LONGLEAF PINE FORESTS AND WOODLANDS: OLD GROWTH UNDER FIRE!

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INTRODUCTION

"Old growth forest" evokes certain images and often strong feelings for many of us. To some degree, our images and definitions of old growth converge. Descriptions often include approximations of the following: stable for decades or centuries; a deep and many-layered canopy; massive and long-lived trees in the canopy; large dead logs in various degrees of decay; indicator species adapted to stable environments and incapable of rapid colonization. But much of the image-building has come from writings about the "ancient" forests of the Pacific Northwest, and from descriptions of remnant deciduous forests in the Appalachian chain. As we explore the diversity of forest types in the East, we must examine these often unspoken assumptions about old growth carefully. The degree to which they apply is rooted in the ecology of each forest type. Undoubtedly, *all* are characterized by complex ecological connections.

I will talk today about a once widespread forest type of the Southeast--1ongleaf pine dominated forests and woodlands. It is a system that depends on fire--more or less frequent, and often of low intensity (Heyward, 1939; Garren, 1943; Christensen, 198 1). Because human-mediated landscape fragmentation has drastically changed the behavior of fire on longleaf pine dominated landscapes, these forests and woodlands will never be self-sustaining.

Additionally, virtually all of these forests have been disturbed (cutting, plowing, fire exclusion), or converted irreversibly to other uses. Consequently, preserving existing remnant old forest will only partially fulfill an objective to conserve the range of diversity in longleaf pine ecosystems. It is likely that protecting minimally to moderately disturbed second growth longleaf pine forests, in order to produce some facsimile of "old growth forests" in the future, will be an important part of the old growth management strategy for the East.

In this presentation I describe natural longieaf forests, and provide an overview of the environmental factors ecological processes important in creating and maintaining their diversity. I present information about historical and current distribution and its status. Finally, based on the ecology and status of the forests, I offer suggestions for management to preserve the biological diversity associated with old growth longleaf pine systems.

DIVERSITYAND ECOLOGY OF NATURAL LONGLEAF VEGETATION

PRESETTLEMENT DISTRIBUTION OF LONGLEAF VEGETATION

At the time of European settlement longleaf pine forests and woodlands were found on the Atlantic and Gulf Coastal Plains from Southeastern Virginia to Eastern Texas. These forests extended inland into the Piedmont Physiographic Province (upland section), the Blue Ridge (southern section) and the Ridge and Valley Province (southern section). (See Fenneman, 1938, for physiographic maps, and Little, 197 1, for a map of longleaf pine distribution.)

Frost (1990) divides the range of longleaf pine into two areas. In general, coastal plain uplands and sandhills where fires returned on one to three years frequency were dominated by longleaf pine. Where fire ignitions were more infrequent or where topography resulted in areas being protected from some fires, longleaf pines were found in combination with various other pines, such as shortleaf, loblolly and slash, and/or hardwoods. Frost suggests the typical fire return time in transition areas was three to five years for pine mixtures and longer for pine-hardwood mixtures.

Longleaf pine occurred most on old, well-developed soils (order Ultisols) . Significant areas of geologically younger soils (Entisols) and soils with water impeding layers of iron minerals (Spodosols) were occupied by longleaf pine forests and woodlands. Smaller amounts of these vegetation types are/were found on distinctive clay Alfisols. Although longleaf could dominate forests over a variety of soil conditions, surface soils are generally mineral soils with low nutrient (nitrogen and/or phosphorus) contents (Wahlenberg, 1946).

Within longleaf landscapes, forests grade from well-drained to very poorly drained sites that are a product of soil texture and topographic position.

As one moves inland from the coast, the soils and underlying geologic strata are older and show the effects of long periods of erosion. That is, coastal landscapes tend to be nearly flat, with small rises (old dunes systems, for example) and depressions of various sizes. More inland landscapes are characterized by bigger changes in relief and may be described as hilly or rolling. In the Upper Piedmont and Mountains, longleaf vegetation may be found on steep, exposed rocky slopes.

