

STANDING TALL:

How Restoring Longleaf Pine Can Help Prepare the Southeast for Global Warming

NATIONAL WILDLIFE FEDERATION

2009



CONFRONTING GLOBAL WARMING

Report

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Standing Tall: How Restoring Longleaf Pine Can Help Prepare the Southeast for Global Warming

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For more information about NWF's longleaf pine programs, please visit www.nwf.org/longleafpine.

**Cover photo: Longleaf pine needles
and cones in mid September.**

Photo by: William D. Boyer, USDA Forest Service,
Bugwood.org

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Northern bobwhite quail, a favorite of hunters in the southeastern United States, thrive in the rich understory of longleaf pine ecosystems. The dramatic loss of their preferred habitat over the last two centuries has contributed to declines in bobwhite populations.

Foreword

It is time for both the uniqueness and plight of the longleaf pine forest to come to national attention. Growing up in Alabama, the longleaf pine savanna was my homeland environment and is dear to my heart. A substantial part of America's environmental future is tied to this one species, which dominates the trees in the land it occupies. The longleaf also holds the key to an important part of the future economy of the southeastern United States.

The original longleaf ecosystem was once one of America's largest, stretching from the eastern Virginia plains to central Florida and thence westward to Texas. Ancient in origin, it comprised—and its scattered old-growth remnants still comprise—one of the biologically richest habitats in North America. Many of the plant and animal species are endemic. That is, they are found nowhere else.

Longleaf wood is also one of the commercially most coveted forest products, rivaling redwood and white pine in quality. From the end of the Civil War into the early part of the 20th Century, longleaf timber was a major source of wealth for the Reconstruction South. But its full value was not appreciated, and it was not managed properly. Almost all of the old trees were cut down, whereupon the wealth dried up. Today, we realize that, fortunately, the ecosystem of which it was the defining element can be restored.

As this report and other accounts leading up to it demonstrate, the restoration of the once great longleaf forests will be one of the wisest investments the South can make for its long-term economic future. Managed properly, regrown forest can be a permanently profitable source of goods and income. Its expansion will moreover preserve a substantial fraction of America's biodiversity. Finally, as one of the most resilient of trees, it will add to the ability of the Southern forests as a whole to withstand the mounting challenge of climate change.



Mary Ann Friedman



Flickr: Vicky TGAW

Edward O. Wilson
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Executive Summary



William D. Boyer, USDA Forest Service, Bugwood.org

Longleaf pine (*Pinus palustris*) forests are one of America's natural treasures, yet past exploitation has left them hanging by a thread, now covering just 3 percent of their pre-settlement range. Because other pine species in the Southeast may be more susceptible to global warming, longleaf pine forests have an opportunity to reclaim some of their former glory. Indeed, re-establishing longleaf pine ecosystems will benefit all Americans by improving climate resilience, economic opportunity, and ecosystem vitality.

This report provides a summary of recent literature on how global warming will affect forests in the Southeastern United States and how longleaf pine is expected to be resilient to many of these changes. It makes a strong case for why longleaf pine ecosystem restoration should be the centerpiece of forest-based climate adaptation and carbon sequestration efforts in the region, as well as efforts to improve the economic opportunities of traditionally underserved landowners. Key findings of the report follow.

Global warming puts southeastern forests at risk. As global warming pollution accumulates in the atmosphere, more and more climate changes are coming to the southeastern United States. Temperature increases, shifts in precipitation, more severe storms, sea-level rise, and other climate changes are stressing natural ecosystems and forcing communities and governments to rethink how we manage our forests, water supply, and other natural resources. More intense weather and climate extremes—for example, increasing frequency and severity of fires, hurricanes, droughts, and floods—will most directly impact these forests.

Longleaf pine ecosystems are naturally resilient to climate extremes in the Southeast. Originally the dominant native pine of the South, now mostly eliminated from its historic range, longleaf pine is better suited to thrive in the coming decades than other southern pine species. Longleaf pine grows under very dry and very wet conditions, is tolerant of and even dependent on frequent fire,

is better able to weather severe storms, and is more resistant to beetle infestations likely to be exacerbated by warmer and drier conditions.

Longleaf pine restoration is a promising global warming adaptation strategy for southeastern forests. We need to invest in conservation strategies that are most likely to help wildlife and biodiversity cope with rapid change and to maintain the natural resources upon which communities across the nation depend. Restoring and expanding healthy longleaf pine forests can ensure long-term economic returns for landowners, provide crucial wildlife habitat, and enhance natural retention of fresh water on the landscape. Furthermore, recent experiences with Hurricane Katrina and the 2009 wildfires in Myrtle Beach, South Carolina have poignantly illustrated how longleaf pine forests can retain much of their economic value and help protect communities from devastating natural disasters.

The wide spacing among trees in a longleaf pine forest allows sunlight to reach the forest floor, supporting a diverse understory of wiregrass and other species.

Longleaf pine ecosystems should be a centerpiece of land-based carbon sequestration efforts in the Southeast. Improved forest management will be an important tool in the effort to reduce the amount of carbon dioxide in the atmosphere, and thus limit the overall amount of warming during the coming decades. Longleaf pine ecosystems are well suited for long-term storage of carbon. Longleaf pine trees live longer than other southern pine species; are less susceptible to fire, pests, and storms; and produce wood more likely to be used in long-lasting structures.

