NC NEWS
NORTH CENTRAL FOREST EXPERIMENT STATION
February 1999

Feeding Fiber to a Hungry Nation—NC's Newest Work Unit

In The News

When you add it all up, Dan Netzer, Don Riemenschneider, and Ed Bauer—the core of NC's new intensive forestry research unit—have 80 years' research experience in the genetics, establishment, and maintenance of hybrid poplars. Their work has paid off in fast-growing trees that produce prodigious amounts of fiber. "This system is five- to ten-times more productive than traditional forestry," said project leader Don Riemenschneider. "That means a 50,000-acre plantation could produce as much fiber as one of our Lake States national forests. As I see it, we're going to need that kind of potential, applied to all kinds of lands, to meet tomorrow's demand for fiber."

Early adopters of intensive culture seem to agree:

- In the next 10 years, at least 30,000 acres of intensively managed hybrid cottonwood plantations will be established for fiber production in Minnesota.
- A new project is beginning in Minnesota to produce 25 megawatts of electricity based on the direct combustion of farm-produced trees. This program will require about 27,000 additional acres of intensively managed hybrid cottonwood plantations grown on a 5- to 6-year rotation.
- Production of over 9 million hybrid poplar cuttings (a $1 million nursery business) will be planted per year in Minnesota starting in the year 2000. Growers will include individual landowners, landowner cooperatives, and large corporations.

To capitalize on the promise of this technique, a new work unit has been established—Genetic and Silvicultural Systems for Sustainable Intensive Forestry. Here are some challenges they've set for themselves:

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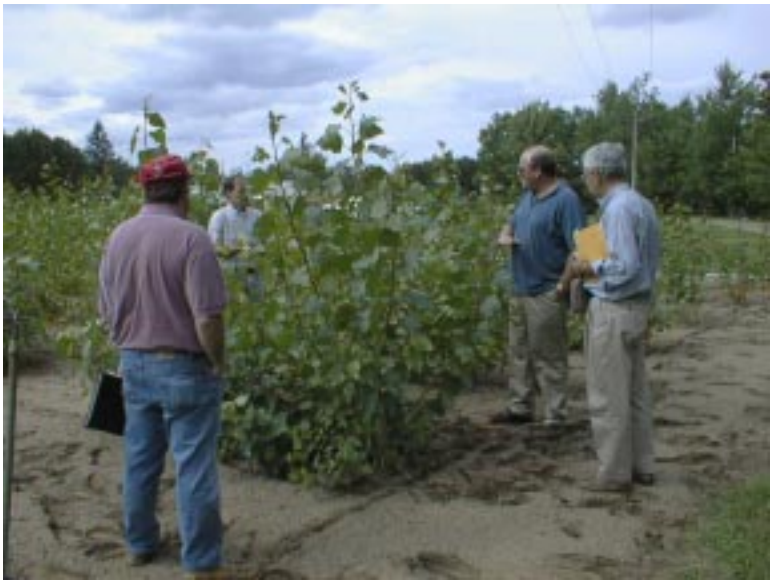

Ed Bauer

Scientists from the new intensive forestry unit discuss hybrid clones with forest industry representatives.

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Banking on Soil for Long-Term Productivity

Ask a soil scientist about forest productivity, and you're liable to hear a version of the old gardener's adage: As below, so above.

Felix Ponder, of the Central Hardwoods unit in Columbia, agrees: "The soil—its physical and chemical makeup—determines how much water, air, and nutrients are available for plant growth. And yet, traditionally, the productivity of a forest stand is determined by looking at the condition of the trees, not the soil. We'd like to reverse this, using the soil as a primary indicator of potential site productivity."

The research needed to develop such a predictive tool is the focus of a national effort called the Long-Term Soil Productivity Study, a cooperative study between research and the National Forest System. Ponder is looking at a typical Ozark formation—cherty, well-drained soils known for growing hardwoods. He wants to understand how human disturbances—various degrees of organic matter removal, soil compaction, weed control, etc.—influence the soil's capacity to nurture tree seedlings. The findings from the first 3 years of this historic study include:

- Better oak seedling survival, height, and diameter growth on sites with weed control than on sites with no weed control.
- Better white oak diameter and height growth on sites with bole-only harvests (vs whole-tree removal).
- More earthworms in uncompacted soils than in compacted soils.
- Better seedling survival, better white oak diameter growth, and taller shortleaf pines in compacted soils than in uncompacted soils.

