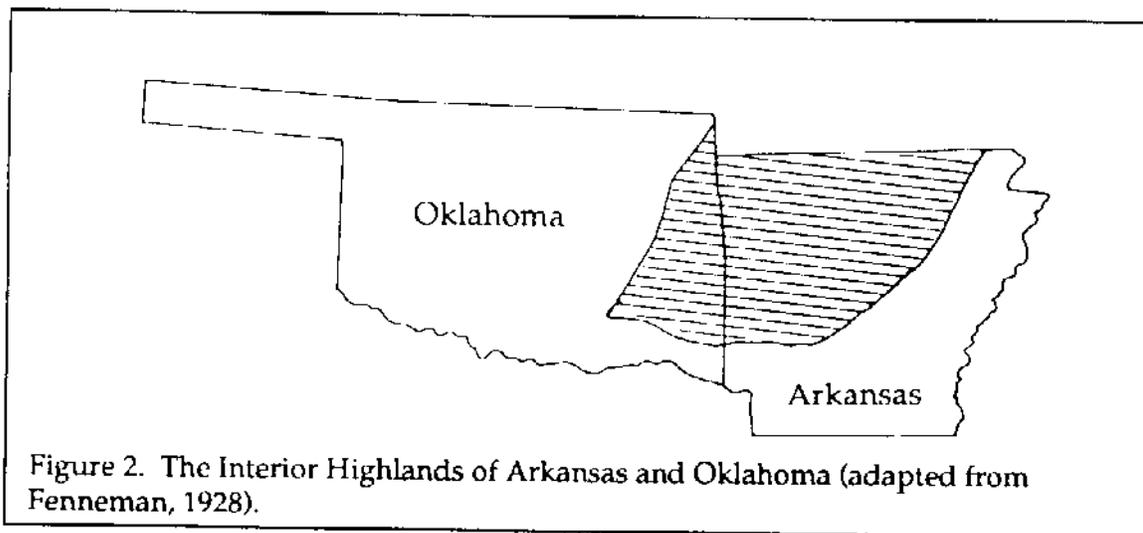
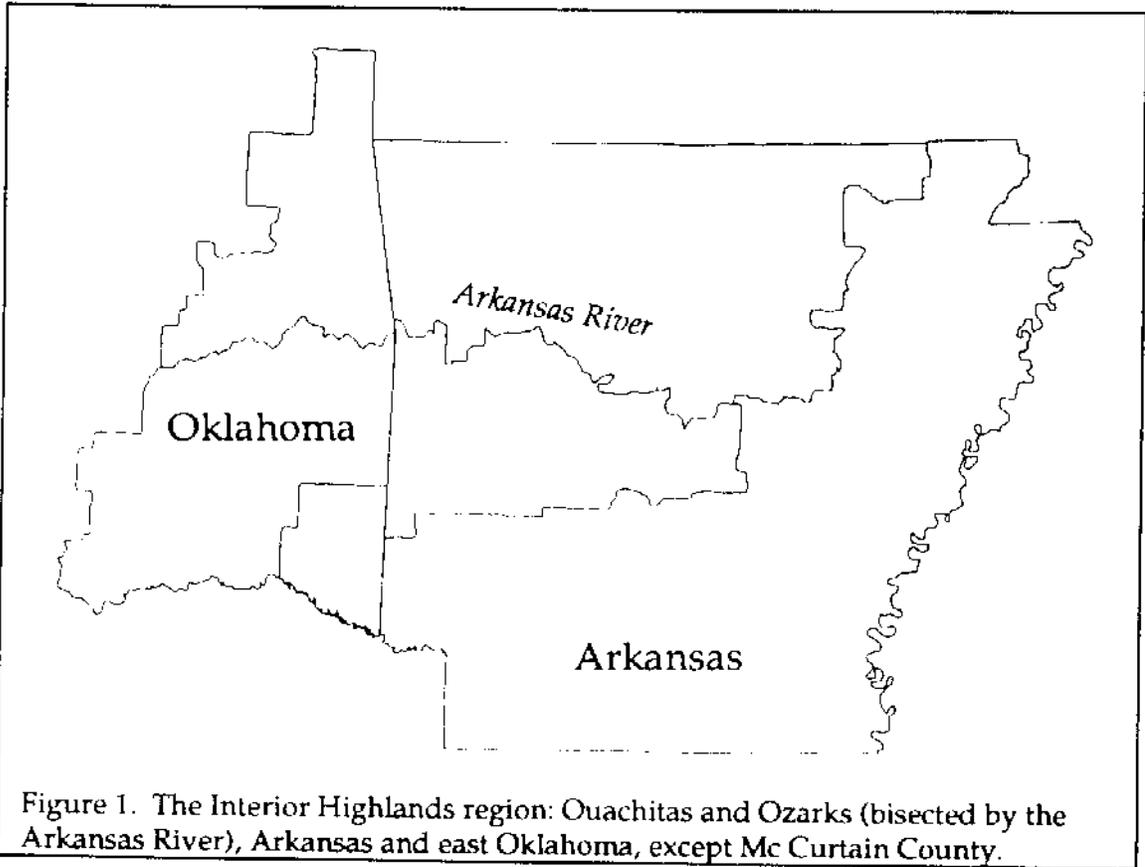
To obtain more detailed information about older stands in the Interior Highlands of Arkansas and Oklahoma (outside of the national forests), landowners, members of conservation organizations, and land managers were interviewed.

