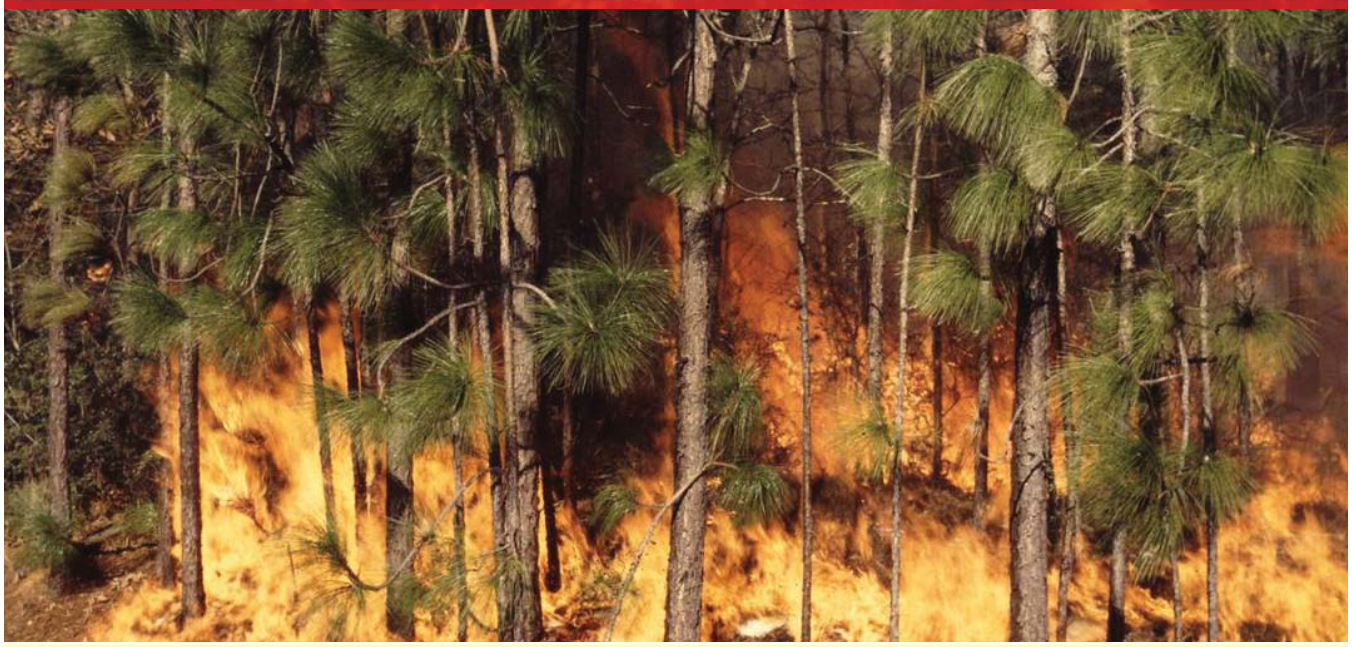
Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS



Fire was re-introduced to the Flomaton Natural Area in 1995. Credit: John Kush.

# Restoring Fire to the Longleaf Pine Forest

## *Summary*

At the time of European settlement, the longleaf pine ecosystem dominated the southeastern landscape. Lightning strikes and the use of fire by Native Americans maintained this habitat as an open savanna with a grassy forest floor that supported a great diversity of wildlife. Once considered the most commercially valuable species in its range, it was extensively harvested and replaced with faster growing species such as loblolly pine. By the 20th century, the longleaf pine ecosystem was so reduced that today, it is considered endangered.

As of 2004, only 15 documented old-growth stands of longleaf pine forest remained in the tree's historic range. Of these 15 stands, only five were considered virgin, unlogged forest. In January 2008, one of these forest remnants became lumber as a small stand of old-growth longleaf pine, with some trees nearly 300 years old, was commercially clear cut and the stumps removed. The site, Flomaton Natural Area in Escambia County, Alabama, had been the subject of 15 years of research on restoring fire to the ecosystem.

