2001

Research and Development Highlights

USDA Forest Service Northeastern Research Station

Connecticut, Delaware, Maine, Maryland, Massachusetts
New Hampshire, New Jersey, New York, Ohio, Pennsylvania
Rhode Island, Vermont and West Virginia

Welcome to this latest report on the scientific achievements of the USDA Forest Service's Northeastern Research Station.

The Northeastern Research Station is one of six regional field units that make up the Research and Development (R & D) division of the Forest Service. Forest Service R & D is one of the world's leading forestry research organizations.

We conduct and sponsor research across the United States and around the world. This research generates credible, relevant knowledge, and exciting new technologies to sustain the health, productivity and diversity of our nation's forests.

No matter what part of the Northeast that you live, we are sure you will find a tree – maybe even a forest – somewhere near you that is helping to improve your life!

I compliment Northeastern Research Station scientists for their outstanding achievements and also the support staffs for their high level of professionalism, a hallmark of the Northeastern Station. I also welcome Michael T. Rains as the new director of the station and encourage the scientists, management and staff members to continue their work together to achieve even higher levels of scientific excellence.

Robert Lewis, Jr.

Robert Lewis, Jr.
Deputy Chief for Research and Development, USDA Forest Service

The research progress highlighted in this report builds on a remarkable success story. Eight decades ago when the Northeastern Research Station was created, its original mission was to better manage forests, study tree species and explore replanting methods at a time when loggers left much of the tree on the stump and discarded or burned half the trees that reached the mill.

We have made outstanding progress since that time: in addition to becoming one of the largest forestry research groups to help public land managers and private landowners, we are also a global leader in forest conservation.

Today, the Northeastern Research Station serves society in our 13-state region by developing and communicating the scientific information and innovative technology required to improve the health and use of our forests. Our activities contribute to the stewardship of land and property, and improve human health and environmental quality.

The progress made is a tribute to the dedicated scientists, researchers and support staff at the Station, to the cooperation of federal, state and local governments and universities, to enlightened leadership in business and industry, and to a wide range of other activists.

Much remains to be done. Many communities have yet to share fully in the benefits of our research and technology. The new century presents challenges – from global climate change to urban sprawl – that were not even anticipated at the time of the Station's founding.

We will continue our work to meet the new challenges and serve society, so that we may leave the Northeast and our country a better place for those who follow.

Michael T. Rains
Director, Northeastern Research Station, USDA Forest Service

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The Northeastern Research Station is based in Newtown Square, Pennsylvania, a suburb of Philadelphia. It serves the people and lands of 13 northeastern states: **Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont and West Virginia**.

The Station has **323** permanent full time employees, and about **150** part time employees.