This last result raises more questions than it answers. "Our hypothesis was that soil compaction would damage tree growth by reducing porosity. Instead, in these early results, we're seeing that the more compacted soils have higher seedling survival rates," he said. The reason? "I suspect that moisture interactions are very important in these well-drained soils. It may be that compaction closes the large pores to finer pores, and this retards evaporation and increases water storage."

Removing the Forest Floor

Ponder expects the picture to come into clearer focus starting around year 5 when the effect of another treatment—organic matter removal—will be felt. Some plots were harvested using bole-only removal, while on others, the whole tree and even the forest floor were removed. "Even now, we're seeing better diameter growth on oaks on the bole-only sites," he said. "We hypothesized that if nutrients are a limiting factor, this will continue to be the case—more organic matter, larger trees. But if moisture is the limiting factor instead, we may see something else."

Extracting a "core" of soil for sampling.

The question of organic matter removal is an important one right now. "More landowners are going to a whole-tree removal system for chipping. They're removing even non-merchantable trees from the site, and this is new. Before total-tree removal becomes widespread, it's important to know what the long-term effects on the soil will be."

Felix Ponder removing organic matter from the forest floor.

"In addition," Ponder said, "the base from which we can draw forest products is shrinking as more lands are converted to housing, etc. It's more important than ever to know how to best use these lands." That's why the researchers are also looking at the impact of heavy equipment on soils. "Our treatment—using sheep foot rollers with 3- x 3-inch prongs—is much more severe than conventional logging. But if this level of compaction doesn't have long-term negative impacts, then we'll know that conventional logging won't either."

Just in case, collaborators are experimenting with ameliorating activities such as fertilization and site repair. Ponder's ongoing research on soil additives may come in handy here. He's experimenting with poultry litter—an abundant resource in some parts of the country—as a potent, slow-release fertilizer for high-value crops such as black walnut. "If we can identify delivery rates that benefit the trees without significant nutrient leaching losses into the groundwater, we can recommend this treatment," said Ponder. Like all good solutions, this would solve not just one, but two problems—the walnut grower's desire for better tree growth, and the poultry producer's waste disposal problem. Either way, it'll be money in the soil bank.

Rising CO_2 Levels May Be a Boon for Some Forest Insects

When it comes to pumping unprecedented levels of heat-trapping gases into the atmosphere, what we don't know may hurt us. That's why NC researchers, in cooperation with Michigan Tech University, are studying the effects of elevated carbon (CO_2) and ozone on tree seedlings planted at the world's largest Free-air CO_2 Enrichment (FACE) facility in Rhinelander, Wisconsin. As they analyze their first year of findings, there's expectation in the air along with greenhouse gas.

Bill Mattson's entomological findings were particularly noteworthy in that they contradicted the developing conventional wisdom. "A body of evidence suggests that plant-feeding insects may be disadvantaged by higher CO_2, because their food plants lose nutritional value," said Mattson, a research entomologist with the East Lansing Forest Insects unit. "Based on what we saw, 'disadvantaged' may not be the right word."

Unexpected Results

The paper birches growing in the FACE rings were indeed lower in nitrogen and calorie concentrations than the control birches. But the introduced gypsy moth caterpillars, far from being deterred, rose to the dietary challenge by eating more than normal, up to 61 percent more than their control counterparts.

According to Mattson's preliminary report, "The 5th instars (caterpillars) in the high CO_2 group actually grew 33 percent larger than their control counterparts, and their bodies were more calorie rich, meaning that they laid down more fatty reserves! Thus, even though food quality declined, the gypsy moth's strong capacity for compensatory feeding allowed the older caterpillars to achieve more growth than the controls. Obviously, for insects like the gypsy moth that are highly adapted to low nitrogen and low calorie diets, elevated levels of atmospheric CO_2 may actually enhance their populations on trees such as paper birch."

Bill Mattson

Trees growing in high-CO_2 environments had nearly twice as many aphid colonies per plant than those in low-CO_2 environments.

Mary Beth Wacek

Project leader Jud Isebrands and Forest Service Deputy Chief Robert Lewis examine trees growing within the FACE rings.