Longleaf pine restoration can help alleviate poverty among African American landowners in the Southeast. The historical range of longleaf pine overlaps with the area in the rural South with large populations of African Americans, who endure high levels of poverty despite the presence of rich forest resources. Community-based forestry programs to educate and empower landowners about longleaf pine conservation and stewardship can help these communities take better advantage of the rich natural resources of the region, and thereby access new short-term income opportunities, build wealth, and enhance the resilience of communities.



I. CLIMATE IS CHANGING IN THE SOUTHEAST

The southeastern United States is beginning to see the effects of accumulating global warming pollution, and the impacts are expected to get worse. Temperature increases, shifts in precipitation, more severe storms, sea-level rise, and other climate changes are stressing natural ecosystems and forcing communities and governments to rethink how best to manage our forests, water supply, and other natural resources. In considering the impacts on forests, changes in climate extremes—for example fires, hurricanes, and droughts—will likely be more important than gradual temperature change.¹

WARMER TEMPERATURES

While the Southeast did not warm significantly during the 20th century, the region will not be so lucky for the 21st century. Models project that average temperatures will increase by 4.5 to 9 degrees Fahrenheit by the 2080s depending on the rate of global warming pollution.² Florida is projected to warm a little less, while warming in the more northerly parts of the Southeast will be more pronounced. Summertime will bring the most warming, such that most of the region will have more than 100 days each year with peak temperatures greater than 90 degrees Fahrenheit. These higher temperatures will thermally stress forests and create conditions favorable for insect infestation, disease outbreaks, and the spread of invasive species.

MORE DROUGHTS AND FLOODS

The future trends for average rainfall in the Southeast are still very uncertain, but it does appear likely that the region will experience more frequent dry conditions punctuated by heavier rainfall events.³ About two

thirds of climate models indicate that, under warmer conditions, increases in evaporation in the region will outpace increases in precipitation, meaning drier conditions especially during summer when water demand peaks.⁴ At the same time, global warming will bring more intense rainfall events, with greater precipitation for individual storms and the potential for high-volume runoff that could stress storm water management systems.⁵ This trend is already apparent in the Southeast: the number of days with very heavy rainfall (not including hurricanes) along the southeastern coast has increased by 26 percent during the 20th century.⁶

MORE FIRES

Frequent, low-intensity surface fire is a natural occurrence in the southeastern United States. Yet, extremely dry conditions in recent years, combined with a legacy of past fire exclusion, have fueled unusually large and intense wildfires. In 2007, for example, fires burned about 600,000 acres in Georgia and Florida,



National Oceanic and Atmospheric Administration

the largest fires in the history of either state.⁷

The future fire frequency in the Southeast will depend on how global warming affects precipitation in the region, as well as how we manage our forests. One recent study found that, while the Southeast may initially see a decline in climatic conditions conducive to fire, an increase in fire sensitivity is projected for inland areas by mid-century and beyond.⁸ In particular, more extremely dry periods combined with higher temperatures and more lightning could lead to more intense wildfires, especially if interspersed with wetter years that allow rapid growth of vegetation that provides fuel for fires.

MORE SEVERE HURRICANES

Hurricanes that strike southeastern coasts are expected to bring higher

wind speeds, more precipitation, and larger storm surge in the coming decades. The destructive potential of tropical storms in the North Atlantic has increased by about 50 percent since the 1970s.⁹ This increase, which primarily reflects longer storm lifetimes and greater storm intensities, is correlated with an increase of 0.9 to 1.3 degrees Fahrenheit in sea-surface temperatures in the main development area for tropical storms in the North Atlantic.¹⁰ If global warming pollution continues unabated during the next century, tropical sea surface temperatures could increase another 3 degrees Fahrenheit—about three times the warming to date.¹¹ This amount of warming could mean increases in maximum wind speed of 2 to 13 percent,¹² often enough to bump a hurricane up to the next more severe category.

Hurricane Katrina damaged millions of acres of forestland in the Southeast, including this property in Slidell, Louisiana.



II. LONGLEAF PINE ECOSYSTEMS ARE RESILIENT

A very distinctive and long-lived species, longleaf pine once covered as many as 90 million acres throughout the southeastern United States.¹³ Today, however, the remaining longleaf pine forests are estimated at 3.4 million acres¹⁴—or just 3 percent of the historical range. This dramatic decline is due mainly to land clearing for human occupation and agriculture, conversion to short-rotation pines to feed the paper industry, and the suppression of fire.¹⁵ Most of the pine forests present in the Southeast today are loblolly pine and slash pine. These species grow faster than longleaf pine, making them attractive to industry.