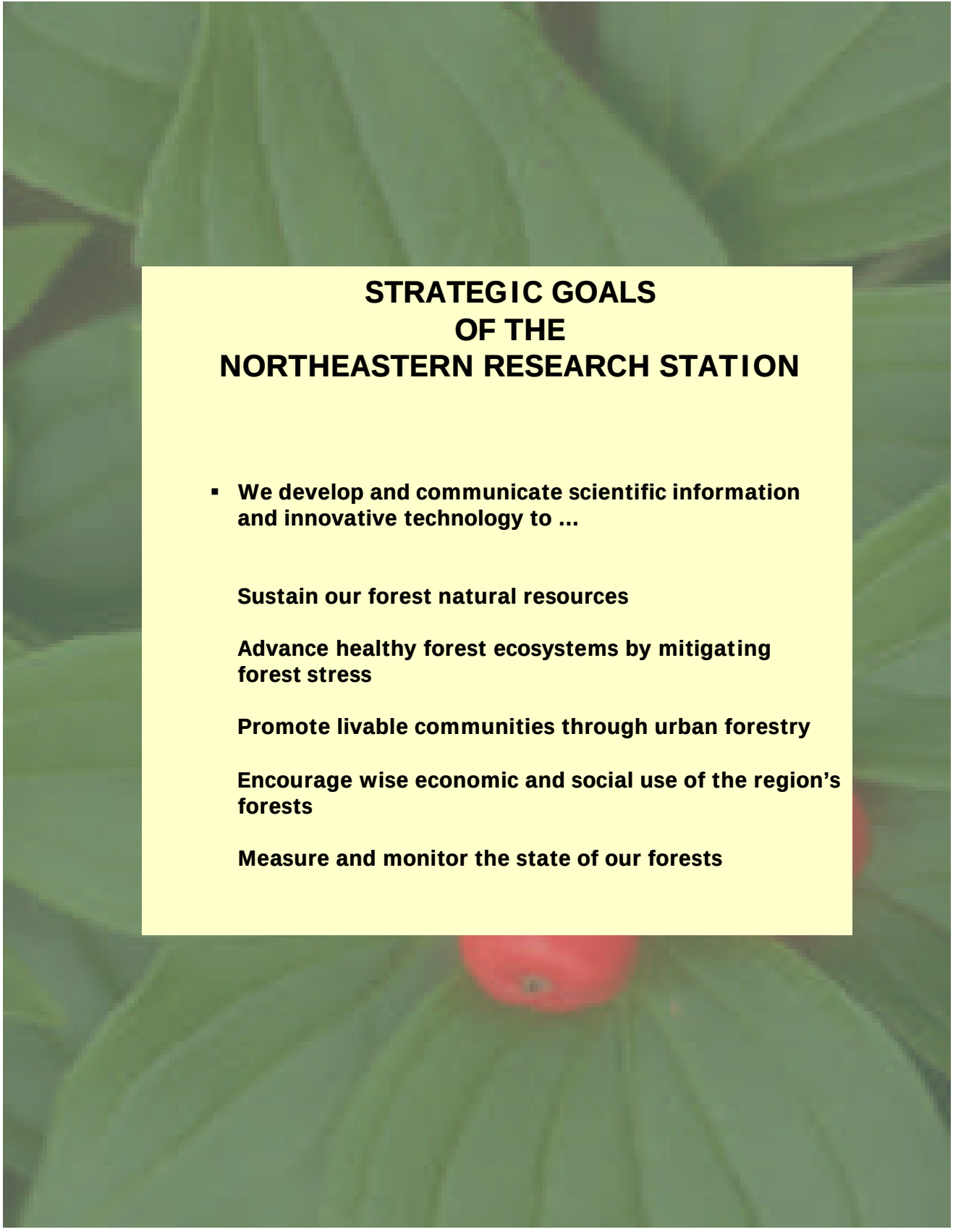
There are **20 research units** each with a study plan that addresses scientific objectives specific to the unit location's forest ecosystems. Some units have laboratories in more than one state, where forests cross human-made boundaries.

Each unit is staffed by a project leader, research scientists, technical and support personnel. The majority of project leaders and research scientists hold Ph.D. degrees and are experts in their fields.

In addition to the research units, the station conducts the regional participation in **two major national research programs** : Forest Inventory and Analysis, and Global Climate Change.

The Station maintains **nine experimental forests** and **six research "natural areas"** in the 13-state region to tackle high priority problems through long-term research that is critical to the development of broad scientific discovery and emerging technologies.

Northeastern Research Station manages two of only 24 worldwide National Science Foundation **"Long-Term Ecological Research Sites (LTERs)**: an internationally renowned site at Hubbard Brook in New Hampshire, and in metropolitan Baltimore one of only two urban LTERs in the world.



STRATEGIC GOALS OF THE NORTHEASTERN RESEARCH STATION

- **We develop and communicate scientific information and innovative technology to …**

Sustain our forest natural resources

Advance healthy forest ecosystems by mitigating forest stress

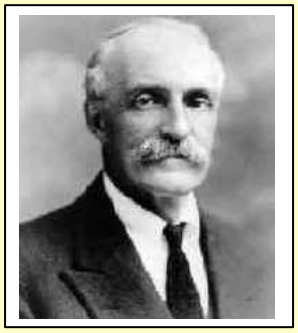
Promote livable communities through urban forestry

Encourage wise economic and social use of the region's forests

Measure and monitor the state of our forests

An Introduction to the Northeastern Research Station

When the Pilgrims stepped from the Mayflower in 1620, they stepped into an ocean of green: primordial forests that swept up behind Plymouth Rock covered 95 percent of the land. Settlement reduced this great forest by 60 percent by the time Gifford Pinchot became America's first Forester, in 1898, and founder of the USDA Forest Service under President Theodore Roosevelt.