Prescribed fire, which was used until 1950 by private landowners to maintain this remnant forest, was reintroduced to Flomaton beginning in 1995. Four prescribed burns over a period of seven years, combined with removal of hardwoods and mowing, succeeded in reducing fuels and promoted longleaf pine seedling recruitment. In addition, about 40 native herbaceous species regenerated from the seedbank.

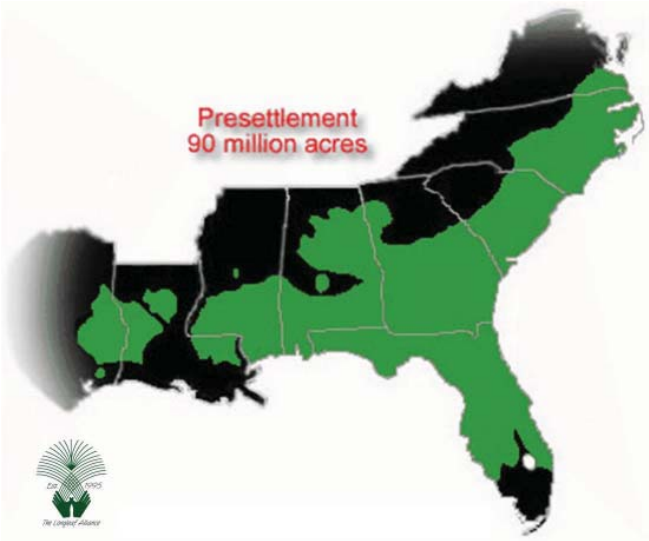
Though the clear-cut removed Flomaton from the list of old-growth longleaf pine forests, the research efforts demonstrate that carefully applied, low-intensity fire can restore not just the tree, but a richly diverse ecosystem closer to the historic conditions of longleaf pine savanna.

## Key Findings

- Careful use of prescribed fire can restore the health of the longleaf pine and its ecosystem.
- After just two years of prescribed fire, seedling recruitment of longleaf pine increased, and saplings were able to establish. Eventually, more than 40 herbaceous species rebounded from the existing seedbank.
- The major obstacle to safe use of prescribed fire at the Flomaton Natural Area was the heavy accumulated fuel load. The forest floor was reduced gradually by applying low-intensity fires over several years, beginning with cool, wet season fires.
- Fire crews carefully mopped up after burns with water to dampen the smoldering duff and reduce the risk of fire killing the feeder roots or girdling the trees at the base.

## Introduction

The longleaf pine (*Pinus palustris* Mill.) forest that settlers encountered in the New World dominated the landscape across an estimated 90 million acres (36 million hectares) along the Gulf and Atlantic coastal plains, from eastern Texas north to southern Virginia and inland to the Piedmont, Ridge and Valley, and Mountain Provinces of Alabama and Georgia. Today, only about 3 million acres (1.2 million hectares) remain.




Native range of the longleaf pine. Credit: Longleaf Alliance.

Known as the tree that built America, its tall straight trunks were used as masts for the shipping industry, and its resin was tapped to produce pitch, tar, and turpentine. Heavy logging, agriculture, and development drastically reduced the range of this forest ecosystem prior to the 20th century, and fire exclusion more recently has led to a decline of seedling recruitment and loss of species diversity in the herbaceous understory.

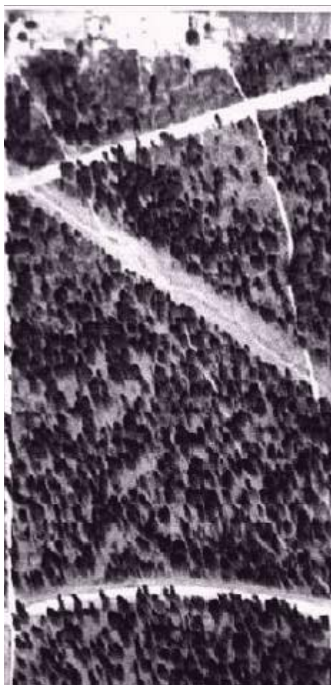
Longleaf pine is one of the most fire-dependent trees of North America. Fire reduces the forest floor and allows the seeds to come in contact with the mineral soil, a prerequisite for establishment. In addition, longleaf pine seedlings remain in a highly fire-resistant, grass stage for 5 to 12 years before beginning a growth spurt. The historic fire regime, 1 to 10 years from lightning-ignited fire and use of fire by indigenous people, once kept the understory free of hardwoods and most shrubs and maintained the forest in an open, park-like condition.