The FIA's estimate was based on the total area of counties with the majority of their territory within the highlands (figure 1). The interviews were based on a broader area, and included land extending into counties that were not predominantly in the highlands (figure 2).

Results and Discussion

A mature stand is defined as a stand that has not undergone a forest-type change since the previous survey (approximately 10 years earlier) and that has a basal area of poletimber and larger trees (12.7 cm dbh and larger) generally greater than the site's potential for fully-stocked stands, expressed as mean annual growth, or site class. For example, site class 6 (1.4-3.4 m³/ha/yr) stands must have a basal area of live trees 12.7 cm dbh and larger of 11.5 m²/ha or more. This definition should eliminate all

seedling stands, sapling stands, stands undergoing succession, most poletimber-sized stands, and understocked sawtimber-sized stands where stand size is based on all live trees.



The minimum basal area for mature stands in each site class are given in table 1.

Table 1. The minimum basal area in each site class for mature stands in the Interior Highlands of Arkansas and Oklahoma.		
Site class	Productivity	Minimum basal area
#7	0.0-1.4 m ³ ha/yr	4.6 m ² ha
#6	1.4-3.4	11.5
#5	3.5-5.9	19.5
#4	6.0-8.3	27.6
#3	8.4-11.5	37.9
#2	11.6-15.7	37.9
#1	15.8 or more	37.9

Minimum basal areas for site classes 4, 5, and 6 are derived from observations that undisturbed stands at least 50 years old never fall below this level for even-aged stands in Arkansas, and all stands classed as timberland in eastern Oklahoma (unpublished data, on file with the Forest Inventory and Analysis Unit, Starkville, MS).

At present, there are no stand age data available for site class 7 plots, and few samples of stands for site classes 1, 2, and 3. For this reason, the minimum basal areas for these site classes are drawn from the conceptual model that site conditions and basal area of relatively undisturbed climax stands in mesic forests are directly related (sensu Held and Winstead 1975). The minimum basal areas for site classes 1 and 2 are lower than that of the model, because the highest basal area known for climax forests in this part of the United States (a mesic forest in Tennessee: 42.6 m²/ha [Held and Winstead 1975]), suggests a theoretical maximum.

Other characteristics

Old-growth criteria assume that stand conditions are at an equilibrium. Given this assumption, characteristics of old-growth include:

- net growth of live trees approaches zero (Hunter 1989)
- older, standing dead trees are present (Hunter 1989; McComb and Muller; 1983, Smith 1989)
- the proportion of standing dead trees is similar to the proportion of live trees in a stand. (Data from Tritton and Siccama (1990) suggest that the ratio of dead-to-live trees is around 0.5 to 1.5 for selected older stands in the northeast.)

The disturbances most likely to affect the stand regeneration layer of potential old-growth stands are fire and livestock use. Wood-production activities are likely to affect overall stand conditions. These disturbances may be temporary or insignificant for some definitions of old-growth. Once some disturbances are eliminated, opportunities may emerge for old-growth restoration. Some disturbances may be typical of old-growth, such as fire in a fire-dependent climax forest.

Details of criteria for data on livestock, fire, and wood production are available in FIA survey manuals (FIA Unit 1989a, FIA Unit 1989b). Livestock is defined as the presence of livestock-use evidence including observations of livestock, tracks, dung, and trails. Fire is defined as burn evidence including burn scars on trees, reduced litter depth with charred remains, etc. Wood production is defined as evidence of harvesting, timber management, and presence of logging debris, including noncommercial wood harvesting.