Pinchot, known as the father of the conservation movement in the United States, was endowed with a love of nature. At Grey Towers, his family's summer home in the Pocono Mountains of Pennsylvania, he was encouraged to explore his natural surroundings. No forestry training existed then in the U.S., so after graduating from college, Pinchot was sent abroad to L'Ecole Nationale Forestiere in France.

"When I got home at the end of 1890 … the nation was obsessed by a fury of development," Pinchot wrote. "The American Colussus was fiercely intent on appropriating and exploiting the riches of the richest of all continents."

Forests once again became the dominant landscape of the Northeastern region, covering up to 61 percent.

Yet forestland is lost to urban sprawl and development at rate of 100 acres a day, according to estimates, and, for the first time, a dominant forest trend reported in 2001 by Forest Service researchers indicates forestland across much of the Northeast has begun decreasing.

The Northeastern states today are both the most densely populated and – for now -- densely forested in the nation. Six of the country's most densely wooded states are here; 10 of the 12 most urbanized states are, too. More than one of every four U.S. citizens calls the Northeast home.

This creates a situation where stresses of human origin such as pollution and fire join natural stresses such as drought and native pests to potentially overwhelm our forests. At the same time there is renewed demand for wood products and more affordable housing in the Northeastern region. Forest-related industry contributes significantly to the economy here: a-quarter of all U.S forest industry wages was paid by industries operating in the Northeast.

As a result of the proximity of forestland and city in the Northeast, the Station devotes substantial resources to the study of the "urban forest" and its relationship to people. The urban forest cover is large and growing: it doubled in size between 1969 and 1994. Trees in the city help cool hot summers, keep air purer, and influence the amount of skin-cancer causing radiation that hits the ground.

Northeastern forests are also "fragmented" forests. Eighty-three percent of Northeast forests, totaling about 80 million acres, are in the hands of private owners. About half the private owners hold 10 acres or fewer. Eight-thousand private forest owners are privately-held industries.

The station dedicates itself to the stewardship of land, property and society by improving the health of forest ecosystems, creating jobs, and providing affordable housing. It strives to improve human health and environmental quality by effective management of eastern forest watersheds that provide much of the nation's drinking water, by developing environmentally safe forest pest control, and through sound management of fish and wildlife habitats on public and private land. It values excellence, innovation, integrity and communication.

The Northeastern Research Station remains committed to the vision of Gifford Pinchot, for whom conservation was an issue of national policy, to be a leading advocate for conservation of our natural resources and to provide invaluable service to the people of our region.

2001 Station Accomplishments

Northeastern Research Station scientists reported a number of landmark achievements in 2001 that will have an impact on the forests and the people of the 13-state region. The station has compiled an impressive record of accomplishment in protecting and managing our forest natural resources over the past several decades, quickly identifying and investigating emerging issues as well as making advances in long-term research that contribute to the global body of knowledge of forest ecosystems. NE's work is performed across broad dimensions of time and space: it ranges from molecules to mountainsides producing knowledge that is relevant today and across generations.

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- ***SCIENCE* MAGAZINE'S TOP TEN SCIENCE BREAKTHROUGHS OF THE YEAR: "CARBON CONSENSUS"**

  Northeastern Station scientists contributed to a major advance in understanding global climate change, which *Science* magazine named one of the top science breakthroughs of 2001.

