UF tree physiologist Tim Martin examines a loblolly pine in the Austin Cary Memorial Forest north of Gainesville.

LOBLOLLY Legacy

Universities and growers are helping the South's most abundant pine species adapt to climate change

By Tom Nordlie

Drive any distance on a rural road in the Southeast and you're likely to come upon rows of pine trees standing at attention like so many soldiers awaiting their orders.

They are the descendents of a vast carpet of longleaf pines that blanketed as much as 60 million acres of southeastern North America when European settlers first arrived. Almost all of those old-growth forests are gone now, replaced first by farms, then cities and planted pine forests.

Today, more than 80 percent of the 25 million acres of second- and third-growth forest that succeeded them are loblolly, a fast-growing native species that is the raw material for everything from roof trusses to cellophane.

About half are on large, corporate-owned pine plantations, with the other half scattered on smaller tracts of land owned by individuals. But all have enormous importance, economically and environmentally. Southeastern pine provides about 16 percent of the world's lumber, and the forest products industry accounts for more than 5 percent of jobs in the Southeast. The trees also filter water, control erosion and provide wildlife habitat.

Like so many other ecosystems, however, Southern pine forests face new challenges from global climate change, including reduced summer rainfall, higher temperatures and increased

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disease and pest pressures. At the same time, loblolly could help to offset the impacts of climate change by serving as a vehicle to lock up atmospheric carbon for centuries.

Earlier this year, a team of researchers with UF's Institute of Food and Agricultural Sciences won a five-year, $20 million grant from the U.S. Department of Agriculture to address both sides of this equation, helping Southeastern loblolly growers adapt to climate change and contribute to global carbon sequestration.

"There hasn't been much focus on climate change by forest managers and landowners, partly because little information is available on the best way forward to prepare for those changes," says tree physiologist Tim Martin, a professor with UF's School of Forest Resources and Conservation and principal investigator for the loblolly project. "This project provides an unprecedented opportunity to integrate forestry research, outreach and education in the region, to address this important societal challenge."

Pine Integrated Network: Education, Mitigation and Adaptation Project, or PINEMAP, involves 11 land-grant universities and numerous forestry research cooperatives and government agencies in 10 Southeastern states. The 50 scientists collaborating on the project are led by Martin, Gary Peter and Martha Monroe of the UF forest resources school and Tom Fox of Virginia Tech.

The team's goal is to enable current and future landowners and forest managers to do three things: harness planted pine to reduce levels of atmospheric carbon; more efficiently use fertilizer, water and other inputs; and adapt forest management to keep planted pine healthy in the face of climate change.

Capturing Carbon

As atmospheric carbon has increased, many proposals have emerged for ways to capture and store it somewhere, including injecting it deep into the ground or the oceans. But pine trees have been sequestering carbon for eons, pulling it out of the atmosphere and converting it into wood, roots, bark and needles. In effect, trees act as living storage facilities for atmospheric carbon. Durable materials made from pine, such as lumber, will keep carbon sequestered indefinitely.

"About a third of the sequestered carbon in the United States is stored in Southeastern forests," Martin says, "and every year, just by virtue of their growth, southern forests sequester about 13 percent of the carbon emissions in the region, so they're very important for offsetting carbon emission."

Because loblolly grows faster than most pines, it's ideally suited for sequestering carbon. That fact, plus loblolly's status as the dominant species in the Southeastern pine industry, made it the ideal focus for PINEMAP.

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"We understand loblolly very well and we understand how to manipulate its management to increase carbon sequestration," Martin says.

"Sequestration won't stop atmospheric carbon levels from rising, but it can be an important component in slowing the rise," he adds. "But while we wait on other solutions, such as alternative energy sources, improved forest management can be implemented immediately."

One of the keys to carbon sequestration is simply getting loblolly to soak up as much carbon dioxide as possible. Geoff Lokuta, a PINEMAP technician, is conducting field work to assess how much carbon dioxide is produced by plant roots and decay organisms in forest soils.