Slidemaker: George D. Fuller (George Damon) 1869–1961. American Environmental Photographs Collection, [AEP Image Number, e.g., AEP-MIN73], Department of Special Collections, University of Chicago Library.

"If longleaf pine goes longer than 10 years without fire, the ecosystem is in trouble," says John Kush, a Research Fellow with Auburn University's School of Forestry and Wildlife Sciences. Kush and colleagues spent 15 years documenting the condition of the forest and the effect of prescribed fire in the Flomaton Natural Area in Escambia County, Alabama. Flomaton was one of only 15 documented remnant stands of old-growth longleaf pine when it was clear-cut in January 2008. One of the smaller of the remnant stands, 60 acres (25 hectares), it was also distinguished as one of only five considered virgin, or unlogged.

At the end of the 19th century, the tract was set aside by its owner, the Alger-Sullivan Lumber Company, as a target for preservation and was managed by controlled burning until the 1950s. The original land owner, Russell A. Alger, recognized the significance of this remnant old-growth stand. In 1963, the Flomaton Natural Area was recognized by the Society of American Foresters as a National Natural Resource that should be saved intact, as it was prior to settlement.

In 1994, a partnership of public and private entities entered into a cooperative agreement to restore the stand, which was located along a U.S. highway within the city limits of Flomaton, to its historic condition and to use it




(Left) Aerial view taken in the early 1950s. It is assumed that the stand was still being prescribed burned on a regular basis. (Right) Aerial photograph, taken in 1992. The gaps that existed in the 1950s photograph were filled in by other southern pine species and several hardwood species. Credit: Flomaton Poster, John Kush.

Photo taken in the mid-1950s. Note the heavily stocked stand with numerous large trees typical of old-growth longleaf pine forests. Credit: Flomaton Poster, John Kush.

for scientific and educational purposes. The managing partners included the Auburn University School of Forestry and Wildlife Sciences, the USDA Forest Service, and the landowner at the time, Champion International Corporation.

The research efforts, supported in part by the Joint Fire Science Program, began with surveys of conditions at Flomaton prior to the reintroduction of fire. Kush and colleagues found that the high density of small diameter trees, heavy forest floor fuels, and invasion of hardwood species, primarily oak, were suppressing regeneration of seedlings. In addition, draped litter in the mid-story increased the danger of fire carrying into the canopy.

In 1993, 2 years before the first prescribed burns, a garbage fire ran out of control burning seven acres of the forest. This was a patchy, smoldering fire during dry fuel conditions that girdled the trees at their base. After 1 year, the weakened trees were infested by two species of beetles, and in the second year 91 percent of longleaf pine more than 80 years old were dead. This accidental fire illustrated the necessity of careful application of fire during controlled burns when accumulated duff on the forest floor and draped litter increase the danger of fire carrying into the overstory. "People traveling along this U.S. highway saw what happened with this small garbage fire," says J. Morgan Varner, an assistant professor in the Department of Forestry and Wildland Resources at Humboldt State University who worked with Kush at Flomaton. "It made people aware that reintroducing fire cannot be done in a haphazard manner."

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To document changes in the condition of the forest during restoration efforts, researchers established 30 small plots (0.2 acres/0.08 hectares) to monitor the overstory, estimate the cone crop, and measure litter depth and seedling recruitment. In addition, a separate study began in 2001 to identify canopy gaps where seedling establishment was most likely to occur.

Two fires of low severity were conducted in 1995. Half the stand was burned in January, and the other half in April, effectively reducing the suspended litter and killing smaller diameter trees without causing mortality to larger diameter longleaf pine.

The same prescription was applied in 1996 followed by careful harvesting of all hardwood species. After these first 2 years of prescribed fire, seedling recruitment rebounded, as did the number of herbaceous species in the understory. "The seed of the herbaceous plants were still there on site, even after 40 years," Kush says.