Standard error

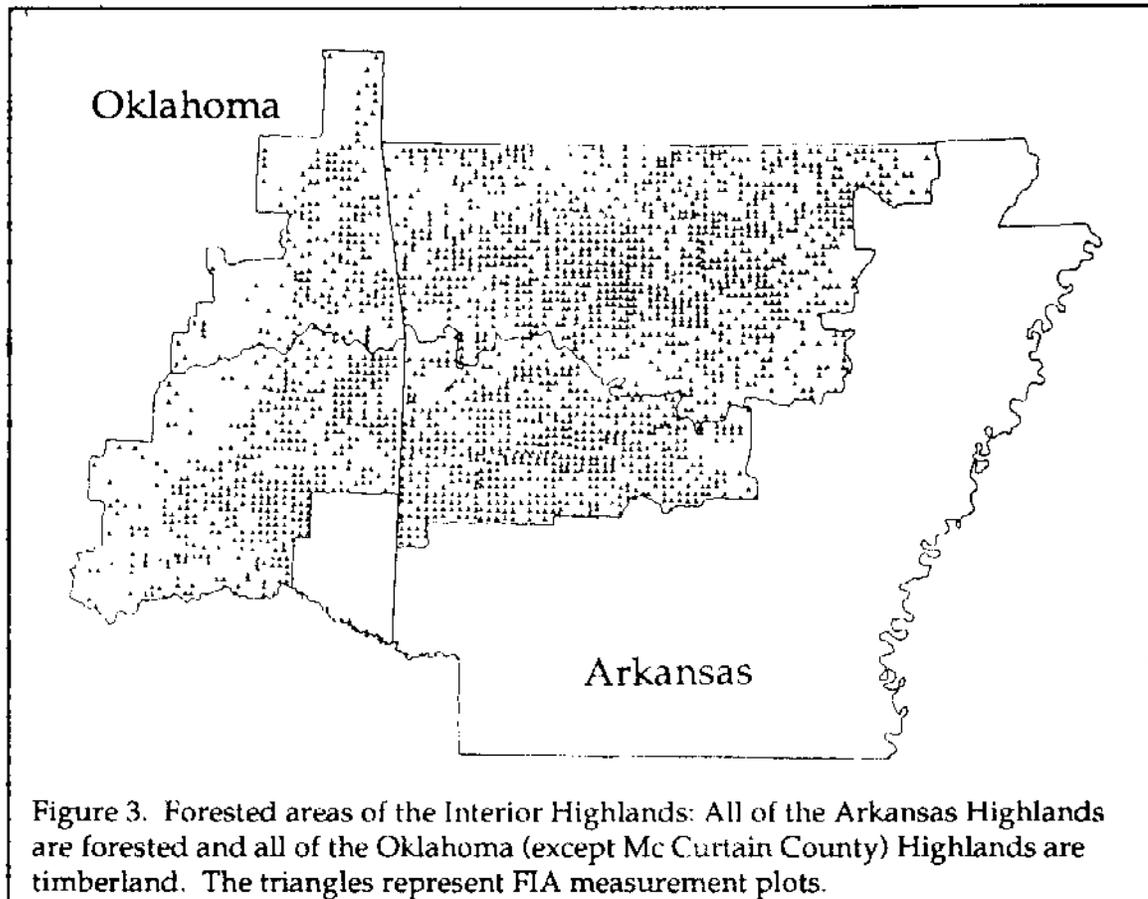
The sampling scheme was not specifically designed to survey older stands, therefore some such areas may have been omitted. Given the assumptions associated with classification accuracy, the statistical confidence in area estimates is given in table 2.

Area estimate (1000's ha)	95 percent confidence, +/- (1000's ha)
20.2	4.48
40.1	6.33
202.4	14.16
404.7	20.01
1,214.1	34.70

The total forested acreage in the Interior Highlands is estimated at 5537.6 thousand ha (figure 3). Of this, 190.9 thousand ha of commercially unproductive forest or production-reserved timberland in Oklahoma were excluded because field data were not available, leaving a total of 5346.7 thousand ha.

Past data were unavailable for 244.0 thousand ha of mature forest that are either commercially unproductive (potential productivity less than 1.4 m³/ha/yr), productive-reserved timberland on public land (withdrawn from timber production by statute or administrative regulation), or timberland with large trees that has recently reverted from agricultural land (Hines and Bertelson, 1987; Hines, 1988a,

