

Bringing the Benefits of Tree Islands Back to the Everglades

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Situated in the Florida Everglades and mainly accessible by airboat or helicopter are unique tree-topped geological formations that have baffled soil scientists for decades. Questions swirl around how they formed almost 5,000 year ago and how they maintain themselves.

Scientists report exploring these islands, pushing past vines, and brushing away the topsoil. There they find that some of the rock beneath has holes like Swiss cheese with water and tiny fish living inside.

These anomalies, known as tree islands, hold important ecological significance for the Everglades and beyond. Once numbering possibly in the many thousands, these teardrop-shaped islands range between 0.25 to 1 km long and are found throughout the Everglades. Their ecological role, soil dynamics, and vulnerability to changes in water level combine to make them an extremely important—yet sensitive—feature of the landscape.

“Tree islands are really what the name implies,” says Fred Sklar, who leads the Everglades Systems Assessment Section of the South Florida Water Management District. “These are nutrient and biodiversity hotspots that are extremely connected to their surrounding environment.”

In a vast swampland of muddy ridges and deep sloughs, the tree islands serve as a dry place of refuge for animals like deer, rabbits, raccoons, and alligators, as well as birds such as white ibis, egret, herons, and snail kites. Dozens of species put the “tree” in tree island, including willows, cocoplum, swamp maples, hardwood hammocks, and gumbo limbos. The vegetation on an island depends on the water level since some trees prefer drier areas while others thrive in wetter ones.

Another unique characteristic of tree islands is their extremely high levels of the nutrient phosphorus, which stands in direct contrast to the rest of the phosphorus-deficient landscape. In fact, the average soil phosphorus concentration in the Everglades (un-impacted by agricultural runoff) is about 350 to 450 mg per kg of soil—but on the tree islands, levels can reach as high as 3,000 to 4,000 mg per kg.

“These high levels on the tree islands are actually important for keeping the surrounding marsh low in nutrients because when the concentration of phosphorus in the rest of the marsh goes up, you get invasions of cattail,” Sklar says. “Those invasions affect fish and wading birds and many other parts of the system.”



Aerial view of tree islands in the northern Everglades. Photo courtesy of Flickr/Brian Garrett.



Tree islands serve as a dry place of refuge for animals like alligators. Photo courtesy of Flickr/Rafał Próchniak.



One of eight replicate re-created tree islands at the Loxahatchee Impoundment Landscape Assessment (LILA), a 32-ha experimental wetland that serves as a physical model of the Greater Everglades Ecosystem. **Inset:** Soil accretion above a feldspar marker has been measured annually since 2009 and averages circa 0.7 cm/yr.

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Despite their value, more than half of the islands have been degraded since the 1920s. This has greatly decreased their capacity to provide many assets to the landscape and organisms living there. Their sharp reduction in number has prompted researchers to explore the possibility of restoring these one-of-a-kind islands.

Knowing how the tree islands formed would help inform their restoration. However, no one is absolutely sure how they came into existence. Some hypothesize bedrock or peat mounds became self-sustaining tree islands through a complicated process of soil formation. Others point to human influence based on the large volume of bone material found in some tree island soils.

Scientists do know a bit more about how the islands sustain themselves. For example, trees constantly pump water that is low in phosphorus up from below, concentrating the nutrient on the island. Being able to replicate conditions that initiate processes like this is essential to restoration progress. By performing experiments to test how to construct a functional tree island, scientists are finding a way to bring the islands' benefits back to the Everglades.

The Decline of the Islands

The tree communities found on these islands are determined mostly by water levels—water levels that are highly variable for many reasons. One has to do with the layout of the Everglades themselves. There is relatively little difference in elevation between the lowest and highest parts of the swamp. Imagine standing at the bottom of a creek in Wisconsin. The surrounding landscape would change sharply, by 10, 20, even 30 m, over a short distance. The pattern is even more extreme on a mountain slope in Wyoming, where elevation varies by hundreds of meters very quickly. However, in the Everglades, such topographic changes are measured in centimeters instead of meters.

“The Everglades, or at least large portions of it, vary by about 1 m in elevation,” says Len Scinto of Florida International University. “If you think of the ground level as 0, that’s the bottom of a deep water slough. If I go up 30 or 40 cm from that, I’m in a sawgrass ridge, and if I go up a bit more, I’m on a tree island. We have drastically different environments that are separated in topography by a meter. This is a landscape of subtleties.”



