Diverse ecosystems like Great Lakes forests are thought to be more resilient to the effects of climate change because they harbor a lot of biodiversity that allows them to better adapt to new environmental conditions.

Accounting for Carbon in Great Lakes Forests

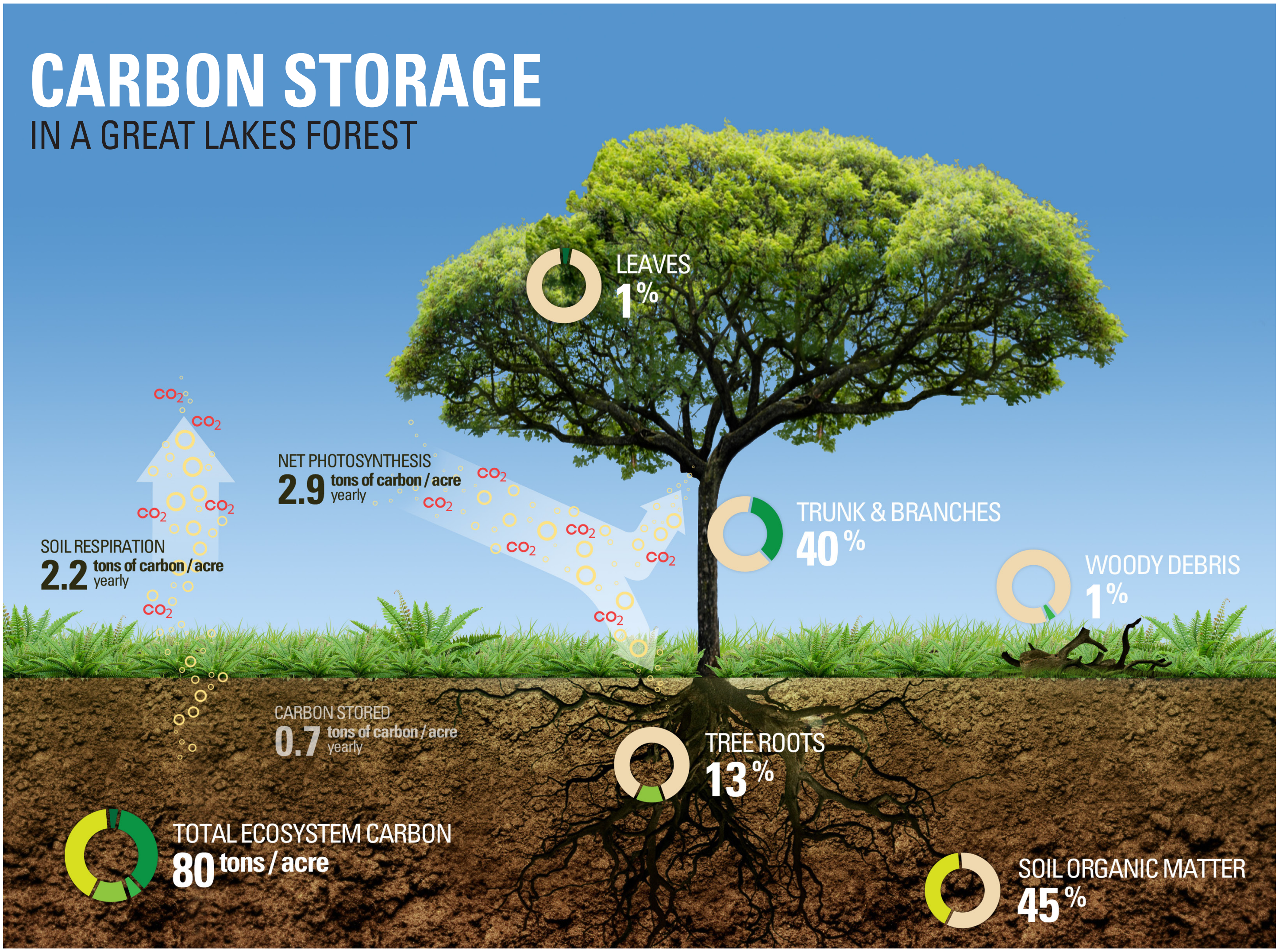
by Christina Dierkes

When most people think of the term "accounting," they think of banks, money and profits. But in a world affected by climate change, accounting for carbon is one of the tools researchers use to determine the consequences of climate change and suggest ways to mitigate the problem.

One of these researchers is Dr. Peter Curtis, a professor in and Chair of the Department of Evolution, Ecology and Organismal Biology at The Ohio State University. Curtis studies the flow of carbon into and out of Great Lakes forests, and often introduces himself as a "carbon accountant" to those unfamiliar with his work. "Just like an accountant would do accounting for money at a business, we're interested in how much carbon goes in and out of a forest," Curtis says. His research at the University of Michigan Biological Station in northern Lower Michigan has been going on for over 20 years, and is likely the only experiment in the world that tests the prediction that aging forests in the Great Lakes region continue to store carbon.

Researchers who study carbon cycles are interested in the "net loss or gain" of carbon in forest ecosystems over time, potentially answering the question "is this ecosystem a carbon sink, where carbon is being stored or sequestered, or is it a carbon source where carbon is being lost from the system," Curtis explains. "Conventional theory predicts that as forests age, as they get to be around 100 years old, the rate of carbon storage slows dramatically and may go to zero as forests approach the old-growth stage, so that uptake and release are equal – losing carbon at the same rate as gaining carbon," he adds. Testing this theory is not easy, but data from projects at the Biological Station have shown that this reduction to zero carbon storage may happen in forests that are about 800 years old, but not in most Great Lakes forests, which are generally no older than 80 to 120 years. "These middle-aged forests are continuing to store substantial amounts of carbon," Curtis adds.

