North Central Research Station

NEWS

SPRING 2004

Future Reality Check: Elevated CO_2 and Ozone Alters Soil Carbon Cycling

For a world creating markets in carbon sequestration, any reduction in soil carbon storage is headline news. A 50-percent reduction warrants publishing in the prestigious journal *Nature*.

Last fall, NC's Christian Giardina and Noah Karberg were part of a study published in *Nature* on how future environments may alter forest function. The effort was led by Dr. Wendy Loya and Dr. Kurt Pregitzer of Michigan Technological University in close cooperation with NC's Houghton Work Unit. Using the Rhinelander, Wisconsin, Free Air Carbon Enrichment (FACE) site, the study compared soil carbon formation rates in northern forests grown in the presence of two gases—elevated carbon dioxide (CO_2) and ozone (O_3)—with forests grown in elevated CO_2 alone. When O_3 was in the mix, forests accrued 51 percent less total soil carbon and 48 percent less decay-resistant carbon.

The "ozone effect" is important, since this component of smog has risen 35 percent over the last century. "Large areas of the Earth are already exposed to ground-level ozone at concentrations known to be toxic to plants," says Pregitzer. "But few studies have examined ozone's effect on naturally growing forests, and we're the only one evaluating both CO_2 and ozone."

At the FACE facility, 80 acres of northern forest have been exposed to

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Mushrooms such as this Hebeloma *represent part of the complex linkage between aboveground processes, such as effects on photosynthesis and growth of trees, with belowground processes, such as production and storage of soil carbon, and communities of soil microorganisms and symbiotic fungi that help trees.*

In The News

FOREST SERVICE
USDA

Christian Giardina

Noah Karberg

Soil Carbon Reductions
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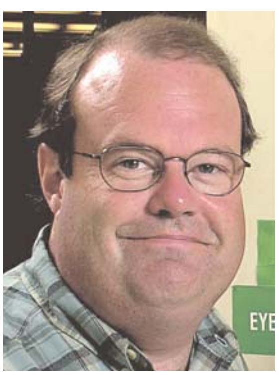
four treatments for 4 years: control, CO_2 only, O_3 only, and a combination of O_3 and CO_2 expected in the year 2050 (about 150 percent of ambient levels). "We know that ozone reduces plant growth, alters plant tissue chemistry, and reduces the allocation of carbon to roots and root exudates," said Loya. "Our results now suggest that in a world with elevated carbon dioxide, reductions in plant productivity due to elevated ozone will also lower soil carbon formation rates." This has serious implications for our efforts to predict how much carbon will be sequestered by natural processes. "The addition of ozone cuts storage rates in half."

What's Causing the Reduction?

Several factors may be at play, including less plant matter entering the soil, more decomposition by microbes, or both. To find out what role decomposition plays, the scientists monitored the sources of carbon used by decomposer soil microbes. Compared to CO_2-only plots, soil microbes in the O_3 + CO_2 plots removed a greater proportion (35%) of the new carbon inputs. "As ozone reduces plant growth," says Giardina, "the soil inputs change, which may affect the mix and activity of microbes feeding on those inputs."

"CO_2 and O_3 are known to influence photosynthesis and ecosystem productivity in opposite ways," write the scientists in the conclusion of the *Nature* article. "It is now clear that their interaction has the potential to cascade through ecosystems, altering soil carbon cycling." For governments calculating future markets in carbon sequestration, that's important news. For more information on this research project, contact Dr. Kurt Pregitzer (kspregit@mtu.edu). To learn more about carbon sequestration research being conducted in the North Central Research Station, contact Dr. Alex Friend, Houghton project leader (afriend@fs.fed.us).

Talk To Landowners Leads to $21 Million Gift To HTIRC



Charles Michler

Charles Michler, Director of NC's Hardwood Tree Improvement and Regeneration Center (HTIRC), loves to talk to landowner groups. As a speaker, he's honest about what it will take to make fine hardwoods even finer: "I always mention the need for graduate students, for land for trials, and for an endowment—a way of financing long-term research."