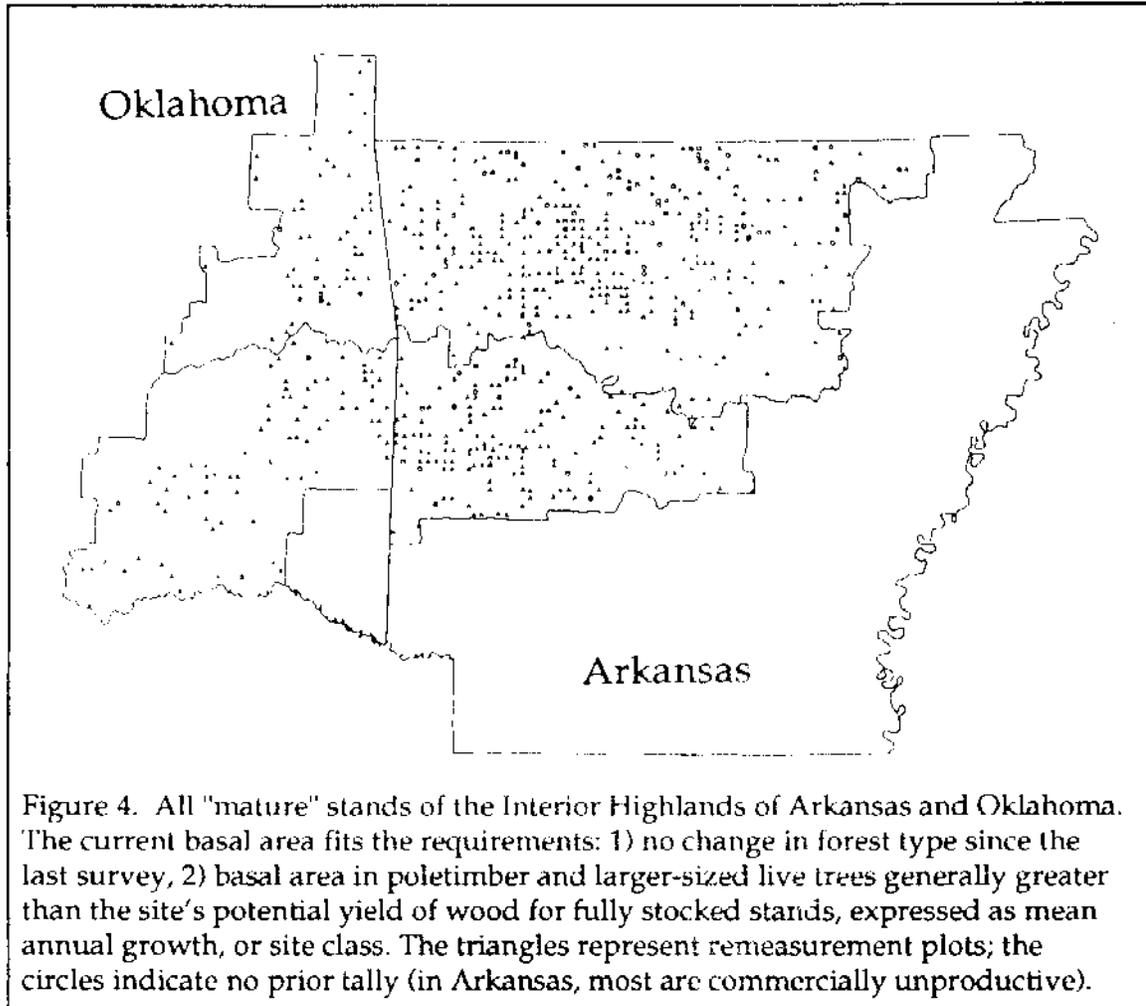
1988b). Of the remaining 5,102.6 thousand ha of forest, 1,199.4 thousand ha qualify as mature forest (figure 4).



When the old-growth criteria are applied to the mature-forest data (figure 5), the estimate of older growth in the Interior Highlands without any disturbances from livestock, fire, wood production or any combination of these is 63.2 thousand ha (table 3).

The amount of older growth without any disturbances is estimated to be 18.1 thousand ha of national forests, 2.7 thousand ha of land owned by other public agencies, 2.4 thousand ha of land owned by forest industries, and 40.0 thousand ha of land owned by private individuals (table 4). There is evidence of some disturbance in 21.7 thousand ha.

Estimates of undisturbed older growth can also be subdivided by forest types (table 5). The national forest includes 2.3 thousand ha of oak-pine forest and 15.9 thousand ha of oak-hickory forest; other public land includes 2.7 thousand ha of oak-hickory forest; private land contains 2.4 thousand ha of loblolly (*P. taeda*)-shortleaf, 6.2 thousand ha of oak-pine, 51.0 thousand ha of oak-hickory, and 2.3 thousand ha of bottomland hardwood forest.