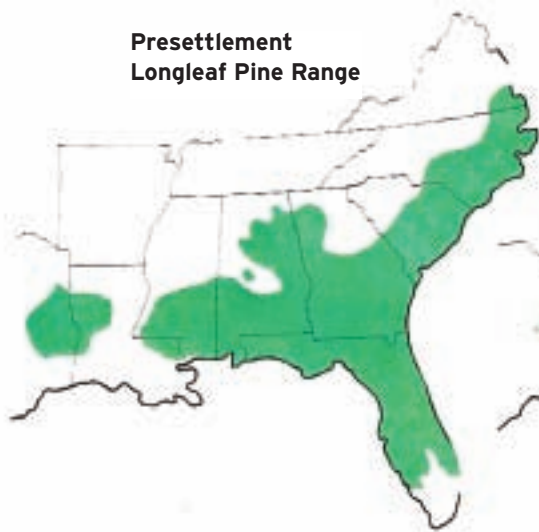
Global warming gives a new imperative to efforts to restore longleaf pine across its historical range. The biology, ecology, and history of longleaf pine ecosystems all suggest that they are better suited for more variable climate conditions than other pine species commonly found in the Southeast today. Compared to other pine species, longleaf pine is more resistant to beetle infestations, thrives from dry to wet conditions, is tolerant of and even dependent on frequent surface fire, and is better able to withstand storms.

While longleaf pine should be able to withstand some climate change, too much warming would also ultimately stress these ecosystems. In fact, studies of lakebed sediments have provided insight into how climate and forest cover have varied over the last 62,000 years.¹⁶ These data show how pine and oak species have exchanged dominance as the climate alternated between glacial and non-glacial conditions, with pines dominating during wetter and warmer periods. If global warming causes a significant drying of the Southeast, then oak trees may eventually replace many pine forests.¹⁷

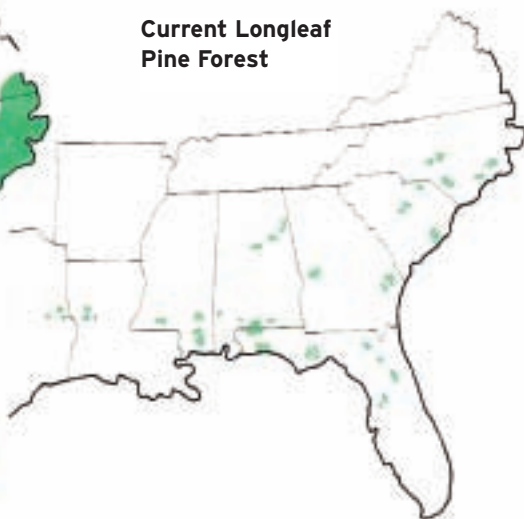


Erich G. Vallery, USDA Forest Service - SRS-4552, Bugwood.org

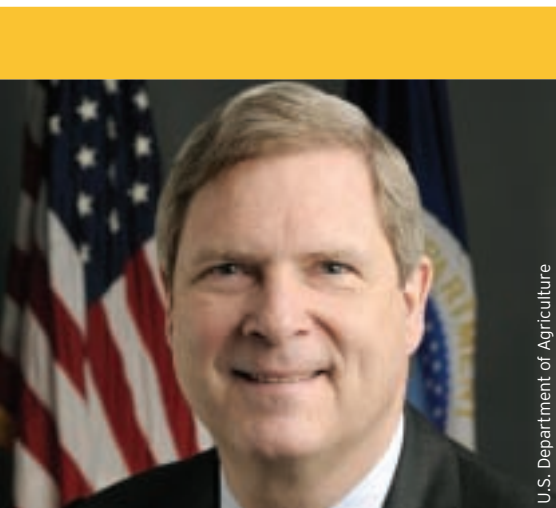
Presettlement Longleaf Pine Range



Current Longleaf Pine Forest



Estimated range of longleaf pine forest prior to European settlement and public landholdings currently harboring longleaf pine forest remnants.¹⁸



U.S. Department of Agriculture

“Restoration will also mean the rehabilitation of declining ecosystems. One example in the South is the longleaf pine ecosystem, a forest that has been reduced from 90 million acres to today a mere 3 million acres. Yet the Forest Service faces a number of barriers in pursuing a restoration agenda. [...] In many regions today, the Forest Service is already charting a path forward by building trust through diverse stakeholders through collaboration and engagement.”

TOM VILSACK

Secretary of Agriculture
National Vision for America's Forests
August 14, 2009
Seattle, Washington

PEST RESISTANT

The southern pine beetle, a native species in the Southeast, causes significant destruction during periodic epidemics. Annual losses have exceeded 100 million board feet of sawtimber and 20 million cubic feet of growing stock. From 1991 to 1996, southern pine beetle infestations contributed to losses of about \$493 million in the United States.¹⁹ Global warming is expected to exacerbate southern pine beetle outbreaks by allowing beetles to survive year-round and expand their range northward.²⁰ One study found that the temperature and precipitation changes this century could increase the infestation risk by 2.5 to 5 times.²¹

While all pine species in the southern United States are susceptible to infestation,²² longleaf pine is generally more resistant to southern pine beetles, which prefer loblolly pine, shortleaf pine, pond pine, and Virginia pine.²³ Recent epidemics in Louisiana and Alabama caused 3 to 116 times more tree mortality in loblolly pine stands than in longleaf pine stands.²⁴ The leading hypothesis for the lower mortality in longleaf pine has been differences in the resin among pine species, however recent findings indicate that other aspects of

how the trees co-evolved with beetles may be more important.²⁵

DROUGHT AND FLOOD TOLERANT

From dry mountain slopes and ridges in Alabama and northwest Georgia to low, wet flatwoods and the excessively drained sandhills found along the coast and the fall line, longleaf pine has adapted to the broad range of habitats found in the Southeast.²⁶ The ability of longleaf pine to survive in dry and wet conditions suggests that the species will be well suited to withstand the shifts toward both more episodic droughts and more severe floods expected in the Southeast as the climate warms. In contrast, increasing temperatures and the associated drying out of forests will likely constrict the available loblolly pine habitat, especially toward the southern end of its current range.²⁷

