Pine

Longleaf Pine Ecosystem Restoration: The Role of Fire

James P. Barnett

SUMMARY. Longleaf pine (*Pinus palustris* Mill.) ecosystems once occupied over 36 million hectares in the southeastern United States' lower coastal plain. These fire-dependent ecosystems dominated a wide range of coastal plain sites, including dry uplands and low, wet flatlands. Today, less than 1.3 million hectares remain, but these ecosystems represent significant components of the Region's cultural heritage, ecological diversity, timber resources, and present essential habitat for many animal and plant communities. Fire was an essential component of the original longleaf pine ecosystems. The landscapes were characterized by open stands of mature longleaf pine with a savanna-like understory that were biologically diverse. Recent improvements in the technology to artificially regenerate longleaf pine has stimulated interest in restoring longleaf pine on many sites. Long-term studies show that the frequent use of fire hastens initiation of height growth, reduces undesirable competing vegetation, and stimulates growth and development of the rich undcrstory. So, fire is an important element in establishing the species and is critical to achieve and maintain the biologically diverse understory that is characteristic of the ecosystem. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworthpressinc.com <Website: http://www.haworthpressinc.com>]*

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INTRODUCTION

Currently there is considerable discussion about restoring ecosystems to some previous condition, but there seems little consensus on the means to achieve restoration; what are the target landscapes; what methodologies should be used; and how is success measured? The present condition of available sites, and legacies from the past land use, along with available technology and methods constrain restoration goals. Restoration of the longleaf pine (*Pinus palustris* Mill.) ecosystem in the southern United States is now receiving a great deal of attention (Landers et al. 1995, Noss 1989). The use of fire plays an important role in the restoration of this fire-dependent system.

Longleaf pine ecosystems once occupied over 36 million hectares in the southeastern United States' lower coastal plain from southern Virginia to central Florida and west to eastern Texas (Frost 1993). These fire-dependent ecosystems dominated a wide array of sites within the region. Today, less than 1.3 million hectares remain (Kelly and Bechtold 1990), with much of this in an unhealthy state. Longleaf ecosystems represent significant components of the Region's cultural heritage, ecological diversity, timber resources, and present essential habitat for many animal and plant communities. This once extensive ecosystem has nearly vanished. The objectives of this paper are to describe the longleaf pine ecosystem and its ecological and economic values, and explore possibilities for restoring the longleaf pine ecosystem to an important part of the southern forests.

THE LONGLEAF PINE ECOSYSTEM

The natural range of the longleaf pine covers most of the Atlantic and Gulf Coastal Plains with extensions into the Piedmont and mountains of north Alabama and northwest Georgia. The species occurs on a wide variety of sites, from wet, poorly drained flatwoods near the coast to dry, rocky mountain ridges (Boyer 1990). It is a long-lived tree, potentially reaching an age of several hundred years; but, longleaf pine forests are often exposed to catastrophic hazards such as tropical storms or fire and to continuing attrition from lightning which shorten possible rotation ages (Landers et al. 1995).

Longleaf pine is a very intolerant pioneer species and the seedlings go through a stemless grass stage. If competition is severe, they may remain in this grass stage for years. The ecosystem is distinguished by open, park-like "pine barrens," which are composed of even-aged and multi-aged mosaics of forests, woodlands, and savannas, with a diverse groundcover dominated by bunch grasses and usually free of understory hardwoods and brush (Landers et al. 1995). The diversity of understory plants per unit of area places longleaf pine ecosystems among the most species-rich plant communities outside the tropics (Peet and Allard 1993). Although the pine barrens are known for persistence and diversity, they occur on infertile soils. The ecological persistence of these areas is a product of long-term interactions among climate, fire, and traits of the key plants.

THE HISTORICAL ROLE OF FIRE

Fire was an essential component of the original longleaf pine ecosystems. Longleaf pine and bunch grass (e.g., wiregrass and certain bluestems) possess traits that facilitate the ignition and spread of fire during the humid growing seasons (Landers 1991). Frequent fire was largely responsible for the competitive success of longleaf pine and the grasses. These keystone species exhibit pronounced fire tolerance, longevity, and nutrient-water retention that reinforce their dominance and restrict the scale of vegetation change following disturbance. Fires that were ignited by Native Americans or that resulted from thunderstorms with frequent lightning prevailed over the region, a complex of quick-drying sites that are exposed to natural and anthropogenic disturbances. Many of these fires occurred during the growing season and largely prevented species native to other habitats from encroaching into the pine barrens. The chronic fire regime also maintained the soil structure and nutrient dynamics to which longleaf pine is adapted (McKee 1982). These fire effects tended to make longleaf pine sites more favorable to resident species than those indigenous to more nutrient-rich habitats.

DECLINE OF THE LONGLEAF ECOSYSTEM

The depletion of the longleaf ecosystem resulted from its many desirable attributes that have caused it to be exploited since the settlement of the nation by Europeans (Croker 1979). However, it was the event railroad harvesting in the late 1800's and early 1900's that provided assess to and depleted the vast remaining longleaf timberland. Cutting proceeded from the Atlantic states west through the Gulf Coast Region with increasing intensity of use with time. Longleaf pine logging reached a peak in 1907, when an estimated 74 million cubic meters were cut (Wahlenberg 1946). The longleaf pine ecosystem now occupies only a small part (less than 5 percent) of its original area. This habitat reduction is the reason for the precarious state of at least 191 taxa of vascular plants (Hardin and White 1989, Walker 1993) and key wildlife species such as the red-cockaded woodpecker, gopher tortoise, and southern fox squirrel (Landers et al. 1995).