  Researchers had been puzzling over how much carbon dioxide – the human-made greenhouse gas associated with climate change – is absorbed by U.S. forests and agricultural lands. Global measurements of carbon dioxide in the atmosphere concluded that plant ecosystems in North America seemed to sponge up most carbon dioxide emissions. Researchers counting this "carbon uptake" with land surveys, however, found a much smaller absorption.

  Scientists were finally able to reconcile the conflicting amounts based substantially on the work of Drs. Richard A. Birdsey and Linda Heath, NE scientists in Newtown Square, PA and Durham, NH. Together with researchers studying atmospheric analyses, they coauthored a paper that is the main basis of the breakthrough.

  The new consensus shows plant ecosystems absorb about 500,000 million metric tons each year in the U.S., enough to offset about one-third of current U.S. emissions of carbon dioxide.

  Science magazine says the outcome will sharpen estimates of how much the planet may warm in the years ahead, and will help researchers pinpoint carbon uptake in other parts of the world.

- **NE DOCUMENTS MAJOR CHANGES IN THE REGION'S FORESTS**

  Researchers have identified and documented substantial changes in Northeastern forests in the latest "census" of the region's forests. The dominant trends reported by the Forest Inventory and Analysis (FIA) Program in 2001 are:

- **Forestland has begun decreasing across much of the Northeast**.
  For the first time in the history of the forest inventory, researchers are declaring a true downward trend in the amount of forestland in the Northeast. Previous years' losses were offset by gains in abandoned farmland that reverted to forestland. Within the last five years, however, the gains were inconsistent, and in 2001, NE researchers declared the downward trend official. The region has the unlucky distinction of now being the first in the nation to show such forestland loss.
- **Forests are maturing: older, large diameter trees now predominate, and**
- **Young forest stands are becoming scarce.**
  Just as a human society comprised only of senior citizens is not desirable, neither is a forest population of mostly older trees. Forest ecosystems require a balance for sustainability, yet that is not now the case in the Northeast. As one researcher notes, "There is no baby boom in the forest."
  The problem is becoming acute for forest wildlife and birds, which rely on the youngest set of trees – seedlings and saplings – for shelter and food.
  Current measurements, however, show most Northeast forests are now comprised mostly of saw timber, the oldest trees with a trunk diameter of 12 inches or greater.
  Researchers point to several causes of the scarcity of young stands, but the most significant is deer. Deer forage and trammel seedlings and other important understory vegetation. Researchers in Pennsylvania, for example, recorded 40 or more deer per square mile. It is believed that 25 or fewer produce a healthy forest ecosystem.
- **Red maple continues to increase its dominance throughout its range.**
  Darwin would love the red maple: it thrives everywhere in the Northeast, in any climate, and deer won't touch it. Unlike most of the Northeast's valued hardwoods, red maple sprouts prolifically from its cut-down stump. It has the tenacity of a weed. And it is taking over our forests.
  NE researchers say this is an economic concern: The Northeast hardwoods, arguably the most valuable hardwood in the world along with tropical mahogany, are being crowded out by the commercially less valuable red maple.

- **FOREST INVENTORY BECOMES AN ANNUAL EVENT**

  The Northeastern Research Station has now annualized the "census" surveys in Ohio, Pennsylvania and Maine, the most heavily forested

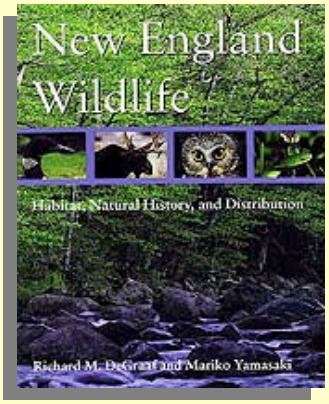
state in the nation. Results, published in partnership with the states, have been vital to the development of policies for and management of forest natural resources. NE has added additional states to the annual inventory in 2002. Detailed statistical tables of the forest inventory and trends were published for land managers in Connecticut, Massachusetts, New Hampshire, Rhode Island and Vermont. Brochures for general audiences were published for residents of Connecticut, New Hampshire and Vermont.