In planted forests around the state, Lokuta takes measurements to determine how much carbon dioxide wafts up from the soil. Then, using sophisticated computer programs, Lokuta and his supervisor, Eric Jokela, a professor in UF's forest resources school, make projections on the effects elevated temperatures may have on the microbes, and whether these changes may reduce the net amount of carbon stored by loblolly forests. Ultimately, Lokuta and Jokela hope to provide data that can guide development of improved loblolly varieties that continue storing carbon despite altered climate.

One of the strengths of the PINEMAP project is that for decades pine tree growers have teamed with university and government scientists in research cooperatives that combine the scientific resources of the universities with the industrial resources of the growers. Today, cooperative members manage more than half of the Southeast's privately owned planted pine forests, and produce 95 percent of the pine seedlings planted each year.

At thousands of sites throughout loblolly's range, these co-ops conduct field studies, collect germplasm, develop

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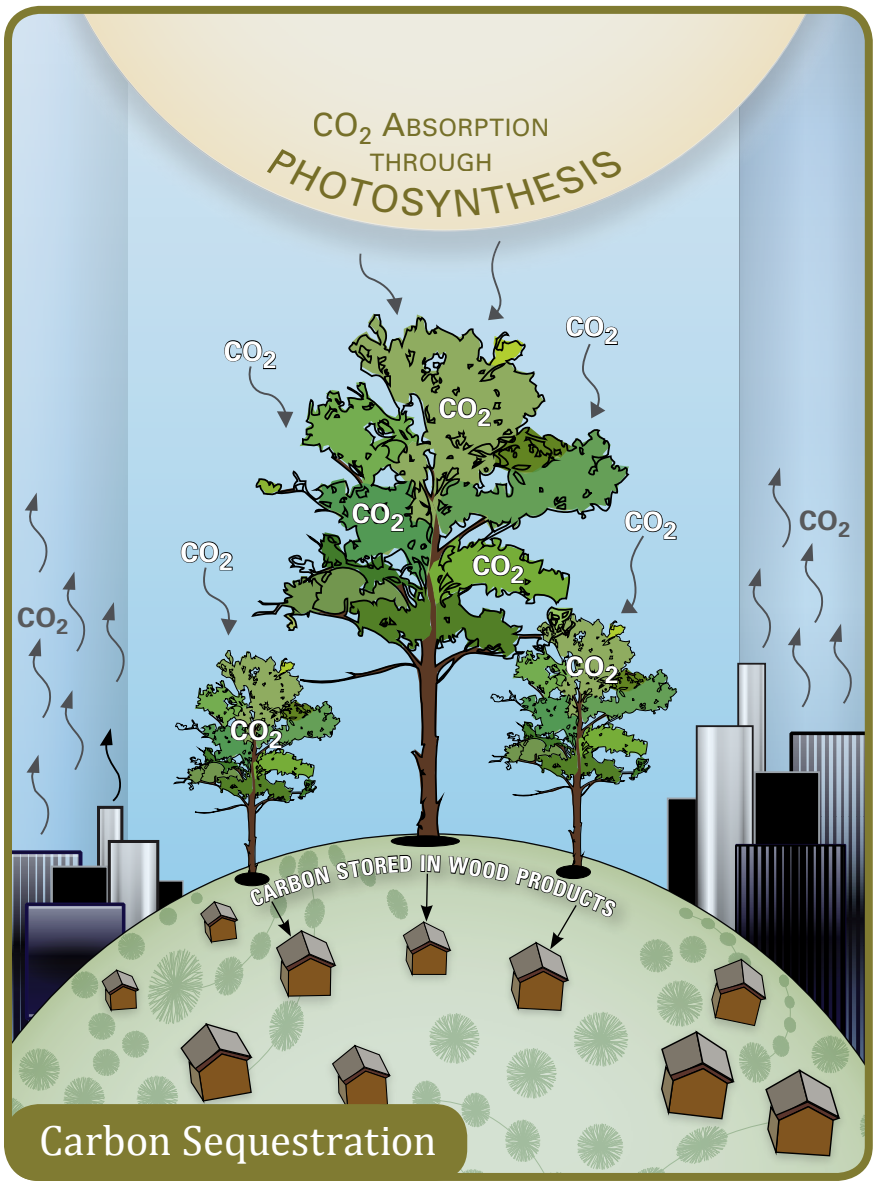