In the audience at Michler's first talk as Center Director was Fred van Eck, a well-known hardwood enthusiast and member of the Walnut Council. As a financier of high-tech companies, van Eck became intrigued by the cutting-edge molecular techniques that Michler described. "He hoped this technology would speed improvements in disease resistance, yield, and growth, making fine hardwoods a better investment."

Several weeks after his presentation, Michler got a call from van Eck, who told him he was impressed with plans for the Center. On March 15, 2000, Fred van Eck died and left a gift of $21 million to Purdue's Department of Forestry and Natural Resources to be used by the Hardwood Tree Improvement and Regeneration Center.

"Fans of fine hardwoods tend to be people who care about land and family," says Michler. "They're interested in improving fine hardwoods because they're thinking about providing decades of beauty and financial security to their heirs. Like Fred van Eck, they're planning their legacy."

Improving Hardwood Forests, One Seedling At A Time

Of the millions of acres of trees planted in the U.S. this year, nearly half will be on privately owned lands. How many trees make it to maturity, say experts, will depend on proper planting and early maintenance. This is especially true for hardwoods.

That's why NC researchers and colleagues have issued a series of publications entitled *Planting and Care of Fine Hardwood Seedlings*. The topics include planting tips, soils, nursery production, finance, plantings for wildlife, and wildlife damage to hardwood plantations

"We've packed these publications with the latest research findings and best practices—everything known to enhance the prospects for successful hardwood tree establishment," says Paula Pijut, a plant physiologist with the Hardwood Tree Improvement and Regeneration Center (HTIRC), a collaboration between NC and Purdue University in West Lafayette, Indiana.

The Center's mission is to enhance future forests by improving genetic traits in hardwood species. "Part of improving the future forest is equipping landowners with a scientific approach to planting and caring for young trees," says Pijut, who is coordinating, compiling, and editing the series.

Choosing and Preparing a Good Planting Site

Soil scientists Felix Ponder of NC's Central Hardwoods Project and Phillip Pope of the Department of Forestry and Natural Resources, Purdue University, share some tips about choosing a good site:

- **Effective soil depth should exceed three feet for most central hardwood species**. The surface soil layer contains most of the organic matter, nutrient and water uptake, and the greatest microbial activity. Small increases in surface soil thickness can cause large increases in site quality.

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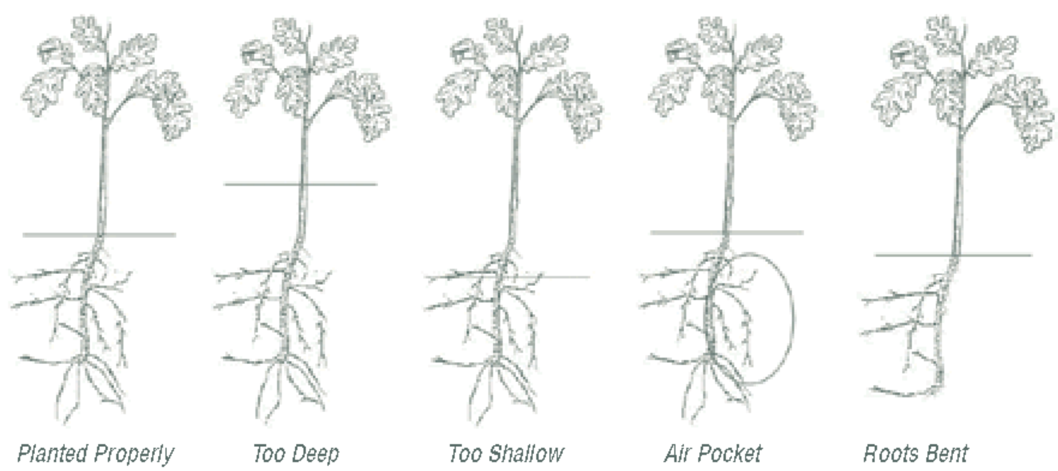
Proper Planting Equals Successful Seedling Establishment



Hardwood Planting Tips
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- For best root development, choose **medium-textured soils** (very fine sandy loam, loam, silt loam, and silt), which tend to have adequate available moisture and nutrients, good structure, internal drainage, and aeration.