- **STUDY CONFIRMS BROADER ACID RAIN EFFECTS**

  For many decades, scientists have studied acid rain and its effects on U.S. forests. But until recently, no one really knew the breadth of the effects. Now, NE scientist Dr. Paul M. Schaberg in Burlington, VT, along with collaborators at the University of Vermont, has made a significant advance. The current findings show how a broad spectrum of evergreen trees are susceptible to the effects of acid rain.
  This builds on Dr. Schaberg's earlier landmark research that focused on the red spruce – an evergreen tree that is scientifically proven affected by acid rain. He discovered that acidified water – rain, snow, even mist and fog – affects calcium levels of cell membranes and makes these commercially-sought trees more susceptible to freezing injury and mortality. Dr. Schaberg's new findings prove that other evergreens are affected in the same way. He is now expanding his work to study the effect on broadleaf trees.

- **WILDLIFE LOVERS' 'BIBLE' IS UPDATED FOR 2001 …**

  When it was originally published, the book *New England Wildlife: Habitat, Natural History and Distribution* was the first comprehensive wildlife guide to all inland New England species. Newly revised and updated by Senior Scientist Dr. Richard M. DeGraaf, Amherst, MA, and Mariko Yamasaki, Durham, NH, it remains the only all-inclusive guide. The University Press of New England printed 80,000 copies available in general interest and online bookstores. The book is called "a necessity for all land managers and naturalis ts as well as birders, walkers, nature lovers, residents and visitors." The Boston Museum of Science must agree: it has created an exhibit from the section on New England birds.



- **…AND THERE'S A CD, TOO.**

  Northeastern Research Station scientists publish hundreds of peer-reviewed manuscripts each year. Now, Dr. DeGraaf has published the station's first computer disc to transfer science findings to private and public land managers. The CD-ROM, entitled "New England: A Model for Ecosystem Management – ECOSEARCH," permits users to experiment with alternative land management practices to determine their effects on wildlife habitats and distribution.

- **AN INNOVATION IN GYPSY MOTH CONTROL**

  The gypsy moth is the most important defoliating insect of hardwood trees in the Northeast. Outbreaks originally occurred in New England; today defoliation by the gypsy moth is far more severe and widespread.

Adult female gypsy moth

Defoliation often occurs in populated areas, especially where homes and developments are located in previously forested lands. Under these conditions, the gypsy moth defoliates not only woodland trees but also valuable park and ornamental trees. Because the insect is firmly established in the densely populated regions of the Northeast, it is very likely that the homeowner in this area and the gypsy moth will meet.

Station scientists developed and are the sole producers of "Gypchek," a viral pesticide that is an effective alternative to chemicals to eradicate gypsy moth populations. In 2001, Dr. James M. Slavicek, of NE's Delaware, Ohio lab, and Dr. John D. Podgwaite at the Hamden/Ansonia, Connecticut lab improved upon their creation when they successfully produced the pesticide in cell cultures. New field tests show this updated form of Gypchek is as effective as the original, and may be less costly to produce.

Severe gypsy moth defoliation of a northeastern ridge.

- **LAB MAKES PROGRESS IN BIOCONTROL OF EXOTIC FOREST PEST**

  The Northeastern Research Station manages the USDA Forest Service's only primary quarantine laboratory in the continental United States, in Ansonia, Connecticut. This quarantine lab is certified for

research on exotic forest pests, and is an integral part of NE's ability to contain these "alien invaders."

In 2001, scientists closed in on biocontrols for one of the most feared of these pests: the Asian longhorned beetle.

Asian longhorned beetle

The beetle was introduced to the United States in the mid-1990s in wood packing material from China. It has no known natural predator in the United States. NE scientists estimate the Asian longhomed beetle has the potential to cause more damage than Dutch elm disease, chestnut blight and gypsy moths combined, destroying millions of acres of America's treasured hardwoods in national forests and backyards. New Station estimates include a potential loss of 30 percent of total canopy cover and 30 percent tree mortality (1.2 billion trees).

So far, the Asian longhorned beetle has not been found outside New York City and Chicago, although the USDA extended the quarantine area in Illinois last November.