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improved pine varieties through traditional breeding and carry out myriad other activities. Over the past half century, they've amassed an enormous body of knowledge about how to grow loblolly pine successfully.

"Over the years, researchers at the different universities have built relationships with land managers," Martin says. "We have a high degree of trust and very close associations with these industrial land managers."

Eight research cooperatives are participating in PINEMAP. Two are based at UF: the Cooperative Forest Genetics Research Program, established in 1953 and the oldest of the eight; and the Forest Biology Research Cooperative, established in 1996. Major southeastern pine producers typically belong to at least one co-op.

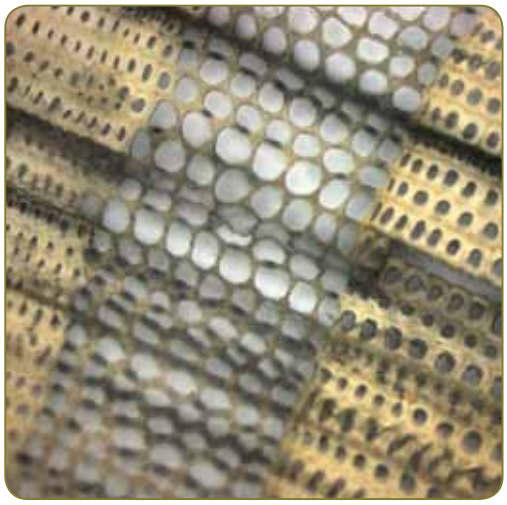
"We're involved with all of them," says Jim Gent, a manager of forest research with Jacksonville-based Rayonier, one of the country's largest landowners. The company owns, leases or manages almost 1.5 million acres of forestland in Florida, Georgia and Alabama, much of it planted in loblolly. "The co-ops are a real good way for us to leverage our research dollars."

Gary Peter, a co-director of both UF-based cooperatives, believes that involvement with the co-ops was a major reason the team was awarded the grant.

"Another group that didn't have our accumulated data would have to establish new trials and wait, or pay to get it," Peter says. "The industry helps steer and guide the questions we explore in the co-ops, and the same will hold true in PINEMAP, which makes sense, because industry people are the ones who will put our findings into practice."

Peter specializes in plant genomics — the identification and study of plant genes and their functions. As PINEMAP's leader for climate-change adaptation, his responsibilities include identifying genetic traits in existing loblolly varieties that would enable the trees to thrive under warmer, drier conditions and then incorporating those traits into new varieties that grow quickly and yield high-quality wood and pulp.

"Southern pines haven't been genetically manipulated much," Peter says. "Over the last 50 years of tree improvement,



Most of the carbon stored by trees is locked into the walls of water-conducting xylem cells in roots, stems and branches.

Trees in PINEMAP experiments are outfitted with instruments to monitor their responses to altered soil, water and nutrient availability.

most of the information collected has been on the genetics of natural trees, so the prior trials inform our knowledge about regionwide variation in germplasm."

For instance, loblolly native to the western part of its natural range evolved to cope with reduced rainfall and wider temperature swings, but it doesn't grow as fast as the material from the eastern coastal zone, Peter says.

"So the aim is to combine the adaptation to drought with improved productivity," he said.

Another area where adaptation is needed is on damaging insects such as the notorious southern pine beetle, which is expected to breed more quickly and become more common as temperatures rise. Peter and UF colleague John Davis are searching the co-op data to find and develop loblolly germplasm that's more insect resistant.