A spring burn in 1997 was applied to discourage the resprouting of hardwoods. Prescribed fires were suspended between 1998 and 2000 due to dangerously dry conditions, and the area was bush-hogged in 2000 and burned again in 2001.

Monitoring of Flomaton between 1993 and 2004 demonstrated that stand density dropped from 256 trees per acre (662 per hectare) to 91 trees per acre (227 per hectare). The low-intensity fires were successful in reducing forest floor depth on average from 6.2 inches (15.8 cm) to 4.5 inches (11.4 cm), and in the canopy gaps that were measured, the grass-stage seedlings experienced a growth spurt.

The reintroduction of fire to Flomaton was conducted with extreme caution due to a number of concerns. "In a fire-suppressed stand, you have to be incredibly careful with introducing prescribed fire," Kush says. It can take 10 to 15 years of low-intensity burns, mopping up immediately after with water to quench smoldering duff, and using alternative treatments such as harvesting of hardwood and

mowing to reduce competition. “You can’t be in a rush, nature doesn’t work that way.”

Major concerns include draped fuel that can carry fire into the crown, smoldering fire in the duff that can girdle older trees at ground level and kill the feeder roots, and snags that continue to burn and drop even after the ground fire has died out or been mopped up.

Though the Flomaton Natural Area was clear-cut in

Flomaton Natural Area after a prescribed burn. Credit: John Kush.

2008, the research efforts demonstrated that low-intensity, frequent fire applied with extreme caution, combined with alternative treatments, can serve as a prescription for land managers in similar remnant stands of old-growth longleaf pine and in other pine ecosystems as well.

## Endangered ecosystem

The longleaf pine ecosystem is considered the most endangered in the United States. A report published by the U.S. Department of Interior National Biological Survey (NBS) finds this ecosystem is even more threatened than wetlands. Longleaf pine habitat, for example, has been reduced by more than 98 percent, while wetlands have declined 28 percent. The pine’s precarious status is all the more dire because terrestrial ecosystems such as longleaf pine receive no regulatory protection as do wetlands under the Clean Water Act.

In 1997, Kush and Varner conducted a survey of remnant old-growth longleaf pine stands, documented the condition of each, and assessed the various threats to them. The tracts ranged in area from 50 acres (20 hectares) to the largest, at Eglin Air Force Base in Florida, 9,020 acres (3,650 hectares).

*...fire exclusion is only one of many threats to these fragmented stands.*

According to the survey, fire exclusion is only one of many threats to these fragmented stands. Other threats include wildland/urban interface issues (60%), the danger of duff fire (47%), invasion of nonnative species (20%), and an uncertain management future (13%).

In addition, the authors noted that these old-growth stands are confined to only four states: Alabama, Florida, Georgia, and North Carolina, which means that the longleaf pine ecosystem has vanished in a large part of its historic range in the Piedmont, Ridge and Valley, and Cumberland Plateau Province. Six potentially significant stands have been reported but not investigated.

Though considered endangered, the longleaf pine ecosystem is also a “bright spot” in the history of prescribed fire, according to Randy Rosiere, a professor of Animal and Range Sciences at Tarleton State University in Stephenville, Texas. “Longleaf pine was probably the first…forest type understood to be a fire type, and the species recognized as being dependent on fire as part of its proper management,” writes Rosiere in his online treatise “Longleaf Pine Forests.”

Among the first to recognize the importance of fire in the longleaf pine ecosystem were preservationist John Muir and Gifford Pinchot, the first chief of the U.S. Forest Service. In an 1899 article in National Geographic Magazine, Pinchot quoted Muir as ranking fire along with precipitation and temperature “as one of the great factors which govern the distribution and character of forest growth.” Both men recognized the role of fire in maintaining the open, park-like habitat, and the adaptation of seedlings and adult trees to fire. In the National Geographic article, written several years before he became chief forester, Pinchot alluded to “what might almost be called the creative action of forest fires.”

“Pinchot described in detail the fire-adapted, thick-barked shoots of longleaf pine seedlings (‘two-thirds bark and one-third wood’) and the ‘barrier of green needles’ that ‘itself burn only with difficulty’ and which ‘shades out the grass around the young stem, and so prepares a double fire-resisting shield about the vitals of the young tree’,” writes Rosiere.