NE scientists have established colonies of the beetle in our Quarantine Lab, enabling study without danger of release. Preliminary studies evaluating biocontrols have now found two species of nematodes – microscopic worms -- that were able to reproduce in and kill the beetles. Additional research is focusing on viral pesticides. The scientists leading these studies are Dr. David J. Nowak, Syracuse, New York, and Drs. Kathleen S. Shields, Melody Keena and Michael McManus, and Vincent D'Amico in Hamden/ Ansonia, Connecticut.

- **NE CREATES A COMPUTERIZED LAND STEWARDSHIP PLAN**

  A new computer program created by Dr. Mark Twery in Burlington, Vermont, provides land managers with an easy way to organize their information and develop stewardship plans that comply with all state and federal guidelines. STEWPLAN is used in conjunction with existing NE-created "NED" software for analyzing forest conditions. Initial response indicates STEWPLAN is extremely helpful to foresters.

- **MORTALITY FINDINGS ARE OFFERED TO HELP LAND MANAGERS**

  The spruce budworm is the most destructive forest insect in the spruce and fir forests of Maine, New Hampshire and Vermont, with increasingly frequent outbreaks during the last century. After four to six years of continuous heavy defoliation, most trees die.

  Analysis of the mortality patterns by Drs. Dale S. Solomon and Linda S. Heath, of Durham, New Hampshire, enabled NE scientists to develop protection guidelines and strategies

for scheduling timber harvests of these commercially valuable woods. This new information is now included in another Station computer modeling program, "FIBER."

- **NATIONAL ASSESSMENT OF URBAN FORESTS**

  Much of the population of the Northeastern region lives within urban forests, but until recently urban forests were not widely studied. NE scientists have now published the first national assessment of urban forests, which will provide background information to guide future policies and program for sustaining the structure, function and benefits of urban forests. Scientists at the Northeastern and North Central Station found that the forest cover in urban areas is large and growing: it doubled in size in 15 years. Dr. Nowak's research found that the nation's cities contain about 3.8 billion trees that cover more than a-quarter of these urban areas.

Cities are part of the environment, too.

- **CITY KIDS ARE EXPOSED TO MORE RADIATION**

  Ultraviolet (UV) radiation is associated with a wide range of human health problems, including skin cancers, cataracts and immune deficiencies. NE research shows that trees influence the amount of UV radiation that reaches the ground. Using a new computer model developed by NE scientists in Baltimore and Syracuse, analyses suggest that UV-B exposure for children in neighborhoods with multi-family dwellings such as apartment houses is twice that for children in neighborhoods with single-family dwellings.

- **SOCIAL ASPECTS OF URBAN FOREST ECOLOGY**

  The Station's reputation as a leader in urban forestry research has grown, as our program to develop computer models that simulate the effects o f urban forests on human health and environmental quality matures. NE scientist Dr. J. Morgan Grove is participating in the first urban Long-Term Ecological Research (LTER) project, in Baltimore. Dr. Grove shared his expertise in modeling human-environmental systems, and documented ways that neighborhood income, education and social cohesion affect and are affected by the presence of trees. For his leadership, enthusiasm and initiative in integrating social and ecological sciences, Dr. Grove was presented with the Forest Service Chief's Honor Award for Early Career Scientists in 2001.

- **TIMBER STUDY REVEALS SUSTAINABILITY OF NEW ENGLAND FORESTS**

  Forest industries are an integral part of the economy of New England. The sustainability of forest natural resources is thus of vital importance to planners, land managers and

governments. In a study of supply and demand for timber from the forests of the Green and White Mountains in Vermont and New Hampshire, scientist Dr. Chris B. LeDoux, based in NE's Morgantown, WV lab, found that current levels are economically sustainable for the next 45 years for saw timber and 67 years for pulpwood.