FIRE ADAPTED

Longleaf pine ecosystems not only tolerate fires, they thrive under a regime of frequent, low-intensity fires. Having evolved under conditions of frequent lightning and periodic human-caused ignitions, fire was instrumental in shaping the plant and animal communities in longleaf systems. Longleaf needles burn easily, but are long and direct fire away from the bud, allowing plants to survive fires that would kill or inhibit the growth of other tree species. Fires also inhibit the growth of sapling longleaf in areas with well-established mature trees, while creating conditions that favor longleaf growth in forest gaps, fostering the wide open distribution of trees for which these forests are known.²⁸ Given the natural preference for frequent, low-intensity fires, longleaf forests are less susceptible to stand-replacing fires than other pine species. They should be better suited to survive the increased incidence and severity of fires expected with a hotter and drier climate.

LONGLEAF PINE WEATHERED HURRICANE KATRINA



John Butnor, USDA Forest Service

When Hurricane Katrina blasted the Gulf Coast in August 2005, about 5 million acres of forest across Mississippi, Louisiana and Alabama were damaged.³¹ Bottomland hardwood forest and pine forests were hardest hit, but not all pine species were affected equally. Researchers in Forrest County, Mississippi, found that longleaf pine was less likely to be damaged than loblolly pine or slash pine (see table).³² Those longleaf pine trees that were damaged tended to lean or blow over, as opposed to snapping mid-stem. Conversely, most of the damage to loblolly pine and slash pines was from snapped trees, which at once lose most of their dollar value, sometimes as much as 90 percent. Trees marketable as valuable chip-and-saw products before Katrina storm were reduced to pulpwood after the storm.

At the U.S. Forest Service Harrison Experimental Forest in Saucier, Mississippi, longleaf pine (in the foreground) remained relatively intact, while loblolly pine (in the background) suffered much more damage from Hurricane Katrina.

Species	Type of Hurricane Damage (%) Forrest County, Mississippi			
	None	Snapped	Leaning	Blown over
Loblolly	16.3	75.9	5.7	2.0
Slash	52.4	38.1	7.8	1.7
Longleaf	64.0	8.9	16.9	10.2

STORM TOLERANT

Strong hurricane winds can wreak havoc on broad expanses of forests, causing downed trees, snapped trunks and limbs, and stripped leaves. Damaged forests increase the risk of wildfire, insect infestation, and the establishment of invasive species. In contrast, trees that are leaning or blown-over, keeping their root systems at least partially intact, tend to hold their value much longer. They can be harvested for higher value, longer lasting forest products, whereas snapped trees can only be used for pulpwood or left onsite unharvested.

When encountering hurricane-force winds, longleaf pine trees are more

In the Harrison Experimental Forest located just north of Gulfport, Mississippi, loblolly pine trees experienced 20 percent more mortality than longleaf pines when the hurricane swept through.³³ According to Randy Browning, a field biologist with the Mississippi Fish and Wildlife Foundation, if longleaf pine still covered its historical range in South Mississippi, private landowners would be dealing with an inconvenience rather than a disaster due to Hurricane Katrina.

likely to have minimal damage or be blown over, rather than snapping mid-stem or being completely uprooted as is common for loblolly pine and slash pine.²⁹ Firm anchorage provided by a large taproot and widespread lateral root system may explain the ability of longleaf trees to withstand strong

winds. Excavations of longleaf pine root systems indicated that longleaf pine taproots extended two meters vertically in the soil and the lateral root system extended up to 6 meters horizontally from the taproot.³⁰



USDA Forest Service Archive, USDA Forest Service, Bugwood.org

III. HELPING PEOPLE AND WILDLIFE ADAPT TO GLOBAL WARMING

As global warming threatens forests, wildlife, and other natural resources, we need to revisit our conservation strategies to ensure that the new climate realities are taken into account. One important adaptation strategy will be to enhance the resilience of ecosystems, for example, by focusing investments in species like longleaf pine that are naturally suited to a broad range of climate conditions and can withstand increased incidence of disturbances like storms, fire, and insect infestations. Protecting, restoring, and expanding healthy longleaf pine forests can be an important way to ensure long-term economic returns for landowners, provide crucial wildlife habitat, and make our communities more resilient to global warming.