ENVIRONMENTAL FACTORS AND DIVERSITY OF LONGLEAF SYSTEMS

Many researchers have documented the importance of site moisture in determining the composition and structure of vegetation in longleaf pine landscapes. For a synthesis of related literature, see Christensen (1988). This relationship is reflected in a preliminary classification of longleaf plant communities by Peet and Allard (1993). Major groups of communities (identified with multivariate analyses of vegetation data from across the Southeast) are distinguished by site moisture: xeric, subxeric, mesic, seasonally wet series. According to the authors, the five xeric types occur on coarse, well-drained sands, and the six subxeric types on somewhat finer textured soils. Four mesic types are the most species rich, but are very rare in the modem landscape as a result of historical conversion to agriculture. Seasonally wet types (eight) include both shrubby flatwoods and grassy (nearly treeless) savannas. The community types within these series are distinguished by physiography and geography. For example, within the xeric series, Fall-line, Atlantic, Southern, Atlantic Maritime and Gulf Maritime community types are recognized. The strong geographic component of the variation is evident also in the composition of the rare plant species component of longleaf pine communities. Of nearly 200 rare plants taxa, 96 narrow endemics (confined to a single state) were identified. Cluster analyses grouped wider-ranging rare species into four groups distinguished geographically: species generally confined to the Carolinas, those found in the Carolinas plus Georgia and Florida, species nearly confined to Florida, and those restricted to Louisiana and Texas (Walker, 1993).

CHARACTERISTICS OF OLD GROWTH LONGLEAF PINE SYSTEMS

Vegetation-Physiognomy and Canopy

"Good" examples of longleaf pine communities are typically described as open and parklike stands of pine, with a species rich herbaceous layer dominated by grasses. There is little, if any, shrub layer and the sparse subcanopy and sapling layer consists of patches of longleaf pines. The density and size of canopy trees and the density and abundance of the

herbaceous layer is site dependent: mesic sites with somewhat richer soils are more productive, and may, in fact, support some additional tree species, especially in microsites that are naturally somewhat protected by fires.

The U.S. Forest Service, in cooperation with The Nature Conservancy, is preparing definitions of old growth types in the southern and eastern regions. (Refer to papers by Mark Delf and Margaret Devall, these Proceedings.) Longleaf forests and woodlands are to be included in two separate definitions. The description for flatwoods is still in preparation. I have referred to the draft definition for "Upland Longleaf and South Florida Slash Pine Forests, Woodlands and Savannas" for much of the description and the data that follow. That definition was prepared by J. Larry Landers and William D. Boyer. The data are generally applicable to all but the seasonally wet flatwoods and savannas (Peet and Allard, 1993).

In the draft description of upland longleaf forests, the authors suggest that old growth conditions, with respect to the canopy tree characteristics, are measurable in forests a little over 100 years old. Characteristics of the canopy of old longleaf pine forests include: large boles, contorted and flat-topped crowns with only a few massive primary branches, decay within some live trees, cessation of height growth, and resin core formation. Some additional attributes, as described in the draft definition, are shown in Table 1. These were based on a variety of published data. Some are descriptions of extant old growth forests, but most are older records of stands that were harvested in the past. Note the low density of trees and the presence of multiple size classes. The uneven-sized condition suggests natural uneven-aged regeneration in these forests. Alternatively, larger scale events of even-aged regeneration (e.g., following hurricanes) could be broken apart gradually by the effects of smaller scale disturbances, such as local hot fires or small blow-downs, with subsequent regeneration over the long life of the forest. Thus scale is important in interpreting forest processes with regards to forest establishment.

TABLE 1. Canopy and tree characteristics of old growth upland longleaf pine forests, woodlands and savannas. Data were reproduced from draft manuscript by Landers and Boyer.

ATTRIBUTE	**RANGE OF MEANS IN STUDIES CITED**
Tree density, #/acre (/ha)	0.2-10 (0.5-24.7)
Age of large trees, yrs.	100-350
Number of 10 cm size classes starting with 5 cm diameter	5-8
Diameter at breast height of largest trees, cm	47.7-82.5
Standing snag density, #/ac (/ha)	0.1-0.6 (0.2-1.5)
Number of canopy layers	1-2
% Canopy in gaps	38-8

Longleaf pine trees may reach ages up to 500 years. The average ages of old representative trees in the stands included by Landers and Boyer (Table 1) ranged between 100-350 years. The large trees ranged in size from 19-33 inches in diameter at 4.5 feet. The canopy consists of one to two layers, but in keeping with the low stem density, up to 80 percent of the canopy may be "occupied" by gaps.

This table does not document some other very important attributes of old growth longleaf pine woodlands, such as condition and composition of the understory, presence of old growth dependent animal and rare plant species. I will discuss these briefly.