- **VERMONTERS EXPRESS THEIR WOODLAND PREFERENCES**

  Dr. Donald Dennis at NE's Burlington, Vermont lab studied public preferences for land use. When he surveyed users of the Green Mountain National Forest, he found that they preferred moderate amounts of timber harvesting and snowmobile access, and lower levels of off-road vehicle use. They prefer a mixture of mature forests and young, open forest areas. They were indifferent toward expanding the network of hiking trails.

Forest Service Fire Tower in the Green Mountains

- **INNOVATIVE STUDY DETAILS ECONOMIC IMPACT OF SPECIAL FOREST PRODUCTS**

  An NE expert in non-timber forest products (mushrooms, berries, bark, boughs, maple syrup and flowers, among others) contributed several chapters to an upcoming book, detailing the surprising effect of these products on the American economy. Dr. Marla R. Emery , at the Burlington, VT lab, has documented individuals, regional and ethnic groups who supplement income by gathering and selling or using these forest products. Dr. Emery's research, first described in her 1998 book, *Invisible Livelihoods*, was able to link use of non-timber forest products with lower public assistance rates in the areas studied.

- **SUPER CITED SCIENTIST**

  The Institute of Scientific Information (ISI), part of the Thompson Corporation, has named Dr. Mel Tyree, a Forest Service scientist based in Burlington, VT, one of the world's most highly cited and influential scientific authors. ISI maintains an index to the world's scientific literature, in which authors frequently cite other scientists' work.

  Advances in science are built upon previous developments and discoveries, and the pattern and frequency of citation are key indicators of the influence and importance of a scientist's contribution to the field. Tyree joins a select group that comprises less than ½ of one percent of all published researchers. The selected authors range between 1500 and 34,000 citations each.

Tyree's main effort in recent years has been to study the hydraulic architecture of trees, that is, how the plumbing system in trees is designed. He recently completed a book, *Xylem Structure and the Ascent of Sap*, a summary of 20 years of research on wood structure and hydraulic architecture and their impact on wood growth and productivity, to be published by Springer-Verlag this year.

- **SUPER-GRADE SCIENTISTS**

  Tyree, along with Dr. Richard M. DeGraaf of Amherst, MA recently achieved another career benchmark. In 2001, both joined the elite ranks of what are known as Super Scientists in the USDA Forest Service. Super Scientists, or Senior Scientists, are the highest grade of researchers, achieved through significant contribution to research in their field. Tyree and DeGraaf are two of only eight Forest Service Super Grade Scientists nationwide.

- **POSTER TAKES NATIONAL AWARDS**

  Talk about steady hands! Carolyn McQuattie, plant pathologist at NE's Delaware, Ohio lab, used her steady hands and an "ultramicrotome" – an ultra precise piece of slicing equipment – to carve a submicroscopic layer of plant tissue from a sugar maple. After placing the layer on a slide, she used x-ray microanalysis to show trace metals in the plant tissue. Using a special camera, she photographed the results and turned it into a poster.

  The Microscopy Society of America recognized the work with two awards: first place (biological sciences) and second place (ultramicrotomy), and is traveling the poster around the country for a year. The award for ultramicrotomy is especially significant: it is usually awarded to the medical community, but McQuattie's work in forest research stood out among the 200 entries.

- **TWELFTH ANNUAL INSECT FORUM AN INTERNATIONAL SUCCESS**

  The Station continues to attract participation and interest from around the world for its "Gypsy Moth and Invasive Species Forum," an event started by NE scientists in 1989. Held annually in Annapolis, the forum is now four days of scientific discussion about invasive insect species that threaten the world's forests. Hundreds of participants and speakers take part in this valuable idea-exchange.

- **STATION PUBLICATION FIGURES ARE RELEASED**

  The Northeastern Research Station published 352 scientific and technical publications in 2001. Of those 155, or 44 percent, were published in refereed journals. The 5-year trend indicates the average number of publications in refereed journals is 167.

  The station conducted 171 field tours for 4,275 participants, 107 short courses and 224 video or slide presentations.