Longleaf pine in the grass stage. Credit: John Kush.

In the 20th century, the noted southern conservationist and self-taught naturalist Herbert L. Stoddard also recognized the importance of controlled burns as part of a management plan for longleaf pine habitat, focusing his research on the coastal longleaf/wiregrass coastal plains ecosystem of Georgia. In his book, The Bobwhite Quail: Its Habits, Preservation and Increase, published in 1931, he outlined an integrated strategy for wildlife management that relied on restoration of fire to the longleaf pine forest at a time when state and federal land managers, responding to the devastating fires that followed extensive logging, were advocating, and implementing, fire exclusion. Stoddard is

also noted for being instrumental in the foundation of the Tall Timbers Research Station in 1958, "the first research station in the nation devoted to the study of fire ecology," according to The New Georgia Encyclopedia.

Ground-nesting birds like the quail are not the only birds that thrive in a fire-maintained longleaf pine ecosystem. The Red-cockaded Woodpecker (*Picoides borealis*), federally listed as endangered, is "the only bird in North America that makes its cavities in living pine trees," according to a report by the Longleaf Pine Alliance. Kush and Varner's survey revealed the presence of the Red-cockaded Woodpecker in a few remaining old-growth stands of longleaf pine they explored: the 185 acre (75 hectare) Goethe State Forest in north Florida; the 395 acre (160 hectare) Platt Branch in Glades County, Florida, owned by the Florida Fish and Wildlife Conservation; and the 4,077 acre (1650 hectare) Moody Tract in Appling County, Georgia, owned by The Nature Conservancy.

Red-cocked populations are also found on the largest tract, Eglin Air Force Base, which Varner and Kush describe as "the most ecologically viable old-growth longleaf pine landscape in existence." "The Air Force has a high-profile and is a good steward of the land," says Kush. "They are managing for endangered species in hopes their neighbors will also be good stewards."

The Yellow-bellied Sapsucker (*Sphyrapicus varius*), an over-wintering resident in southern forests, also uses the longleaf pine for roosting and foraging, preferring larger-diameter trees, both healthy and weakened. Approximately 20 to 100 percent of its diet consists of tree sap that it taps into by creating holes, or sap wells, in the bark of trees. Prior to restoration efforts, bird diversity in the Flomaton was low. During the years of restoration, researchers monitored the feeding behavior of the sapsucker by measuring the sap wells the bird establishes. "During restoration, unexpected things happened," says Varner. "We anticipated that the changes would be gradual, but instead conditions changed rapidly." In fact, Kush and Varner observed an astonishing number of sapsuckers. "The trees were white like candles, covered in sap," says Varner. "We think the health of the residual trees was improved and the sugar content of the sap was higher."

The Flomaton Natural Area was the only old-growth longleaf pine ecosystem that has been intensively surveyed to monitor the effect of reintroducing prescribed fire on the health of the forest and its denizens. Until it was clear-cut, it served as a living laboratory. People traveling on the U.S. highway through the area were able to observe first hand the negative effects of the accidental garbage fire and, over the years, the positive effects of careful, frequent, low-intensity fire. "This project has had a huge effect on naturalists' awareness of the need for a cautious approach to reintroducing fire to longleaf and other pine ecosystems," says Varner.

### *Management Implications*

- The remaining old-growth longleaf pine ecosystems are considered endangered. Few are in pristine condition, and all will require introduction or maintenance of prescribed burning to restore them to conditions resembling the historic state.
- Research conducted at the Flomaton Natural can be used as a general guide to reintroducing fire in similar ecosystems.
- Fire must be administered with extreme caution in fire-excluded stands with thick forest floor fuels. Burn prescriptions should focus on duff moisture as a guide to minimize duff smoldering and subsequent tree mortality. Mopping up with water after fire can avert mortality of mature trees.


The Flomaton Natural Area served as a demonstration laboratory for visitors traveling through the area. Credit: John Kush.

## Further Information: Publications and Web Resources

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## *Scientist Profiles*

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