Under-stow Vegetation

The understory component of longleaf pine forests is extraordinary in several aspects. Significantly, the understories of some of these sites, notably mesic frequently burned sites, support species richnesses (at a scale of 1 square meter; species/m2) as high as any in the world (Walker and Peet, 1983). Even at larger scales, comparable to those typically reported for forest vegetation (species/O. I ha), mesic longleaf pine forests are among the richest in North America (Peet et al., 1990). In addition to overall richness, the understory component of well-maintained longleaf pine vegetation provide habitat for nearly 200 rare species of (mostly) herbaceous species (Hardin and White, 1989; Walker, 1993). The presence of large numbers of habitat specific understory species supports the contention that the critical, and most characteristic element of good quality old growth longleaf systems is the "old growth" understory.

Animal Community

Old growth longleaf forests provide habitat for a variety of animal species that undoubtedly evolved in landscapes with old growth components. Among these is the red-cockaded woodpecker, which requires old living pine trees for cavity excavation and foraging. To what degree the quality and quantity of its food source (the insect community) is dependent on old growth conditions, including an intact understory, is the subject of ongoing study (e.g., I<. Franzreb and J. Hanula, USDA FS, Southeastern Forest Experiment Station). According to Landers and Boyer (1993) citing unpublished data of Todd Engstrom, a research ornithologist at Tall Timbers (Tallahassee, FL), red-cockaded woodpeckers are among 22 birds that are more common on the old growth Wade Tract than in nearby second growth stands. Gopher tortoises and flatwoods salamanders are two additional vertebrates that are characteristic of intact longleaf pine landscapes. The salamanders are most common in areas with grassy understories, and use downed logs and limbs in these areas (John Palis, personal communication). The association of distinctive animal species with intact ground layers reinforces the significance of the understory component in old growth longleaf ecosystems.

Fire Relationships

Fire is essential for establishing and maintaining the vegetation structure and composition described above. In the absence of fire, hardwoods and shrubs invade. Herbaceous components are reduced. Rare plant species may be lost. (For more detailed discussions and references, consult Christensen, 1988. Also see Means and Grow, 1985; Noss, 1988; Hardin and White, 1989.)

The natural fire regime included fire during all seasons, but lightning caused ones were concentrated during a few months, mostly cited as April-July, depending on what part of the range is considered (Platt et al., 1988a; Platt *et* al., 1988b; Platt *et* al., 1993). Fire return time varied, but averaged one to three years on wetter sites and six to 10 years on drier ones.

Fire effects include maintaining low competition for longleaf seedling establishment and light-loving herbs, producing a mineral seedbed for pine germination, and creating a spatially heterogenous habitat that may be needed to maintain habitat diversity. Without fires, canopy species would not regenerate and herbaceous species would not persist.

STATUS

DECLINE IN LONGLEAF PINE ACREAGE

When Europeans settled the Southeast, longleaf pine dominated, or shared dominance, on 92 million acres (Landers et al., Manuscript). Decline in acreage since then is shown in Figure 1. The numbers from this figure were extracted from Landers, VanLear and Boyer (Manuscript). Since 1975, the rate of loss averaged about 140,000 acres/year. The numbers of trees in smaller age classes continues to decrease regionwide, indicating an aging, but not regenerating resource.

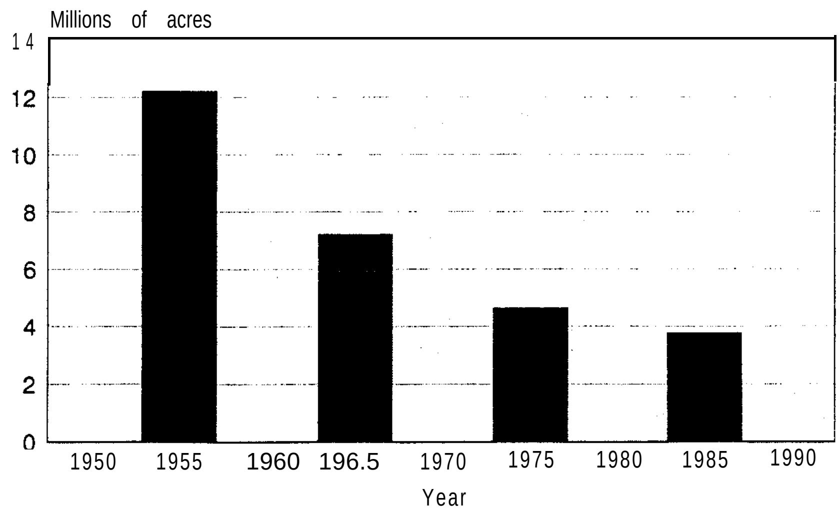

Figure 1. Decline in Longleaf Pine Forest Area (Kelly and Bechtold, 1990).