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Will other insects respond to elevated CO_2 in the same way? So far, Mattson has found two native species of aphids—the white-spotted and smoky-winged—feeding and reproducing on the succulent leaves and shoots of trembling aspens in the FACE rings. Surprisingly, there were more of them in the high CO_2 environments than in the low:

"High CO_2 plots had twice as many infested plants (54 vs 27%). Moreover, the high CO_2 trees had nearly twice as many aphid colonies per plant than the low CO_2 plots (2.2 vs 1.3 colonies/plant) in the early season. In middle August, the pattern was more than twice (1.7 vs 0.7). Not only were colonies per plant more numerous under high CO_2, the size of the colonies were larger too, averaging about 110 and 50 individuals/colony in the high and low CO_2 environments, respectively.

Attracted to Ozone

The report continues: "Ozone enrichment also enhanced aphid success, at least during the early part of the growing season on aspens. For example, there were nearly twice as many aphid colonies on high ozone trees as on control trees (2.10 vs 1.05 colonies/plant). However, during August, after several severe bouts of ozone injury resulted in dying leaves and dead shoot tips, the pattern had reversed itself, and high ozone aspen trees had fewer colonies (0.6 vs 1.9), and fewer aphids per colony (50 vs 110 individuals/colony). In the case of the birches, which were much less damaged by the high episodes of ozone, high ozone apparently enhanced aphid numbers. High ozone trees had more than twice as many aphids per leaf as the low ozone trees (21.4 vs 9.7 individuals/leaf).

Bill Mattson

Gypsy moths growing in high-CO_2 ate more to compensate for low food quality.

"At least two other species of leaf eating insects were more abundant in the high CO_2 plots than in the low: the native, serpentine leafminer of aspen, and the little green weevil, an exotic species."

Could it be that the CO_2 leaving our exhaust pipes is actually creating an advantage for certain forest pests? And what does that mean for forest productivity? According to Mattson, "It's too early to predict the answers to these important questions—but there is no doubt that humankind's tinkering with the atmosphere could lead to major changes in the natural world as we know it, and not all of them will be to our liking, or to our benefit."

People on the Move

Moving on...

David Lothner, *St. Paul*, retired.

Kevin Low, *St. Paul*, resigned.

Congratulations!

Ryan Anderson, *Aurora*, and **Gary Stachowicz**, *Brownstown*, were promoted.

Graham Mahal, *St. Paul*, received an award from State and Private Forestry for his extraordinary effort in generating a web document version of the Silvics of North America, Volume 1 Conifers and Volume 2 Hardwoods.

Lynne Westphal, *Chicago*, received an award for exceptional initiative and sustained excellence in recruiting and mentoring a minority student at the Evanston location.

Herb Schroeder, *Chicago*, received an award for his exceptional initiative in providing advice and assistance in converting the Evanston office over to the IBM system.

Kudos From Japan...

"I saw the 1997 Owl Symposium Proceedings on the internet. It is very convenient!!"

—Aki Higuchi
Niigata University
Niigata, Japan

Thanks Aki! You too can check out the owl proceedings, descriptions of our research, and the products of that research on our newly designed web page. It's packed with tools to help you better understand the natural world and our connection to it.
http://www.ncfes.umn.edu

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1. **Diversity:** Researchers intend to apply quantitative genetic theory and gene mapping technologies to optimize their breeding and selection programs. They also plan to maintain breeding populations of important conifer species, which may someday be in demand for the same kind of intensively managed systems currently used for poplars.

2. **Cultural considerations:** Weed management is another critical aspect of intensive culture, but current methods are inadequate and not very well matched to selected crop tree genotypes. The unit will continue to study how well the new, lower rate herbicides do in the war against weeds in hybrid poplar plantations. In addition, they will use genetic engineering to develop herbicide-tolerant variants of commercial crop trees.

3. **Riparian ecosystems:** Fast-growing trees could have a bright future in reforesting floodplains, providing effluent buffers between agricultural operations and streams. But first we need to understand the growth characteristics of riparian species, methods for establishing and sustaining those trees, and the interactions between plantations and the surrounding plant, animal, and human communities. The new work unit plans to become partners with Federal and State agencies as well as universities to test select genotypes and cultural methods in riparian systems.

4. **Technology Transfer:** Turning state-of-the-art technologies into everyday realities requires person-to-person contact. That's why unit members will continue to participate in client workshops, industrial cooperatives, and face-to-face meetings with legislative assistants. "The most exciting part of this new project is the opportunity to serve the people in a very direct way," Riemenschneider said. "Some of my most rewarding days have been spent walking through a plantation with a farmer discussing problems and successes in his operations and his hopes for the future."

