

The faster trees grow, the younger they die

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Fast-growing trees die younger, releasing the carbon they had stored back into the atmosphere.

As climate change spurs forest tree growth, it also shortens trees' lives. That results in a quicker release of climate-warming carbon back into the atmosphere.

Oxygen. Clean air. Shade. Trees provide people all sorts of benefits. A major one: removing carbon dioxide from the air and storing it. That makes trees an important part of the fight against climate change. But when forest trees grow faster, they die sooner, a new study finds.

That quickens their release of carbon back into the air — which is disappointing news for global warming.

As a potent greenhouse gas — CO₂ traps the sun's heat and holds it close to Earth's surface. Trees pull carbon dioxide, or CO₂, from the air and use its carbon to build leaves, wood and other tissues. This effectively removes CO₂ from the atmosphere. So trees play an important role in removing the CO₂ that contributes to climate change. But they only hold onto carbon as long as they're alive. Once they die, trees decay and release that CO₂ back into the atmosphere.

This movement of carbon between forest and the atmosphere is called a carbon flux, notes Roel Brien. He's a forest ecologist at the University of Leeds in England. It's a natural process that happens as trees grow and eventually die.

"These fluxes affect the amount of carbon a forest can store," he explains. It's not unlike the way a bank account works. Forests store carbon the way a bank account stores money. If you spend more

than you make, your bank account will shrink. But he notes that it will grow if you put more money into the account than you take out. Which direction a forest's "carbon account" goes has a huge influence on climate.

Recent studies have found that trees around the world are growing faster than ever. Rising atmospheric CO₂ is probably driving that rapid growth, Brienens says. Much of that CO₂ comes from burning fossil fuels. High levels of this gas are boosting temperatures, especially in colder regions. Warmer temps speed tree growth in those areas, he says. Fast growth should be good news. The faster trees grow, the faster they store carbon in their tissues, boosting their "carbon account."

In fact, having more CO₂ and living at warmer sites may explain why city trees grow faster than rural trees. But city trees don't live as long as their country cousins. What's more, fast-growing tree species, in general, live shorter lives than their slow-growing relatives.

Forests have been soaking up our excess CO₂, Brienens says. Already they have removed one-quarter to one-third of all CO₂ that people have emitted. Existing computer models assume that forests will continue to sop up CO₂ at the same rate. But Brienens wasn't sure forests would be able to keep that pace. To find out, he teamed up with researchers around the world.

Lore of the rings

The scientists wanted to see if the trade-off between growth rate and lifespan applies to all types of trees. If so, faster growth might lead to earlier deaths, even among trees that normally live long lives. To find out, the researchers combed through tree ring records.

Each season a tree grows, it adds a ring around the outer layer of its trunk. The size of the ring shows how much it grew that season. Seasons with plenty of rain make thicker rings. Dry, stressful years leave narrow rings. Looking at cores taken from trees allows scientists to track tree growth and climate.

Brienens and the team used records from forests the world over. In all, they examined rings from more than 210,000 trees. They came from 110 species and more than 70,000 different sites. These represented a wide range of habitats.



This tree's rings show it grew quickly when it was young but slowed down starting in its fifth year.

The scientists already knew that slow-growing species generally live long lives. A bristlecone pine, for example, can live for a whopping 5,000 years! A super fast-growing balsa tree, in contrast, won't live

past 40. On average, most trees live for 200 to 300 years. In almost all habitats and all sites, the team found the same link between growth and lifespan. Faster-growing tree species died younger than slow-growing species.

The group then dug deeper. They looked at individual trees within the same species. Slower-growing trees tended to live long. But some trees of the same species grew faster than the others. Those faster-growing ones died an average of 23 years earlier. So even within a species, the trade-off between growth and lifespan held strong.

The team then examined what factors might influence tree growth. These included temperature, soil type and how crowded a forest was. None was linked to early tree death. Only fast growth during the first 10 years of a tree's life explained its having a shorter life.