Table 2 lists the primary agents affecting the documented decline in longleaf pine area. For a complete discussion of this trend, see Frost, 1993. Of these, the suppression of fire may have contributed most significantly to the loss of characteristic understories. Its effect to some degree can be reversed. In contrast, the ground disturbing activities associated with intense agriculture and forest management are virtually irreversible with current knowledge.

TABLE 2. Factors associated with the historical decline in longleaf pine acreage. Information originally presented in Frost, 1993. For a complete discussion, refer to the original publication (Frost, 1993).

PRIMARY AGENTS IN THE DECLINE OF THE LONGLEAF PINE ECOSYSTEM

1. Naval stores production, 1607- 1930
2. Logging (steam technology), 1850- 1930
3. Establishment of high densities of feral hogs on open range, 1750-1880
4. 20th century fire suppression, 1920-1950

CURRENT STATUS

A recent estimate of acreage in longleaf pine is about 2.9 million acres (Lander *et al.,* Manuscript). Only a very small proportion of this could be described as minimally disturbed and retaining a considerable proportion of the characteristic composition and structure of "natural" stands. Frost (1993) identified only four small tracts (less than 2000 acres) of remaining "primary" forest.

Of the longleaf acreage, 7.5 percent is in private ownership and 25 percent is public land. The remaining large blocks are almost without exception in federal ownership on national forests and military installations. While small blocks may be managed to protect some elements, such as rare plant populations, other elements (e.g., wide-ranging vertebrate species) and natural processes (e.g., the creation of characteristic landscape heterogeneity) must be managed on larger units.

MANAGEMENT CONSIDERATIONS

DESIRED FUTURE CONDITIONS FOR LONGLEAF PINE OLD GROWTH

One might describe the desired future condition of the longleaf pine old growth resource in many ways. One example of a regional management objective could be stated as follows: the range of longleaf pine vegetation types will be represented in their respective old growth configurations. Some of the sites may be small, but large enough to maintain significant elements of biological diversity (e.g., viable populations of rare plant species). Others will be large enough to maintain populations of all characteristic longleaf pine dependent vertebrates and to provide to some degree for landscape level processes (e.g., fire creating habitat diversity) to occur.

MANAGEMENT STRATEGY

Accepting this objective along with currently available knowledge of longleaf pine ecosystem ecology dictates certain considerations for a regional management strategy:

1. The effort must be regionwide, and the cooperation of private and public managers will be needed.

2. Sites representative of old forest types must be distributed across the conditions which longleaf forests occupied prior to European settlement.

3. Both retention of existing old forests and restoration of disturbed forests are needed. The following kinds of sites may be considered as "candidates" for old growth longleaf sites: sites that have old (> 100 yr. old) trees now; sites with younger trees, but with minimally disturbed ground layers; sites with intact soil profiles (never plowed or mechanically prepared for planting trees). Site quality must include an evaluation of the understory and ground layer vegetation. Sites that will support a variety of characteristic organisms and processes will require an intact or restored herbaceous community.

4. Use of prescribed fire must be feasible on all sites. Human intervention will be needed for planning and implementing prescribed fires, and for retaining the legal and social environment that permits, even encourages, fire use.

SUMMARY POINTS

* Longleaf pine ecosystems once dominated the southeastern landscape. Less than 1 percent remains. The largest contiguous, single-owner tracts are found on public lands, especially national forests and military installations.

* The understories, as much as the old canopies and tree populations, embody the ecological complex associated with old growth longleaf pine forests. The successful reconstruction of a complex longleaf community understory has yet to be demonstrated.

* Fire is essential to maintain and restore forest values. Human intervention will be essential in the management of the longleaf pine resource.

* Finally, managing land to provide for the range of longleaf pine systems in an old growth condition will require the cooperation of land-owners, managers, scientists, and conservationists.

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