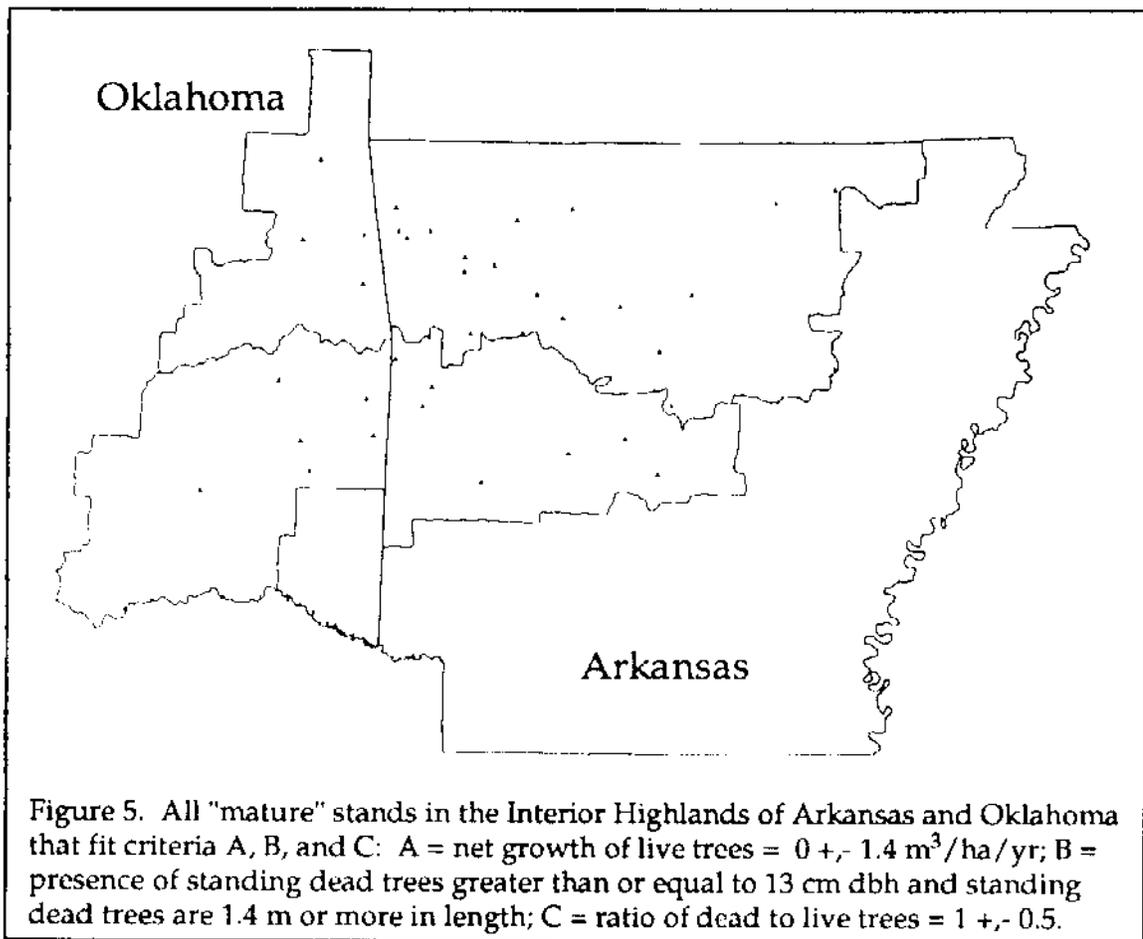


Selected Tracts of Older Growth

Stand histories for selected tracts of older growth outside the National Forests are described. These summaries provide descriptions of several of the finest older growth forests in the Interior Highlands.

Hot Springs National Park

Hot Springs National Park, in Arkansas, contains some of the finest natural pine communities in the Ouachita Mountains. Forest stands on Sugarloaf Mountain, North Mountain, and Hot Springs mountain, totaling approximately 121 ha have not been disturbed much by people for over 60 years; some areas may have been undisturbed for over 100 years. The south-facing slopes are fairly open, stunted forest, while the north-facing slopes are covered with a luxuriant, closed forest. On both slopes the age of trees often exceeds 130 years. One tree on the south-facing slope of Sugarloaf



Mountain had 191 annual rings; the oldest tree cored so far had 242 rings. Many trees on north- or east-facing slopes are 51-66 cm diameter. In addition to shortleaf pine (*Pinus echinata*), blackjack oak (*Quercus marilandica*) can be found on the drier slopes and white oak (*Q. alba*) on the north-facing slopes. Some patches appear younger than the rest of the forest, apparently due to natural disturbance. There are also some treeless openings, especially on the upper southeast-facing slopes of Hot Springs Mountain. These forests are important natural shortleaf pine communities because of their age and natural condition. Fifty-two hectares of Sugarloaf Mountain are registered as a Society of American Forester's Natural Area (Pell, 1982).

Hot Springs National Park is managed as a natural area of the national park system. Hazard trees near trails are removed and trails and culverts are kept in good repair. Except for the hazard trees, no cutting has been done since the National Park Service took over management in 1921; the areas had been in a federal reservation established in 1832. There is no evidence that extensive cutting has taken place during the last 150 years, although some firewood was cut during the 19th century (Pell, 1982). A study to determine the fire history of the area established that the

overall mean fire-return interval has changed from under 32 years in the period before 1938 to approximately 1,200 years after 1938 (Johnson and Schnell, 1985).

Disturbance type ¹	(Old-growth criteria ²)			
	None	A	A,B	A,B,C
-----thousand hectares-----				
Livestock	108.6	44.2	32.0	10.0
Fire	101.9	27.4	19.7	4.5
Wood production	93.9	8.7	2.2	2.2
Fire and wood production	55.6	9.2	4.9	--
Livestock and wood production	24.8	4.9	2.4	2.4
Fire and livestock	17.8	5.1	2.5	2.5
Fire, livestock, and wood production	5.3	--	--	--
None of the above	791.4	222.9	158.6	63.2
Total ³	1,199.4	322.5	222.4	84.9

¹Disturbance. Presence of livestock evidence is noted regardless of age, but is assumed to be less than 10 years old. Presence of fire and wood production evidence is noted if the disturbance occurred since the previous survey (approximately 10 years).