Forests will store, or sequester, carbon by photosynthesis, a process in which green plants take in atmospheric carbon dioxide and convert it into sugar. The sugar feeds the plant and helps it create new branches and leaves during its growth. This process locks the carbon that was previously present in the atmosphere into the plant, essentially making it inactive in terms of its effects on the climate. Because carbon dioxide, or CO_2, is a major greenhouse gas, plants and



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Carbon Cycling: A forest's carbon pool is spread across all parts of the ecosystem, generally with slightly more stored belowground in roots and the soil than aboveground in trunks, branches, and leaves. Up to 80 tons or more of carbon can be stored in an acre of Great Lakes forest depending on location. While photosynthesis takes in about 2.9 tons of carbon in that same area each year, decomposers only release 2.2 tons of carbon, allowing these Great Lakes forests to remove an additional 0.7 tons of carbon per acre from the atmosphere each year.

especially trees are an important player in the effort to mitigate global warming. In addition to locking carbon into the main body of the tree, an exchange of nutrients between the plant and the soil adds carbon compounds to the ground as well, further binding carbon that could otherwise impact the world's climate.

Like other living organisms, plants also respire, or "breathe out," CO_2. This releases carbon into the atmosphere, as does the decomposition of organic matter in the soil by micro-organisms. In addition, cutting down trees as part of forest management or for timber adds active carbon back into the cycle, as woody debris and exposed soil organic matter begin to decompose almost immediately. Balancing the effects of carbon storage and carbon loss therefore becomes an important part of managing forests for climate change.

"The health of our forested lands is one way that we offset our national carbon footprint," Curtis reasons. In a world where burning fossil fuel adds CO_2 to the atmosphere 24 hours a day, forests help offset fossil fuel carbon emissions and thereby slow the rate of atmospheric carbon dioxide increase and its accompanying effects on the climate. Knowing which management practices – whether they concern large public parklands or just the trees in someone's backyard – best maintain a high level of unreactive carbon in the soil and in trees can help professionals and laypeople alike turn the local carbon cycle in favor of mitigating climate change. And that knowledge often comes from scientists like Curtis and his colleagues.

Curtis' findings on current carbon storage in Great Lakes forests are an important factor in how these forests can be managed as part of climate change mitigation: should these "potentially old forests" be cut and replaced with young, rapidly growing forests which may store more carbon, despite the process of harvesting releasing substantial amounts of carbon as well? Or should the current Great Lakes forests be managed so they can acquire characteristics of old-growth forests, which are more biodiverse and may be more resilient to climate change? "That's an interesting and potentially very important topic for forest managers if you're managing with climate change in mind," Curtis explains.

Located in the heart of the Great Lakes forests, the woods of the Biological Station share a management history that is very typical of forests across Great Lakes states like Michigan, Wisconsin and Ontario, as well as Ohio. 150-foot towers measure the flow of carbon dioxide as it enters and exits above the canopy of the trees, and researchers on the ground measure everything from fallen leaves to soil carbon content to the bug population to determine the size of the carbon pool, or the overall amount of carbon present in the research area. Carbon cycle data from the research has already been used by the United States Forest Service to inform its management of national parklands, and it will become more important as international climate treaties recognize the role of forests as the primary ecosystem capable of long-term carbon storage. Because carbon dioxide is a major greenhouse gas, plants and especially trees are an important player in the effort to mitigate global warming.

"In the Great Lakes forests, we're in a very interesting time right now called an ecological transition," Curtis explains. "Of course we need forests to continue to store carbon, but they are also functioning in another very important way as biodiversity storehouses," he adds. This function of forests will become more important with climate change as species determine their new place in a changing environment, as the different habitats often present within forests will harbor a lot of biodiversity, and diverse ecosystems tend to deal with change much better than ecosystems dominated by a small number of species.

Sensors on 150-foot towers above the forest canopy measure the flow of carbon dioxide into and out of the trees at the University of Michigan Biological Station. In Great Lakes forests, carbon flow during photosynthesis and soil respiration results in the net storage of about 0.7 tons of carbon per acre each year.

Curtis' recommendation based on his findings to date is simple: "When in doubt, don't cut it. Let the forest age naturally, and it's not just going to be alright, it's going to be better." Considering the many questions people have about earth's future climate, a simple suggestion like this is sure to be a good start.

More information about Curtis' research, as well as the upcoming webinars on climate change impacts in the Great Lakes region, is available at ***ChangingClimate.osu.edu***. The *Global Change, Local Impact* Webinar Series is a multi-departmental effort within Ohio State University, led by OSU Extension, Ohio Sea Grant, and Byrd Polar Research Center, to help localize the climate change issue for Ohioans and Great Lakes residents.

Peter Curtis is professor of plant ecology at Ohio State University. He conducts research on ecosystem responses to climate change and directs the Northern Forest Carbon Cycle Research Program at the University of Michigan Biological Station. He has published widely on ecological responses to rising atmospheric carbon dioxide, how climate and land use affect forest carbon storage, and the role biological complexity and ecological resilience can play in aiding our future forests.