- The best hardwood sites are **north- and east-facing, on gently sloping, concave, or lower slope positions**. These tend to have better soil moisture, soil depth, and higher organic matter.

- A good hardwood site should have **good drainage and little or no water saturation**.

- Tree performance is best at a soil pH between 6.0 and 7.2. **Correct low pH by applying agricultural lime** before planting. Use dolomitic lime if the soil is low in magnesium.

Hardwood Planting Do's

Now that your site is ready, here are planting tips from *Planting Hardwood Seedlings in the Central Hardwood Region* by NC's Paula Pijut.

- **Plant hardwood tree seedlings in late winter or early spring when the seedlings are dormant and the ground has thawed**.

- When choosing **bare-root seedlings**, look for a shoot height of at least 18 inches, and a root collar (the part of the root just below ground level) at least 1/4-inch thick. Make sure roots are healthy looking, well developed, with several lateral roots and a minimum root length of 8 to 10 inches.

- **Plant as soon after delivery as possible**. In the interim, cover seedling roots with moist burlap, peat moss, or a similar material to protect them from drying.

- **Dig a large enough hole or furrow** to accommodate the entire root system.

- Plant the **root collar just below the soil surface**.

- Place **roots straight within the hole**, not twisted or bent (J-rooted).

- **Pack soil firmly** around the seedling to avoid air pockets (this can cause the roots to dry out, causing seedling death).

- **Control weeds for the first three to four growing seasons**, clearing at least 3 to 4 feet out from the stem.

Hardwood Planting Don'ts

- **Don't plant in the fall** because winter could bring freezing and thawing of the soil (frost heaving), seedling desiccation, disease problems, wildlife damage, and winter injury.

- **Don't plant when the site is excessively wet or dry**, because water-logging or drought stress may jeopardize seedling survival and growth.

- **Don't submerge root systems** in buckets of water when preparing to plant. Brief exposure of bare-root seedling roots to direct sunlight can cause dehydration and seedling death.

- **Don't hold the seedling by the roots** when planting, but by the shoot top.

You can download the publications at: http://www.agriculture.purdue.edu/fnr/HTIRC/publications.html or purchase color copies from Purdue University Extension, http://www.ces.purdue.edu/extmedia/fnr.htm. Look for more of the series on the HTIRC Web site as they become available.

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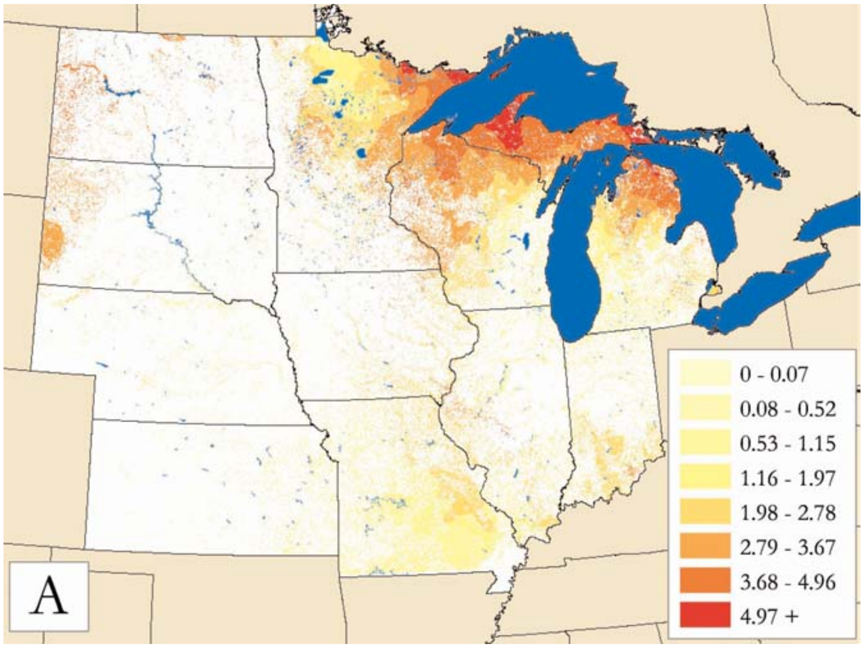
Down, But Not Out: Downed Woody Materials as a Measure of Forest Health

NC's Forest Inventory and Analysis (FIA) crews are taking a new measure of forest health by counting the downed woody material (DWM) that crunches and decays underfoot. "Fallen trees, branches, and leaf litter play an important role in policy and management decisions," says North Central forester Chris Woodall, FIA's National Indicator Advisor for DWM, "especially when it comes to fire-risk mitigation, habitat conservation, and carbon accounting."