RELIABLE ECONOMIC RETURNS FOR LANDOWNERS

Most landowners in the Southeast have preferred to manage for loblolly pine and slash pine because of their faster early growth, short rotation lengths, ease of regeneration, lower establishment costs, and traditional forestry bias toward those species. The equation shifts in favor of longleaf pine when global warming is considered. With lower risk of losing trees to wildfire, pests, disease, drought, or storms, longleaf pine is a lower-risk investment than other species. Furthermore, as the commodity pulp market shifts overseas, the southeastern timber industry is returning to a focus on the high-end wood products, including saw

logs and poles, that longleaf pines produce.³⁴

In fact, when a longer planning horizon is considered, longleaf pine is already economically competitive with other pine species because of its higher quality wood products and the opportunity for ongoing revenue from selling pine straw and land leasing for hunting and other recreation.³⁵ Wood from longleaf pine is denser and heavier than other southern pines, therefore earning higher economic returns on a per volume basis. As much as 66 to 72 percent of longleaf pine stands can produce high-quality poles that continue to bring a premium price, compared to less than 8 and 12 percent of loblolly pine and slash pine stands, respectively.³⁶

Longleaf pine forests also provide a source of income for landowners in the years before the timber harvest.³⁷ The value of pine straw as a forest product is increasing, even as timber revenues are declining.³⁸ A recent analysis found that the financial performance of loblolly pine and longleaf pine plantations is comparable when pine straw raking is considered.³⁹ Any management strategy that includes pine straw raking would need to consider the role of needles for natural forest fire fuel, the impacts of herbicides and raking on development of native groundcover, and the impacts of nutrient cycling from straw removal. Overly intensive raking could negatively impact the ecosystem.

Private pine forests can also be leased for hunting rights. Surveys consistently indicate the value of hunter access to private lands as a tradable commodity throughout the natural range of longleaf pine. Where longleaf pine forests are maintained in open park-like condition, the high quality of this habitat for quail, turkey, and deer brings a premium in hunting leases and related services that are

provided by private landowners.⁴⁰ Longleaf pine forests may be suitable for livestock grazing. Properly implemented silvopasture management strategies could allow private landowners to generate additional income between periods of tree harvest, ideally without compromising the environmental services provided by the ecosystem.⁴¹ Grazing may also be useful for reducing the understory vegetation in places where prescribed burning may be difficult and for controlling invasive species.⁴² More research is needed to understand what level and types of sustainable livestock grazing might be suitable.

SUPPORTING BIODIVERSITY

As global warming makes forests of the Southeast more vulnerable, the array of plant and animal species these ecosystems support will also be in jeopardy. Ecosystems with more natural resilience, like longleaf pine, will likely fare better and provide enhanced opportunities for species to survive. Thus, taking steps to protect, restore, and expand longleaf pine forests is a sensible strategy for



Amadou Diop

"I am not just looking to maximize my timber returns. I want to have an attractive place that provides good habitat for wildlife and where I can potentially derive some short-term income from hunting leases, pine straw production, and maybe grazing livestock. With help from the Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Incentives Program (WHIP), it has been economically feasible for me to grow longleaf pine."

EDWARD DAVIS
Private Landowner
Tallapoosa, Alabama



Flickr: konomike

The Clemmons Educational State Forest in Clayton, North Carolina, extols the virtues of pinestraw as part of its program to restore longleaf pine.

ALLEVIATING POVERTY THROUGH LONGLEAF PINE RESTORATION



Amadou Diop

Longleaf pine restoration project in Tallapoosa, Alabama.

Despite being endowed with rich natural resources, many parts of the rural south are characterized by inadequate education programs, poor health care and high levels of crime and unemployment. For example, Alabama is home to highly profitable forestry operations, yet the poverty rate among residents of the Black Belt counties, who are predominantly African American, is nearly 35 percent.⁴³ Building wealth is a core strategy for alleviating poverty and creating economic and social opportunity in a region blessed with valuable natural resources.

Restoration of longleaf pine forests can create long-term assets for rural landowners. A significant portion of forested land in the Alabama Black Belt region is owned by African Americans, representing an important and often under-utilized source of wealth. National Wildlife Federation is working with African American groups to teach rural landowners how to regenerate longleaf pine forests and to build wealth through recreation receipts, payments for carbon sequestration, recreation and ecosystem services, and forest certification.

Working with small, private landowners who have limited resources presents a number of challenges. Contemporary logging operations are designed to harvest large tracts, leaving smaller landowners with few options for harvesting and marketing their timber.⁴⁴ Some of the same constraints may apply to harvesting pine straw. At the same time, many African Americans lack trust in public agencies and do not always fully participate in the forest stewardship programs they offer,⁴⁵ partly resulting from a legacy of discriminatory practices at the U.S. Department of Agriculture.⁴⁶ Community-based forestry strategies that focus on education and technical assistance, coalition building, networking and cooperative development have shown some success in addressing these challenges.⁴⁷



Chris Evans, River to River CWMA, Bugwood.org

conserving biodiversity in the southeastern United States.

The fact that longleaf pine ecosystems already have rich biodiversity makes the case for their conservation even more compelling. More than 1,300 plant species are endemic to the Coastal Plain habitat in the Southeast, a large proportion in longleaf pine ecosystems.⁴⁸ Longleaf pine forests are also home to about 100 bird species, 36 mammal species, and 72 species of reptiles and amphibians.⁴⁹

As longleaf pine forests have declined, more than 30 plant and animal species associated with them have been federally listed as threatened or endangered by the U.S. Fish and Wildlife Service,⁵⁰ and at least 100 at-risk species are found in these forests.⁵¹ These include wildlife species like the red-cockaded woodpecker, gopher tortoise, indigo snake, and flatwoods salamander. Restoring the longleaf ecosystem should reduce the pressure on these endangered and at-risk species.