²Criteria:

A: Net growth of live trees = 0 +/- 1.4 m³/ha/yr. Based on a survey of trees on permanent plots between surveys: east Oklahoma 1976, 1986; Arkansas 1978, 1988.

B: Presence of standing dead trees greater than or equal to 13 cm dbh. Standing dead trees are 1.4 m or more in length.

C: Ratio of dead to live trees = 1 +/- 0.5. Calculated as (average dbh of dead trees 13 cm or more)/(average dbh of live trees 13 cm or greater).

³Excluded are 244.0 thousand ha that qualify as mature for which there is no prior tree tally. These stands are either commercially unproductive (i.e., potential productivity less than 0.6 m³/ha/yr, productive-reserved timberland on public land (i.e, withdrawn from timber production by statute or administrative regulation), or timberland with large trees that has recently reverted from agricultural land. Excluded also are forests in east Oklahoma that are commercially unproductive or productive-reserved timberland.

Table 4. Area of "mature" forested land by disturbance type, old-growth criteria, and ownership class, Interior Highlands.

Disturbance type (a)	All owners	National Forest	Other public	Forest industry	Other private
----- thousand hectares -----					
No old-growth criteria					
Livestock	108.6	--	--	--	108.6
Fire	101.9	16.5	4.5	7.0	73.8
Wood production	93.9	56.3	--	2.4	35.2
Fire and wood production	55.6	27.8	2.6	4.2	20.9
Livestock and wood production	24.8	--	--	4.6	20.2
Fire and livestock	17.8	--	--	--	17.8
Fire, livestock, and wood production	5.3	--	--	--	5.3
None of the above	787.1	314.3	37.3	37.0	402.7
Total	1,199.4	414.9	44.5	55.3	684.7
Criteria A, B, and C					
Livestock	10.0	--	--	--	10.0
Fire	4.5	--	--	--	4.5
Wood production	2.2	2.2	--	--	--
Livestock and wood production	2.4	--	--	2.4	--
Fire and livestock	2.5	--	--	--	2.5
None of the above	63.2	18.1	2.7	2.4	40.0
Total	84.9	20.3	2.7	4.9	57.0
(a) Excluded are 39.6 thousand ha on National Forest land, 23.4 thousand ha on other public land, and 181.0 thousand ha on other private land that qualify as mature for which there is no prior tree tally.					

U.S. Army Corps of Engineers land

The U.S. Army Corps of Engineers manages several lakes in the Interior Highlands which are surrounded by older-growth forests. Lake Ouachita is in the east-central part of the Ouachita Mountains, in Montgomery and Garland Counties in Arkansas. The Corps of Engineers has jurisdiction over a band of land around the lake which contains several stands of older growth. The largest stand contains 96 ha (table 6) and is forested predominately with red and white oaks with an average age of 95 years (J. Kiser, personal communication).

Table 5. Area of "mature" forested land by ownership class, disturbance type, forest type, and old-growth criteria, Interior Highlands.

Ownership class and disturbance type	All types	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Bottomland hardwoods
----- thousand hectares -----					
National Forest					
No prior tree tally	39.6	12.1	4.5	22.9	—
No old-growth criteria					
Fire, livestock, or wood production	100.6	62.6	13.7	24.2	—
None of the above	314.3	98.7	32.5	183.2	—
Total	414.9	161.3	46.3	207.4	—
Criteria A, B, and C					
Fire, livestock, or wood production	2.2	—	—	2.2	—
None of the above	18.1	—	2.3	15.9	—
Total	20.3	—	2.3	18.0	—
Other public					
No prior tree tally	23.4	4.5	16.2	2.7	—
No old-growth criteria					
Fire, livestock, or wood production	7.2	2.5	—	4.7	—
None of the above	37.3	2.6	2.3	19.1	13.3
Total	44.5	5.1	2.3	23.8	13.3
Criteria A, B, and C					
Fire, livestock, or wood production	—	—	—	—	—
None of the above	—	—	—	2.7	—
Total	—	—	—	2.7	—
Private owners					
No prior tree tally	181.0	11.9	28.8	140.2	—
No old-growth criteria					
Fire, livestock, or wood production	300.2	42.5	30.5	212.5	14.7
None of the above	439.7	63.5	53.7	317.6	4.9
Total	740.0	106.0	84.3	530.1	19.5
Criteria A, B, and C					
Fire, livestock, or wood production	19.4	2.4	—	14.8	2.3
None of the above	42.5	—	6.2	36.2	—
Total	61.9	2.4	6.2	51.0	2.3

