How saving some of the Southeast's oldest trees might help scientists monitor climate change

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In the swampy floodplains of North Carolina's Black River stand ancient trees with a story to tell. Many of these bald cypress (*Taxodium distichum*) were well over a millennium old when Columbus discovered the Western Hemisphere. As it turns out, their locale has greatly promoted their longevity: by being relatively inaccessible, the trees have been spared from loggers' saws. But the inexorable sprawl of humans is threatening to breach their mucky moats and disrupt habitats for these trees, many of which have stood for hundreds of years.

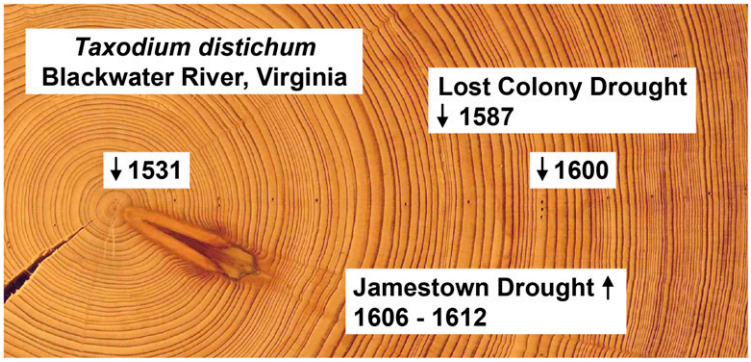
The true value of these small patches of largely undisturbed forest may not lie in their wood, however. It may stem from what scientists can glean about how such ecosystems respond to ongoing and future climate change. A few thousand acres of such cypress-studded wetlands are now protected along the lower reaches of the Black River. But researchers are mobilizing to build a consortium that will locate, map, and raise money to purchase hundreds of additional acres of these majestic old trees.

Climate Chronicles

The southeastern United States once boasted an estimated 40 million acres of bald cypress forests. Cypress wood is prized for its strength and rot-resistance, so these massive trees—the largest of which can contain six homes' worth of lumber—quickly became a logger's favorite. Cypress is highly valued among scientists for other reasons. For one thing, its growth rings are clear and easy to read, says David Stahle, who analyzes tree rings to discern past trends in climate, at the University of Arkansas in Fayetteville.

Bald cypress is a widespread species, living in wetland habitats from Delaware to eastern Texas and throughout the lower Mississippi Valley (1). Its longevity ranks in the top 10 among trees in the Western Hemisphere; ancient rot-resistant trees that have died and fallen into oxygen-poor swamps offer researchers the ability to assemble a series of rings from trees that lived during overlapping intervals, thus generating uninterrupted chronicles of climate that can stretch back hundreds if not thousands of years, says Stahle.

Although the population of bald cypress trees in the southeastern United States is a fraction of what it once was, a few thousand acres of cypress-studded wetlands are now protected along the lower reaches of North Carolina's Black River. Image courtesy of David Stahle.



Studying bald cypress tree rings, such as these from a tree in Virginia, can provide insights into the impact of past climate events such as the droughts that afflicted Jamestown and the so-called Lost Colony of Roanoke, Virginia. Image courtesy of David Stahle.

Climate is what you expect, goes an old meteorologist saying, but weather is what you get. Tree-ring analyses have given researchers entirely new notions about the climate people should expect. Study after study has shown that the climate of past centuries, even that experienced in Colonial era America and the preceding millennium, doesn't necessarily match up with the relatively steady conditions seen since scientists began taking data with instruments in the mid-to-late 1800s. The surprising results often shed new light on history as well, Stahle notes.

For example, tree-ring records suggest that 1587 was the driest single year in coastal North Carolina during the past 1,000 years. It's probably no coincidence that 1587 was also the year that British colonists attempting to settle North Carolina's Roanoke Island disappeared without a trace. Just 20 years later, colonists setting up Virginia's Jamestown colony had the bad fortune of arriving in the second year of a 7-year drought (2). "Trees are able to capture events that are far outside the historical record," says Neil Pederson, a forest ecologist at Harvard Forest in Petersham, Massachusetts.

And the events they chronicle aren't limited to climate: bald cypress that lived along streams near Tiptonville, Tennessee, a couple of centuries ago recorded a sudden and sustained growth spurt beginning in 1812, the year after a series of massive earthquakes shifted the course of the Mississippi River and flooded large areas of newly sunken land to form Reelfoot Lake (3).

The oldest known tree along the Black River is at least 1,653 years old. And there's a real possibility that even older cypresses stand sentinel over the floodplains there, says Pederson. The oldest trees aren't necessarily the largest, he notes; saplings that take root in poor soil or in the shadow of larger trees, for example, can grow to be relatively stunted and eventually sport sinuous, gnarled trunks that are deceptively small (4). "The more we go into the forests, the more we find older trees," he notes.

Future Growth

Cypress forests were—and still are, where remnants exist—a wonderfully diverse habitat. Their loss likely contributed to extinction of the Carolina parakeet, which nested in old-growth forests along rivers and in swamps before the birds died out early in the 1900s. However, even small patches of old-growth forest can provide suitable habitat for some species, as proven by recent recolonization of forests along the Black River by wood storks (*Mycteria americana*), which were driven close to extinction last century.

In that vein, scientists are working to protect cypress forests, starting along the Black River, via the Ancient Bald Cypress Consortium. Stahle will direct the project, which during its first 3 years plans to accurately map and precisely age the old-growth forests that persist along the river; it will also help raise $1 million to help preserve and protect them from encroaching development. Once they've made progress saving the Black River's cypress forests, the group will expand its mapping and conservation efforts to similar old-growth remnants in other regions of the Southeast. By preserving the habitat, the effort will also "preserve individual trees as living chronicles of climate variability," says Stahle.

"There's no way to undervalue these old-growth forests," says Pederson. They've been socking away carbon in their trees and in soils for untold centuries, he notes. The rot-resistance of cypress means that carbon stored in their wood—in living trees, but especially in logs that have fallen into oxygen-poor waters and sediments—is returned to the atmosphere by decomposition exceedingly slowly.

Furthermore, scientists worldwide are concerned about how today's warming climate is affecting carbon stored in ancient ecosystems, from arctic permafrost to tropical rainforests. "How might these cypress forests respond to climate change?" Pederson asks rhetorically. At this point no one knows, he says, but field studies of old-growth cypress forests, such as those along the Black River, may provide answers vital for climate modelers seeking to better predict how concentrations of atmospheric carbon dioxide might rise as Earth's climate warms even further. In particular, researchers might investigate how long-term trends in the total amount of carbon locked in the trees, as well as the forests' soils, correlate with changes in temperature or precipitation.

Such changes could stifle growth of the trees and slow their uptake of carbon or, even worse, trigger widespread tree mortality that would eventually return large amounts of carbon dioxide to the atmosphere once the trees decomposed. "These forests could be quite sensitive to climate change," says Pederson. "Those carbon stores might not be as stable as we'd like to think."

1 Stahle DW, et al. (2012) Tree-ring analysis of ancient baldcypress trees and subfossil wood. *Quat Sci Rev* 34:1–15.
2 Stahle DW, Cleaveland MK, Blanton DB, Therrell MD, Gay DA (1998) The Lost Colony and Jamestown droughts. *Science* 280:564–567.
3 Stahle DW, VanArsdale RB, Cleaveland MK (1992) Tectonic signal in baldcypress trees at Reelfoot Lake, Tennessee. *Seismol Res Lett* 63:439–447.
4 Pederson N (2010) External characteristics of old trees in the eastern deciduous forest. *Nat Areas J* 30:396–407.