Gopher tortoise, a threatened species, is key to the survival of many other longleaf ecosystem inhabitants, who find shelter in its burrows.⁵²

DEPARTMENT OF DEFENSE AS A CONSERVATION PARTNER



U.S. Fish and Wildlife Service

Many of the remaining strongholds of longleaf pine forests in good condition are found on lands managed by the U.S. Department of Defense (DoD). For example, the Eglin Air Force Base in Okaloosa County, Florida, has one of the most extensive old-growth longleaf pine forests in the nation. Over the last two decades, DoD has emerged as an important conservation partner, working with the U.S. Fish and Wildlife Service, The Nature Conservancy, and other federal, state, and private groups to advance efforts to protect habitat for endangered species, such as the red-cockaded woodpecker.⁵³

Fort Bragg in the sandhills of North Carolina pioneered a program to identify strategies to protect habitat and species, while at the same time providing useful military training grounds. As development encroached on the military installation, DoD even took the step to ensure that adjacent properties remained undeveloped, allowing them to meet their conservation objectives and to maintain good relationships with neighboring communities. The type of program started at Fort Bragg is now being applied to other military installations.⁵⁴ DoD continues to play an important role in longleaf pine protection and restoration, and through the Southeast Regional Partnership for Planning and Sustainability (SERPPAS) is a key sponsor of the America's Longleaf Initiative (see page 18).

Active management of longleaf pine forests on military lands is contributing to the recovery of the endangered red-cockaded woodpecker

Healthy longleaf pine ecosystems also support treasured game species, such as Northern bobwhite quail, wild turkey, and white-tailed deer. The wiregrass understory associated with longleaf pine ecosystems provides excellent habitat for bobwhite quail and other ground-nesting birds. Seasonal hunting leases in longleaf pine forests can provide an important income source for private property owners.



Flickr: ucumari

Many popular game species, including white-tailed deer, thrive in longleaf pine forests.

MAKING OUR COMMUNITIES MORE RESILIENT

Thriving longleaf pine forest ecosystems can also have benefits for adjacent human communities, especially as climate change brings more weather and climate extremes. Expanding development combined with the increasing frequency and intensity of forest fires and severe storms will pose greater risk to homes built in the wildland-urban interface. Well-managed longleaf pine ecosystems, with greater resilience to both fires and storms than other pines, will reduce the risk of property loss, especially in areas with sprawling development. The fires that raged near Myrtle Beach, South Carolina, in April 2009 are an excellent example. The blaze consumed 30 square miles

and caused \$25 million of damage to some 70 homes. Areas dominated by longleaf pine were largely undamaged and even rejuvenated by the fire.⁵⁵

Forested land also can play an important role in regulating water supply, reducing flood risk during heavy rainfall events and helping recharge ground-water aquifers that provide important water sources during drier periods.⁵⁶ As global warming leads to more evaporation from reservoirs and lakes, natural storage in ground-water aquifers will become an increasingly attractive alternative. Climate change, increasing population, and land use changes are all expected to exacerbate water stress in the Southeast.⁵⁷

Frequent, low-intensity fires are a natural part of healthy longleaf pine ecosystems. Because the understory grows back quickly, these fires have little effect on net atmospheric carbon dioxide.



IV. REDUCING GLOBAL WARMING POLLUTION

Since the middle of the 19th century, global warming pollution, including carbon dioxide, has rapidly accumulated in the atmosphere because of human activities, primarily the burning of coal, oil, and gas. Reducing this global warming pollution is essential if we are to avoid the worst climate change impacts. We need to employ a wide range of solutions—from improved energy efficiency to greater use of renewable energy sources—to achieve the necessary reductions.

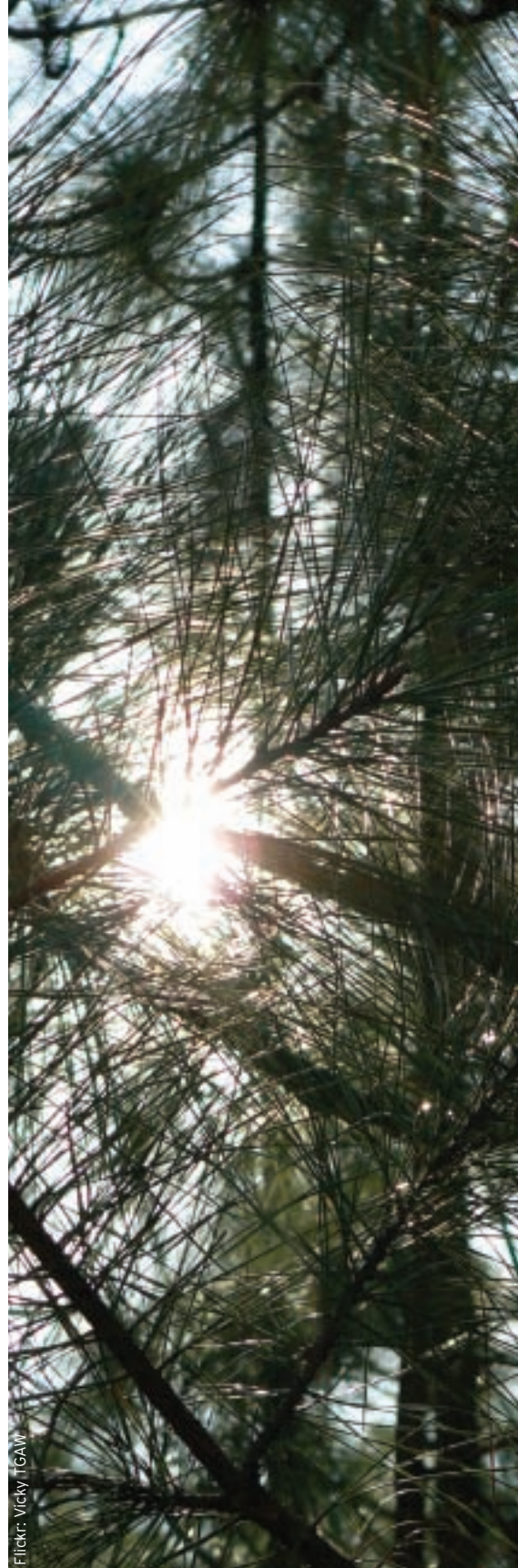
Forests are an important carbon reservoir, both globally and in the United States. Improved forest management also will be an important tool in the effort to reduce the amount of carbon dioxide in the atmosphere, and thus limit the extent of warming during coming decades. Longleaf pine trees live longer than other southern pine species; are less susceptible to fire, pests, and storms; and produce wood more likely to be used in long-lasting structures. These ecosystems are well suited to long-term storage of carbon and should be a centerpiece of land-based carbon sequestration efforts in the Southeast.⁵⁸