Compartment	Stand	Ha	Ba (m ² /ha)	Average age	Predominant species
1	1	4	14.9	82	Shortleaf pine
6	17	96	8.4	95	Red and white oaks
13	29	16	8.4	147	Sweetgum and oaks
13	30	14	9.3	122	Sweetgum and oaks

Data provided by J. Kiser, U.S. Army Corps of Engineers

Lake Greeson is on the southern border of the Interior Highlands, in northern Pike County, Arkansas. The Corps of Engineers bought the land around Lake Greeson (3440 ha – not including the lake) a few years before 1950, when the lake was impounded. The ridges and valleys surrounding the lake are forested mostly with shortleaf pine; in most stands the trees are from 40 to 65 years old, but a few stands are a little older. These forests are in the same condition as much of the Ouachita National Forest: The forest was cut around the turn of the century and again in the 1940's. Little timber was then cut until 10 years ago. The Corps is concerned about the visual impact of cutting: The land appears very different from the surrounding timberland. Detailed information on the stand is available (see table 7) (K. Meeks, personal communication).

Gillham Reservoir is also on the southern edge of the Interior Highlands, in Pike County, Arkansas. The Corps of Engineers has 2687 ha of land at this site, including the 550 ha of the reservoir. The forest, which is composed of shortleaf pine and several oak species, has been selectively cut in the past, probably in the 1950's. The older shortleaf pines at the upper end of the reservoir are 50 to 70 years old and the oaks are 70 to 100 years old (M. Price, personal communication).

International Paper Company land

International Paper Company owns land in the Bismarck Mountains around Needle's Eye, a rocky, steep, droughty site with spots of mature growth, located in Hot Springs County, Arkansas. The area comprises around 6070 ha of upland forest; the valleys are managed, but the steep ridges are left alone. The slopes are predominantly forested with shortleaf pine, but scrub oaks, including post oak (*Q. stellata*), southern red oak (*Q. falcata*), blackgum (*Nyssa sylvatica*), and sweetgum (*Liquidambar styraciflua*) also occur. The presence of black gum and sweetgum suggest that the area may have burned in the past. The trees are at most 80 years old, and are not large (Ron Davidson, personal communication).

Table 7. An average tree summary for a stand on compartment 09 of land around Lake Greeson.

Acres	Product	Species	DBH cm	BA m ² /ha	Net Vol. m ³ /ha
740	Reproduction	Shortleaf	9.9	0.02	0.00
		Red oaks	9.7	0.02	0.00
		Other white oaks	9.9	0.02	0.00
		White oak	9.7	0.02	0.00
		Other hardwoods	7.6	0.02	0.00
		Gum	9.1	0.02	0.00
		Hickory	8.9	0.02	0.00
		total	9.4	0.02	0.00
	Pulpwood	total	19.7	0.07	0.00
	Sawtimber	Shortleaf	39.1	0.30	8.14
		Red oaks	39.4	0.30	5.26
		Other white oaks	41.4	0.32	5.17
		White oak	39.6	0.30	4.84
		Gum	39.4	0.30	6.34
		Hickory	35.6	0.30	3.43
		total	39.1	0.30	7.52
	Culls	total	20.8	0.09	0.00
	Chip and sa	total	27.7	0.16	3.00

Data provided by K. Meeks, U.S. Army Corps of Engineers

James Garrison Clark's land

James Garrison Clark bought land near Arkadelphia, Arkansas around 1900, to provide timber for his sawmill. He selectively cut timber until the 1930s, and his heirs have continued his tradition. Bob Rhodes owns some of this land and has developed large stands of old-growth pine. Peggy Clark's holdings include stands scattered in Hot Spring County, Clark County, and surrounding counties, totaling 1214 ha in the Interior Highlands, but not all of this is large timber. A few stands have been selectively cut in recent years. The forests include shortleaf and loblolly pines. Hardwoods, including southern red oak, willow, and water oaks (*Q. phellos* and *Q. nigra*) white oak, post oak, overcup oak (*Q. lyrata*) and Nuttall oak (*Q. nuttallii*), can be found in the creek and river bottoms. There are some five log pines, and some of the trees are 91 to 107 cm in diameter (Peggy Clark, personal communication).

Cossatot River State Park Natural Area

There are small, scattered stands of old growth in the Cossatot River area, which includes the Cossatot River State Park - Natural Area – approximately 19.3 km along the river owned by the Arkansas Natural Heritage Commission, adjacent to and downstream from the Ouachita National Forest. The area includes 329 ha of pine plantations and 600 to 800 ha of forest that has recently been selectively cut. Old-growth forest occurs on the steeper slopes and includes mixed pine - oak forest and woodland and glade communities comprised of eastern red cedar (*Juniperus virginiana*), oaks, and elms (*Ulmus spp*). The glade vegetation appears to be intact; the trees are old but not large (William Pell, personal communication).