Doctoral student Jared Westbrook is investigating a natural defense mechanism pines use to discourage insect attacks — resin flow. When wood-destroying insects bore through bark to begin colonizing a tree, it responds by pushing sticky resin through the holes to expel the invaders. But not all loblolly varieties are equally successful with this strategy. By making standardized wounds in trees and collecting resin over a set time period, Westbrook is identifying varieties that would be good candidates for crossbreeding.

In the laboratory, geneticists are working to pinpoint individual genes that control resin flow and other desirable traits. This may lead to genetic engineering of improved loblolly varieties, something that hasn't been done before to any notable degree.

Getting all this new information out to landowners and forest managers is the job of UF environmental education and extension Professor Martha Monroe, who will work with natural resource extension agents and teachers throughout the Southeast.

Among Monroe's responsibilities are bringing extension agents up to speed on climate change and how forest management could enhance carbon sequestration; providing education programs for students; and assessing public perception of climate change and learning more about the barriers and incentives that will promote change in forest management.

The project will create an undergraduate intern program and support dozens of graduate students and postdoctoral associates.

"These undergraduate, graduate and postdoc opportunities are essential to the success of the project, and also to helping change the future," Monroe says. "Our students will become the next generation of scientists and educators. We are helping them develop the skills to work across disciplinary lines to solve complex problems."

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Planning For Today

For the professional foresters who make their living growing loblolly, PINEMAP is a welcome effort — but not just because of climate-change concerns, says Marshall Jacobson, a forest productivity manager for Plum Creek, a timber company that is the nation's largest private landowner. In Florida alone, Plum Creek practices forestry on 590,000 acres in 22 counties.

"I'm concerned with what it takes to grow trees better all the time," says Jacobson, based in Athens, Ga. "My interest, and what the project promises, is to give us the science to react to whatever might come — production issues, problems, opportunities."

This sentiment is echoed by other industry personnel who'll be involved in PINEMAP.

"We do think about climate change and its potential implications," Gent says. "But there will be increased pressure for pine trees as a resource, because of interest in biomass energy. On top of that, there will be increased conversion of forestland to other uses, like housing developments. So we'll need to grow more wood on less land to stay profitable."

There's another economic aspect, says Plum Creek's Ben Dow, resource supervisor for the company's Florida peninsular holdings. It's the supply chain, which encompasses the demand for southeastern pine products and the various sources that can meet those needs.

"There will be increased global consumption of this resource from the manufacturing of southern pine products," Dow said. "We need to know how the changes in global consumption will be balanced by the changes in southern pine growth."

So regardless of how much the Earth's atmosphere may heat up in the coming decades, forest productivity is something producers worry about now, every day. Still, they're well aware that pine trees have the capacity to mitigate the threat of global warming, simply by growing tall and healthy.

"Anything we can do to manage forests more effectively will help us address these issues more effectively," Gent says.

But it's not just the needs of the big companies that PINEMAP addresses. The project will also target people who grow pine trees on small tracts of land, Peter says. Though scattered, they account for almost half of Southeastern pine production.

"We also have a nicely established network through the cooperative extension service to take research from the universities and extend that to non-industrial landowners," Martin says. "Extension agents and county foresters have established relationships with family farmers, so they can take research developed in the PINEMAP project and extend it to those land managers really efficiently."

"One aspect of this work will be to develop loblolly varieties suitable for production on marginal lands that smallholders aren't currently farming," Peter says. If PINEMAP can offer ways to turn a profit from farmland that's currently not in use, that's a plus for landowners who may be struggling to make ends meet. The key is being able to demonstrate that following PINEMAP recommendations will yield benefits that help farmers as they help fight global climate change.

If planted pine isn't profitable, Peter says, landowners may be tempted to sell their forests to developers. If that happens, most of the trees will be cleared away, and with them their potential for carbon sequestration. So, in a sense, PINEMAP's mission comes down to one fundamental idea — making planted pine too valuable to do without.

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