LONGLEAF PINES HAVE LONG LIVES

Longleaf pine stands continue to grow and add carbon for about 120 years, after which natural mortality is balanced with new tree growth.⁵⁹ Individual trees can survive beyond 450 years, providing a long-term natural reservoir for carbon.⁶⁰ The natural lifespan of other pine species in the Southeast is much shorter: up to 200 years for slash pine⁶¹ and up to 275 years for loblolly pine.⁶² The natural fire, pest, and disease resistance of the species means that carbon stored in longleaf pine is at

much lower risk of being rapidly released to the atmosphere, even as global warming increases the likelihood of these disturbances. Furthermore, the ability of longleaf pines to withstand hurricanes and severe storms, which are common to the Southeast and expected to become more severe, enhances its value for long-term carbon sequestration.⁶³

Even once a longleaf forest is harvested, the carbon stored in the tree trunks will not be rapidly returned to the atmosphere. With a specific gravity 8 to 12 percent higher than



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other commercial pine species of the Southeast and low decay rates, longleaf pine is valued for high-quality wood products that last a long time.⁶⁴ In contrast, the pulp and fiber products derived from short-rotation forest management return carbon to the atmosphere over a relatively short period. Indeed, wooden infrastructure throughout the Southeast today was built with longleaf pine harvested as the region was settled centuries ago.⁶⁵

MORE CARBON UPTAKE POSSIBLE AS ATMOSPHERIC CARBON DIOXIDE LEVELS INCREASE

An open question for many ecosystems is how their ability to store carbon will respond to higher carbon dioxide levels. Several studies have found that elevated atmospheric carbon dioxide significantly increases both the aboveground biomass and the belowground root biomass for longleaf pine.⁶⁶ One limitation of these

studies is that they examine only seedlings and young forests, making it hard to draw conclusions about how mature forests will respond to elevated carbon dioxide.

Some additional carbon dioxide uptake by longleaf pine ecosystems may be offset by an increase in soil respiration, as has been the case in many other ecosystems,⁶⁷ or an increase in fire. One study found that soil respiration levels in longleaf pine ecosystems do not appear to be affected by higher carbon dioxide levels,⁶⁸ but the study did not examine the impact of warmer temperatures on soil respiration. In addition, some carbon dioxide uptake may be offset by a decline in the growth of some of the understory species.⁶⁹ More research across a range of site-types, age-classes, and stand densities is needed to understand how the carbon storage capacity of longleaf pine ecosystems will respond to changing climate conditions.

Narrow tree rings are typical for slow-growing, high density longleaf pine. This tree is from Lake Louise in southern Georgia.



Henri D. Crissino-Mayer

V. RECOMMENDATIONS FOR ACTION

With the advent of global warming, the impetus to restore longleaf pine ecosystems in the southeastern United States now extends beyond their long cherished ecological and cultural benefits. As the most climate resilient pine species in the Southeast, longleaf pine may prove to be a better and less risky investment for private landowners. At the same time, longleaf pine ecosystems can sequester carbon from the atmosphere, reduce flooding risk during heavy rainfall events, and are less susceptible to high intensity fires that cause loss of life and property.

Improved state and federal policies and resources are needed to encourage and support longleaf pine restoration on public and private land. Shifts in forestland ownership and expanding development pressure in the Southeast will further complicate efforts to restore longleaf pine ecosystems. Thus, active engagement and participation of private landowners, who manage the majority of forestland in many states in the Southeast, will be essential.

CREATE A NATIONAL MANDATE FOR LONGLEAF PINE ECOSYSTEM RESTORATION

It is high time to raise the profile of longleaf pine ecosystem restoration to be comparable with that of other major restoration projects, such as the Everglades, Chesapeake Bay, and the Great Lakes. Like these other ecosystems, longleaf forests harbor unusual and diverse wildlife, and they played an important and still underappreciated role in the history of our nation. Longleaf pine ecosystems

have suffered from similarly massive losses and degradation, today being relegated to just 3 percent of their former extent.