The unit plans to maintain a small core staff, reaching out to collaborators when it needs to bolster its skills bank. If you're interested in finding out more about this exciting research, you can contact Tim Swedberg at (651) 649-5257.

Contributed by Dan Netzer

NC NEWS is published monthly by the North Central Forest Experiment Station, 1992 Folwell Avenue, St. Paul, MN 55108, for our employees, our cooperators, and citizens interested in natural resources and the environment. Contact: Research Information, (651) 649-5259 or Editor Janine Benyus at (406) 777-2933; Benyus@Montana.com
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Bigger Gaps, Better Forests?

When you talk to NC researcher Terry Strong, you realize the timeline in his head is longer than yours—by about a century. "The even-aged hardwood forests we see today are a result of decisions made around 1900, when loggers began clearcutting," said Strong, a research forester with the Northern Forest Silviculture unit in Grand Rapids. "In the same way, the forests of the next century will be the result of management decisions we're making today."

Already, he sees hints of what is to come in the sugar maple-dominated understory of managed stands. "Sugar maple grows well in harvest prescriptions that call for creating four to eight canopy gaps per acre, each about 30 feet across. As the canopy closes, it actually favors the shade-tolerant species, like sugar maple," he said.

The concern is that too much maple could mean not enough tree diversity. According to project leader John Zasada: "Our job is to create a forest that's flexible enough to respond to whatever may come up—climate change, exotic pests, even a shift in the kinds of products society wants. The best preparation for change is species diversity."

Increasing the size of some of these openings, and letting in more sunlight for shade-intolerant species, is one way to diversify the species mix. But letting in too much sunlight can cause problems for crop trees. "Sunlight can promote the growth of epicormic branches, which leads to defects on the bole," Strong said. "The trick is to maintain enough residual tree density to minimize defects, while still maximizing growth and tree diversity in the stand."

In search of this balanced silviculture, Strong and colleagues began a study in 1994 to look at the effects of various gap sizes in an even-aged mixed hardwood stand near Eagle River, Wisconsin. "We wondered if incorporating a few larger gap sizes during the first management entry would achieve both diversity and tree quality," he said. Indeed, early results from that study suggest that a 60-foot opening may be ideal—large enough to encourage tree diversity, but not so large that raspberry takes over the opening. Based on these promising results, Bob Raade, District Silviculturist of the Washburn District of the Chequamegon-Nicolet National Forest, plans to try the larger gap sizes to encourage yellow birch.

Making a Good Guide Better

Once proven, this doubling of canopy size would be quite a revision to the bibles of northern hardwood management written in the 1950's and revised in the 1980's. In the early guides, Lake States researchers Carl Arbogast, Francis Eyre, and Walter Zilgitt described how to place old-growth hardwoods under uneven-aged management. They suggested a residual stand structure that would sustain yields of high-quality sawlogs indefinitely. Gus Erdmann later added to these recommendations, focusing on the even-aged stands we inherited from the clearcutting era.

In a noteworthy followup, Strong studied tree quality on the same sites that Arbogast and Erdmann used in their original research at the Argonne Experimental Forest near Three Lakes, Wisconsin. He compared several cutting methods—a light, medium, and high level of individual tree selection, with residual basal areas of 90, 75, and 60 square feet; a diameter-limit cut; a crop tree release; and an uncut control. "We found that heavy diameter-limit cutting (also called high-grading) left poor quality trees behind," Strong said. "The lighter individual tree selection treatments had fewer epicormic branches and thus better tree quality."

Jeff Neise, former member of the Economics of Northern Forests unit in East Lansing, analyzed the economics of those tree quality changes over a 20-year period. His findings further bolster the intermediate cutting recommendation, showing that high returns and high quality can be achieved without high-grading.

Dollars and Sense

Ideally, forest landowners want their management actions to make both economic AND ecological sense. To see how the entire plant community fared under various treatments, Strong did a vegetation survey of each treatment. He also looked at soil carbon (an indicator of changes in soil fertility). The good news is that all the treatments (except high-grading) seemed to leave soil carbon undiminished.

"The next big question we'd like to look at is soil compaction," he said. "Winter harvests minimize compaction, but people have to work during the summer too. Eventually, we'd like to recommend sites that are least impacted by summer logging."

Thinking about impacts over the long haul is Terry's strong suit. "What you leave behind is as important as what you take out," he said, "how much, in what pattern, and in what condition." If the results of his latest study hold up, it looks like larger gaps may leave a better forest—for today's landowner, and for generations of landowners to come.