Cucumber Creek Watershed

The Cucumber Creek watershed, located in Le Flore County south of the Ouachita National Forest in Oklahoma, includes 7285 ha. The Oklahoma Nature Conservancy owns 607 ha – some of the forest was cut in the last 20 to 30 years, but the forest includes some large shortleaf pine on the steeper slopes that are 51 to 76 cm in diameter and blackgum and hickory (*Carya spp*) may be up to 91 cm in diameter. Large sycamore trees (*Platanus occidentalis*) occur along the stream. The upper part of the watershed has probably not been cut since the turn of the century (Robert Hamilton, personal communication).

Conclusions

Based on FIA data, an estimated 24% of the Interior Highlands is mature. Applying the most stringent old-growth criteria, 7% of the mature stands are older growth. These 84.9 thousand ha represent less than 2% of the total forested land in the region. The 45.1 thousand ha of the relatively-undisturbed older growth outside of the National Forests represent less than 1% of the forested land in the Interior Highlands. Little of this older growth represents true "old growth," because most of the forests have been disturbed in the past.

Knowledge of the structure and composition of the older-growth forests of the region is sparse. Few scientific studies have been carried out in the older stands outside of the National Forests. Some of these stands are among the best examples of older growth in the Interior Highlands. Additional research is needed regarding the function of developing old-growth forests, the plants and animals inhabiting these forests, and the relationship of older forests to younger forests. The older forests differ in composition, density, basal area, and the amount of logs and snags. Old-growth definitions of the different forest communities of the Interior Highlands are needed (Martin, 1990, this volume).

There are limited areas of older stands. This suggests the overwhelming importance of efforts to manage and conserve older forests and to begin restoring old growth in

the Interior Highlands. The managers of the National Forests are in the best position to manage and restore the old-growth resource because little remains on private and other public land. The remaining stands are small and scattered. The older growth within the National Forests can be managed to ensure that use of the surrounding lands does not negatively impact the older stands. Stands that represent a variety of forest types and situations can be chosen for restoration.

Literature Cited

- Fenneman, N.M. 1928. Physiographic divisions of the United States. In: The National Atlas of the United States of America. 1970. Washington, D.C.: U.S. Department of the Interior, Geological Survey.
- Forest Inventory and Analysis (FIA) Unit. 1989a. Forest survey inventory workplan, Alabama 1989-1990. Starkville, MS: USDA Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis Research Work Unit. 120 p.
- Forest Inventory and Analysis (FIA) Unit. 1989b. Interactive data access user manual: forest resource data for Midsouth states. Version 3.0. Starkville, MS: USDA Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis Unit.
- Held, M.E. and J.E. Winstead. 1975. Basal area and climax status in mesic forest systems. *Ann. Bot.* 39: 1147-1148.
- Hines, F.D. 1988a. Forest statistics for Arkansas' Ozark counties - 1988. Resource Bulletin SO-131. New Orleans, LA: USDA Forest Service, Southern Forest Experiment Station. 39 p.
- Hines, F.D. 1988b. Forest statistics for Arkansas' Ouachita counties - 1988. Resource Bulletin SO-137. New Orleans, LA: USDA Forest Service, Southern Forest Experiment Station. 28 p.
- Hines, F.D.; D.F. Bertelson. 1987. Forest statistics for East Oklahoma counties - 1986. New Orleans, LA: USDA Forest Service, Southern Forest Experiment Station. 57 p.
- Hunter, M.L., Jr. 1989. What constitutes an old-growth stand? *J. For* 87(8): 33-35.
- Johnson, F.L. and G.D. Schnell. 1985. Final report to National Park Service, Santa Fe, New Mexico. Unpub. Ms.
- Martin, W. 1990. Defining old-growth deciduous forests: seeing the forest and the trees. In: Proceedings on restoring old growth forests in the Interior Highlands of Arkansas and Oklahoma; 1990 September 19-20; Morrillton, AR.

- McComb, W.C. and R.N. Muller. 1983. Snag densities in old-growth and second-growth Appalachian forests. *J. Wildl. Manage.* 47(2): 376-382.
- Pell, W. 1982. Site abstract. Hot Springs pine forest and display spring, Garland County. Unpub. Ms.
- Smith, K.L. 1986. Sawmill. Fayetteville, AR: The University of Arkansas Press. 246 p.
- Smith, T.L. 1989. An overview of old-growth forests in Pennsylvania. *Natural Areas Journal* 9(1): 40-44.
- Tritton, L.M. and T.G. Siccama. 1990. What proportion of standing trees in forests of the Northeast are dead? *Bull. Torrey Bot. Club* 117(2):163-166.
- USDA Forest Service. 1986. Land and Resources Management Plan, Ozark - St. Francis National Forest.