Regeneration of longleaf pine was limited because of a combination of circumstances. The completeness of the harvest left little seed source for natural regeneration and much of the harvested land was cleared for cropland or pasture. Longleaf pine does not successfully invade open land in competition with more aggressive pine or grass species. Regeneration sometimes succeeded old-growth when periodic fires provided a seedbed and controlled woody competition, and when wild hogs did not reach a density high enough to destroy established seedlings (Landers et al. 1995). The disruption of natural fire regimes, resulting in part from forest fire protection policies implemented during the 1920s, allowed invasion of longleaf sites by hardwoods and more aggressive pine species. Longleaf pine and its associated species cannot compete under these conditions. Regeneration, both naturally and artificially, is more difficult than for any other southern pine due to the delay in stem elongation (the grass stage) that is a genetic trait of the species. Also, survival of planted bareroot nursery stock is generally poor and established seedlings in the grass stage are very sensitive to competition.

RESTORATION OF THE LONGLEAF PINE ECOSYSTEM

A key to restoration of the longleaf pine ecosystem is to ensure that its recovery benefits society. Without economic benefits, long-term conservation projects usually do not succeed (Oliver 1992). Longleaf pine forests have high economic value due to the quality of solid-wood products produced. Harvesting or forest management need not be eliminated or even moderately restricted to restore and maintain longleaf pine ecosystems, as evidenced by the fact that logging at the turn of the century apparently had little effect on groundcover diversity (Noss 1989). Restrictions on harvest would be a disincentive to many landowners and could result in the elimination of much of the remaining longleaf pine on private lands.

Restoration of the longleaf pine ecosystem is achievable since pockets of longleaf pine occur in much of its former range. It should be feasible to gradually expand longleaf pine acreage through education, research, and commitment on the part of resource managers. Restoration is now a goal on much of the public land in the southern United States, where longleaf pine remains as a component of the forest. In fact, much of the current acreage of the ecosystem occurs on public lands.

A number of interacting factors will determine whether the restoration of the longleaf pine ecosystem can be achieved. These include the capability to successfully regenerate longleaf pine on its native sites, to use fire to enhance establishment and management of both the overstory and the understory species, to educate the public and resource mangers on the value and technology of restoration, and to evaluate restoration success.

Reforestation Technology. Utilization of the trees in the original forest was so complete that inadequate numbers of seed trees remained to naturally regenerate many of the harvested stands. So, artificial regeneration must be used to restore longleaf on the appropriate sites were it originally grew. Until recently, regeneration success from planting was generally unacceptable due to problems related to severe competing vegetation, delayed stem elongation, and poor storability of bareroot seedlings. We now have the knowledge and technology to reestablish longleaf pine by planting bareroot stock. The keys to successful establishment are: well-prepared, competition-free sites; healthy, top-quality, fresh planting stock; meticulous care of stock from lifting to planting; precision planting; and proper post-planting care (Barnett 1992). Attention must be given to all of these factors to obtain acceptable regeneration.

Planting of container stock is now accepted as the most successful method of regenerating longleaf pine (Barnett and McGilvray 1997). This improved survival and growth is generally attributed to root systems that remain intact during lifting while the roots of bareroot plants are severely damaged. Thus, container seedlings experience a significantly shorter period of transplant stock or adjustment than bareroot stock. However, using container stock does not eliminate the critical need for controlling competition during the first growing season after planting.

Role of *Fire*. Fire is an essential component of the restoration and management of the longleaf pine ecosystem. Long-term studies show that the frequent use of fire hastens initiation of height growth, reduces undesirable competing vegetation, and stimulates growth and development of species that are an essential component of the understory. Seasonal burning studies show that late spring burns are much more effective in the restoration process than the typical winter burns that are usually favored for other pine species (Grelan 1978). Fire is an important element in establishing the species and is a critical component for achieving and maintaining the biologically diverse understory that is characteristic of the ecosystem.

Education and Commitment. Education of the public regarding the current status of the longleaf pine ecosystem, its potential economic value, its outstanding biodiversity, and the role of fire in maintaining the system is an initial step in securing support for restoration (Landers et al. 1995). A primary need in this process is to promote the use of fire as an ecological force necessary for maintenance of this fire-dependent ecosystem. Frequent prescribed burning, including use of growing-season fires where appropriate, promotes the diversity and stability of these communities (Noss 1989). Many private landowners are concerned about the environment and will support restoration, if through the process they generate income from their land. Longleaf pine can be managed in an ecologically sensitive manner that generates income satisfactory to interest a landowner in restoration (Landers et al. 1990)

Determination of Success. One way to measure the success of the restoration process is to determine through periodic forest surveys if the area in the longleaf pine type increases. Another method is to determine if the production of longleaf pine nursery stock increases in relation to the other southern pines. Some would question whether an increase in area of longleaf pine plantations equates to an increase in ecosystem restoration. Certainly it takes more than planting trees to restore the ecosystem, but it is the critical first step. Recent research indicates that the productivity of an ecosystem is controlled to an overwhelming extent by the functional characteristics of the dominant plants (Grime 1997). So, with reestablishment and appropriate management, including the appropriate use of fire, restoration processes that include development of the typical diverse understory vegetation will begin.

CONCLUSIONS

Fire was an important component of the original longleaf pine ecosystem. Landscapes were characterized by open stands of mature pine with a savanna-like understory. This very biologically rich understory was typical for the ecosystem. Recent improvements in reforestation of longleaf pine has increased interest in restoring the ecosystem on many sites where it originally grew. It is recognized that fire must play an important role in the restoration process. Frequent use of fire hastens initiation of height growth, reduces undesirable competing vegetation, and stimulates growth and development of species that are a component of the understory. Fire is an important element in establishing the species and is a critical component of achieving and maintaining the biologically diverse understory that is characteristic of the ecosystem.

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