Dr. Leonard J. Scinto measuring soil that has accreted above a feldspar marker as measured by intact coring at the Loxahatchee Impoundment Landscape Assessment (LILA) experimental Everglades wetland.

These subtleties mean that small changes in environmental drivers like water level lead to very large, negative changes for the islands. Starting in the 1890s, the Everglades were drained to create agricultural land. The soil under the Everglades proved good for crops, and so the draining continued. A system of dikes, levees, and canals was installed to control water flow. A devastating and unintended consequence of this was extensive damage to tree islands of the area. Fifty to sixty percent of them dried up—even caught fire—or became too wet. The changing water levels were

too unstable for trees that had evolved to only survive at a specific depth.

The Everglades do go through a natural dry and wet season, but these new changes were not the doing of Mother Nature, and the tree islands declined. Degraded tree islands lose their ability to retain phosphorus, which consequently seeps into the surrounding environment. Additionally, these changes also affected the animals that use the tree islands.

“The water levels animals like birds evolved to use to forage or breed were suddenly controlled by a guy at a pump station,” Scinto explains. “The draining was so significant that I should be standing in about a foot of water in my office at Florida International University, but instead, the Everglades start 8 miles west of me.”

As this damage became more apparent to scientists, many looked for ways to get the water levels back to a more natural pattern and also to restore or even build entirely new tree islands. The Loxahatchee Impoundment Landscape Assessment (LILA) is one site scientists use to study how a tree island can be constructed and what kind of tree life different water levels allow.

Mike Ross, also of Florida International University, is part of the team that looks at how tree islands sustain themselves. Ross, along with Scinto and Sklar, have designed an experiment where they built tree islands and are testing what tree species survive at different water levels.

The first part of the experiment involved constructing one island out of limestone and another from peat and then planting the islands in nearly 6,000 trees with varying water tolerances in 2006 and 2007. Ross and Sklar explain that the results were mixed. The peat island initially nourished tree seedlings while the limestone one proved too dry and required a sprinkler system. But today, the limestone island is the one functioning more like a natural tree island. Overall, the

researchers were surprised to find the islands were mimicking natural processes after just six years, which is “no time at all, in terms of ecosystem restoration,” Sklar adds.

Monitoring the planted tree species comprises the second part of the experiment. Instead of planting trees that prefer wetter environments in wet areas and those adapted to drier conditions in dry ones, the researchers planted the trees randomly at all elevations. Water levels were controlled to reflect the natural changes in the Everglades, and the tree species were monitored.

“Some of the locations on the islands rarely flooded, and some along the tree island edges flooded all the time, so we wanted to see how [the tree species] responded from the experiment,” Ross explains. “Each species has a different story. One species can dry up, another can get a disease, and finally, another can seed in from adjacent areas and overtake some of the planted species.”

These data allowed the scientists to obtain what they call an optimal water curve for the trees. They were able to quantify the mortality caused by flood-

ing in order to know exactly where each species could be planted if they wanted to build a tree island in nature.

The group is now using these data to devise a plan to restore—or more accurately build—tree islands in the Everglades. One plan under discussion, Sklar explains, is to remove limestone-walled canals and levees composed of limestone sediments to restore natural water flow. The excavated limestone can then be used as the base of a tree island. Managers could also punch holes in the limestone and fill them with nourishing peat, creating a hybrid of the two models built at LILA.

“The techniques we would use are coming from LILA,” Sklar says. “We know that limestone islands can mimic natural processes best, but peat is still needed to get seedlings established, so we are thinking to combine the two methods. However, this all requires more research and other work, and these ideas probably won’t be put in place for another 10 years or so. I hope I’m still around to help do that work.”

The group’s work on tree islands is part of a larger goal of studying and restor-

ing the Florida Everglades to their former glory. The area provides the region with great benefits, or ecosystem services.

“It brings about a conversation about the valuation of ecosystems,” Scinto says. “While biologists worry about the birds and alligators, not many people really care about them. What they care about is salt water intrusion into their water supplies, flooding, and shrimp caught in the Gulf that live as juveniles in parts of the Everglades. These direct economic and social benefits are what drive the restoration efforts.”

As these efforts continue, the work done at LILA will be crucial to developing techniques for building functional tree islands—with the hope of being able to mimic, at least to some extent, something that took nature 5,000 years to create.

“We haven’t witnessed tree island formation in our lifetimes at all,” Sklar says. “We’ve only seen the opposite, that is, tree island destruction. Understanding why and how this system has evolved to create this kind of micro-typography is one of the true wonders of the world.”