When the policy change is fully implemented across the U.S., DWM will be measured on about 1,600 sample plots per year or about 8,000 plots over the course of a 5-year inventory cycle. In the meantime, Woodall is compiling and processing the data available from the 38 States currently underway. More information, including data availability and sample maps, can be found at http://www.ncrs.fs.fed.us/4801/dwm/.

What Can DWM Data Tell Us

Researchers in Oregon have been using the DWM inventory data to track the levels of DWM before and after the Biscuit Fire, which burned 500,000 acres in Oregon and northern California last summer. The results are not in yet, but if it turns out that fires start in areas of high DWM tonnage, and if DWM is greatly reduced following a fire, that would point to downed woody materials as a culprit.



Estimates of coarse woody debris (tons/acre) of the North Central States based on FIA's 2001 down woody materials inventory.

Another key policy question is whether or not to remove fire-killed DWM following the fire, says Dave Azuma, a research forester at FIA in Portland, Oregon, who is involved in the study. Policymakers are of two minds. Some believe that it is best to remove dead material after a fire to recover some economic value and reduce the risk of future fires. Others feel that burnt stands should be left alone to avoid causing further environmental damage. "I don't know if this issue will be solved for good, but we may be able to add some information for the policy debate," says Azuma.

Finally, the DWM data should help researchers assess the contribution of DWM to fire risk in specific areas. "Ten tons of fine woody debris does not have the same risk in Montana as it would in Maine, for instance, because climate conditions and species differences carry a different risk of fire ignition in different locales," says Woodall. "There is work to be done to comprehensively assess fire risk across the nation."

A Picture of Health

Still, fire control is just one aspect of the DWM inventory. DWM is more than just kindling; it's a source of nutrition, a sponge for moisture, a form of nesting material, a home for insects, and a shade screen for seedlings. "Our forests are threatened by climate change, urban sprawl, disease epidemics, invasive species, and pests. To assess ecosystem health we need more than just a standing tree inventory. That's where indicators of forest health (like DWM) play an important role."

By James Kling

Fuels Reduction Roadshow—Research's Final Mile

FIA researchers are making the most of DWM data by creating new mapping and modeling technologies. These kinds of tools were on display at a recent "Fuels Reduction Roadshow" at Eastern Region headquarters in Milwaukee, Wisconsin.

The organizers were aiming for something more tech-show than traditional meeting. Managers and scientists sat shoulder to shoulder at computers, test-driving products designed to help managers map and reduce wildfire fuels. Participants learned to:

- Create customized wildland-urban interface (WUI) maps via the Internet. (The WUI is where housing and wildland vegetation are in close proximity)
- Rank and map WUI fire risk based on historical fire patterns and current FIA information
- Create tables and maps of fuel reduction treatment opportunities
- Predict and map effects of management actions on future fuels loads with a simulation tool called LANDIS
- Access local fire-weather, smoke concentration, and fine-fuel moisture predictions via the Internet.

NC's John Vissage and Ron McRoberts setting up for roadshow.

"Years of field collection and analysis go into creating a model or mapping tool, but the 'final mile' is the effort to make sure these tools are used on a daily basis by those who manage fire risk on national forests," says NC Assistant Director Jim Gooder, who helped organize the meeting, together with Assistant Director Rob Doudrick, Landscape Ecology project leader Eric Gustafson, research social scientist Sue Barro, and an Eastern Region team with expertise in fire, silviculture, ecology, aquatics, and planning. According to Barro, "Our researchers got to see what's most useful and what's still needed. For an organization committed to doing science for people's sake, exchanges like this just make good sense."

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