Yet, unlike these other projects, which have each received billions of dollars in federal funding,⁷⁰ the federal government and southeastern states have not organized and set aside funding to tackle longleaf pine restoration in a coordinated and aggressive manner. With the recent completion of the Range-Wide Conservation Plan for Longleaf Pine (see box), we now have a blueprint for





Restoring longleaf pine will require the contributions of government agencies, private landowners, conservation organizations, and volunteers.

CHARTING A FUTURE FOR LONGLEAF PINE

The first-ever *Range-wide Conservation Plan for Longleaf Pine* was published in March 2009 by America's Longleaf, a collaboration of more than twenty organizations and government agencies. The plan identifies a goal of expanding longleaf pine from 3.4 to 8.0 million acres within 15 years. Taking a science-based approach that builds on partnerships, the plan provides a framework for actions to maintain, improve, and restore longleaf pine forests.

The plan identifies dozens of objectives and actions relevant to longleaf pine ecosystem conservation on public and private lands, economic and market-based financial mechanisms, fire management, understory and overstory regeneration, climate change, significant geographic areas for targeted conservation efforts, communication, education and outreach, and evaluating conservation outcomes.

For more information, please see <http://www.americaslongleaf.org>.



such a national mandate.⁷¹ It is critical that federal, state, and private partners move forward expeditiously with implementation of the plan.

INCLUDE RELEVANT ADAPTATION AND SEQUESTRATION PROGRAMS IN FEDERAL CLIMATE LEGISLATION

The U.S. Congress is considering comprehensive climate and energy legislation aimed at reducing global warming pollution and investing in the programs needed to prepare our nation for the new climate realities. Dedicated funding for natural resources adaptation in this legislation will be essential to provide the tools we need to conserve, restore, and carefully manage longleaf pine and other ecosystems in the face of climate change. Not only will it allow us to restore the resilience of degraded ecosystems, it also will create jobs and protect the capacity of natural systems to store carbon.

This legislation should also include programs that support natural carbon sequestration. For example, the proposed Carbon Conservation Program would allow private forestlands to participate in offset markets and in a supplemental emissions reduction program that rewards the protection of forest carbon stocks. Programs that engage private forestlands in these efforts will be especially important for longleaf pine restoration because the vast majority of southeastern forests are privately owned.

IMPROVE LANDOWNERS' ASSISTANCE AND INCENTIVE PROGRAMS

Efforts to educate and empower private landowners about the multiple advantages of longleaf pine restoration can yield benefits for the climate, the economy, and social justice. Such programs need to be extended and fully funded to reach

CLIMATE ADAPTATION PLANNING AT FEDERAL AGENCIES

Federal agencies with natural resource management responsibilities are beginning to take steps to prepare for global warming. Many of these programs will provide opportunities to advance longleaf pine restoration. The U.S. Department of Agriculture (USDA) Forest Service adopted a Strategic Framework for Responding to Climate Change in October 2008, calling for climate change considerations to be fully integrated into the service's activities. The Framework acknowledges that ongoing efforts to restore healthy forest and grassland systems are critical for improving the resilience of these systems in the face of new stressors, especially climate change.⁷²

In September 2009, the U.S. Department of Interior released a secretarial order to launch the department's first-ever strategy to address impacts of climate change on America's land, water, ocean, fish, wildlife, and cultural resources.⁷³ The strategy seeks to coordinate both efforts to enhance natural carbon storage on public lands and to safeguard habitats from climate change impacts. It includes measures such as:

- Regional Climate Change Response Centers, led by the U.S. Geological Survey, that will help bring climate science information to bear on natural resource management decisions
- A network of Landscape Conservation Cooperatives, led by the U.S. Fish and Wildlife Service, intended to develop practical, landscape-level strategies for managing climate change impacts that typically extend beyond the borders of any single National Wildlife Refuge, Bureau of Land Management unit, or National Park.



Safeguarding wildlife from global warming will depend on improving ecosystem resilience. Reintroduction of fire into longleaf pine stands is key to maintaining healthy and resilient forests.

their full potential. An important first step will be to modify the Conservation Reserve Program to create stronger incentives for longleaf pine restoration, for example, by removing past cropping history requirements and properly compensating landowners for long-term commitments.

In addition, expanded cost-share payments for reforestation of longleaf pine should be developed for private landowners through state and federal cooperative forest programs. This should be accompanied by research and technical assistance to effectively

target smaller private landowners, especially among the African American community, to maximize their participation. Training concerning the re-establishment and management of longleaf pine ecosystems, especially on how to incorporate healthy fire regimes, will be essential.

TARGET LONGLEAF PINE RESTORATION PROJECTS IN AREAS VULNERABLE TO GLOBAL WARMING

Strategically located longleaf pine forests can provide important services

from water supply regulation to buffering from severe storms and fires. As climate change brings more weather and climate extremes, we will increasingly look to natural resources to enhance the resilience of human communities. The potential to improve the resilience of towns and cities should be one consideration in choosing places for longleaf pine restoration. Critical watersheds, coastal areas in the line of hurricanes, and areas vulnerable to frequent fires are especially good places to establish longleaf pine.

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