Short-term benefits

The team's big question now focuses on the future. Forests have been taking in more carbon than they have been releasing. Will that carbon flux hold up over time? To find out, they created a computer program that modeled a forest. The researchers tweaked the growth of the trees in this model.

Early on, it showed, "the forest could hold more carbon as the trees grew faster," Brienens reports. Those forests were adding more carbon to their "bank" accounts. But after 20 years, these trees started dying. And as that happened, he notes, "The forest started to lose this extra carbon again."

His team reported its findings September 8 in *Nature Communications*.

Levels of carbon in our forests could return to those from before the increases in growth, he says. That's does not mean planting trees won't help fight climate change. But which trees are used could have a big impact, long term, on climate.

Dilys Vela Díaz agrees. She was not involved with the study, but knows trees. She's a forest ecologist at the Missouri Botanical Garden in St. Louis. The new findings have "huge implications for carbon [storage] projects," she says. A forest of mostly fast-growing trees would store less carbon over the long term. It would therefore have less value for such projects, she argues. Researchers may therefore need to rethink their tree-planting efforts, she says. "We may want to look for slow growing trees that will be around much longer."

"Any CO₂ that we can take out of the atmosphere helps," says Brienens. "We must understand, however, that the only solution to bring down CO₂ levels is to stop emitting it into the atmosphere."

atmosphere: The envelope of gases surrounding Earth or another planet.

average: (in science) A term for the arithmetic mean, which is the sum of a group of numbers that is then divided by the size of the group.

balsa: Trees of the *Ochroma* genus that grow in the tropical Americas. Their wood is extremely lightweight, easy to cut and buoyant. That's why it's often used to make rafts, model airplanes and other projects that may require light weight and the ability for someone to sculpt parts easily.

botanical: Related to botany, the field of biology that focuses on plants. The scientist in this field is known as a botanist.

climate: The weather conditions that typically exist in one area, in general, or over a long period.

climate change: Long-term, significant change in the climate of Earth. It can happen naturally or in response to human activities, including the burning of fossil fuels and clearing of forests.

computer model: A program that runs on a computer that creates a model, or simulation, of a real-world feature, phenomenon or event.

core: Something — usually round-shaped — in the center of an object. (in geology) Earth's innermost layer. Or, a long, tube-like sample drilled down into ice, soil or rock. Cores allow scientists to examine layers of sediment, dissolved chemicals, rock and fossils to see how the environment at one location changed through hundreds to thousands of years or more.

decay: The process (also called "rotting") by which a dead plant or animal gradually breaks down as it is consumed by bacteria and other microbes.

ecologist: A scientist who works in a branch of biology that deals with the relations of organisms to one another and to their physical surroundings.

factor: Something that plays a role in a particular condition or event; a contributor.

flux: A term for the flow of some liquid, sometimes described as a measured rate of flow (such as liters per hour).

forest: An area of land covered mostly with trees and other woody plants.

fossil fuel: Any fuel — such as coal, petroleum (crude oil) or natural gas — that has developed within the Earth over millions of years from the decayed remains of bacteria, plants or animals.

greenhouse gas: A gas that contributes to the greenhouse effect by absorbing heat. Carbon dioxide is one example of a greenhouse gas.

habitat: The area or natural environment in which an animal or plant normally lives, such as a desert, coral reef or freshwater lake. A habitat can be home to thousands of different species.

model: A simulation of a real-world event (usually using a computer) that has been developed to predict one or more likely outcomes. Or an individual that is meant to display how something would work in or look on others.

oxygen: A gas that makes up about 21 percent of Earth's atmosphere. All animals and many microorganisms need oxygen to fuel their growth (and metabolism).

potent: An adjective for something (like a germ, poison, drug or acid) that is very strong or powerful.

species: A group of similar organisms capable of producing offspring that can survive and reproduce.

tissue: Made of cells, it is any of the distinct types of materials that make up animals, plants or fungi. Cells within a tissue work as a unit to perform a particular function in living organisms. Different organs of the human body, for instance, often are made from many different types of tissues.

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