Be in touch with the Northeastern Research Station

State	Location	Project Number	Project Focus	Project Leader	Telephone No.
CT	Hamden *(and Ansonia)*	NE-4501 NE-4502	• Forest insect biology and biocontrol • Pathology and microbial control of insects	Kathleen S. Shields Michael L. McManus	203-230-4330 203-230-4322
DE	State-wide:	Various RWUs NE-4455	• Forest health monitoring; research in invasive species, and forest stewardship decision tools • Forest fragmentation and water quality of mid-Atlantic watersheds	Charles T. Scott Michael L. McManus Mark J. Twery Richard A. Birdsey	610-557-4020 203-230-4322 802-951-6771 610-557-4092
MA	Amherst: State-wide	NE-4251 NE-4501	• Wildlife and fish habitat relationships and recreation opportunities • Invasive species research	Richard M. DeGraaf Kathleen S. Shields	413-545-0357 203-230-4330
MD	Baltimore *(Long-Term Ecological Research Project)*	NE-4952 NE-4454	• Urban forests and human health • Social dynamics of urban communities and ecosystems	David J. Nowak Mark J. Twery	315-448-3212 802-951-6771
ME	Bradley Orono:	NE-4155 NE-4352 NE-4104	• Ecology and management • Ecological Processes • Forest Management Research Cooperative (MOU, as part of NE-4104)	John C. Brissette Christopher Eagar Linda S. Heath	603-868-7632 603-868-7636 603-868-7612
NH	Durham:	NE-4104 NE-4155 NE-4352 NE-4505	• Measurement and modeling of forests and carbon • Ecology and management • Ecological Processes • Forest stressor interactions	Linda S. Heath John C. Brissette Christopher Eagar Kevin T. Smith	603-868-7612 603-868-7632 603-868-7636 603-868-7624
NJ	State-wide:	NE-4455: NE-4501 NE-4952	• Regional climate and fire danger modeling specific to the Pine Barrens • Forest fragmentation and water quality of mid-Atlantic watersheds • Invasive species research • Urban forests and human health	Richard A. Birdsey Kathleen S. Shields David J. Nowak	610-557-4092 203-230-4330 315-448-3212
NY	Syracuse State-wide	NE-4952 NE-4501	• Urban forests and human health • Invasive species research	David J. Nowak Kathleen S. Shields	315-448-3212 203-230-4330
OH	Delaware:	NE-4558 NE-4153 NE-4509	• Multiple stresses and forest health • Forest ecosystem modeling • Biologically based forest pest controls	Robert P. Long Daniel A. Yaussy James M. Slavicek	740-368-0050 740-368-0101 740-368-0033
PA	Newtown Square: Warren State-wide	NE-4801 NE-4455 NE-4152 NE-4501	• Forest inventory and analysis (Program) • Global change (Program) (*and NC-4455)* • Managing forest ecosystems • Invasive species research	Charles T. Scott Richard A. Birdsey Susan L. Stout Kathleen S. Shields	610-557-4020 610-557-4092 814-563-1040 203-230-4330
RI	State-wide:	Various RWUs NE-4952	• Forest health monitoring; research in invasive species, and forest stewardship decision tools • Urban forest stewardship	Charles T. Scott Michael L. McManus Mark J. Twery David J. Nowak	610-557-4020 203-230-4322 802-951-6771 315-448-3212
VT	Burlington:	NE-4103 NE-4454	• Environmental stress on tree growth • Integrating social and biophysical sciences for natural resource management	Mel T. Tyree Mark J. Twery	802-951-6771 802-951-6771
WV	Morgantown: Parsons Princeton:	NE-4557 NE-4751 NE-4353 NE-4701 NE-4803 NE-4805	• Disturbance ecology and management of oak forests • Alternative harvesting strategies • Sustainable forest ecosystems • Efficient resource utilization • Economics of forest use • Hardwood forests and markets	Kurt W. Gottschalk Chris B. LeDoux Mary Beth Adams John G. Baumgras Bruce G. Hansen William G. Luppold	304-285-1598 304-285-1572 304-478-2000 304-431-2701 304-431-2739 304-431-2770

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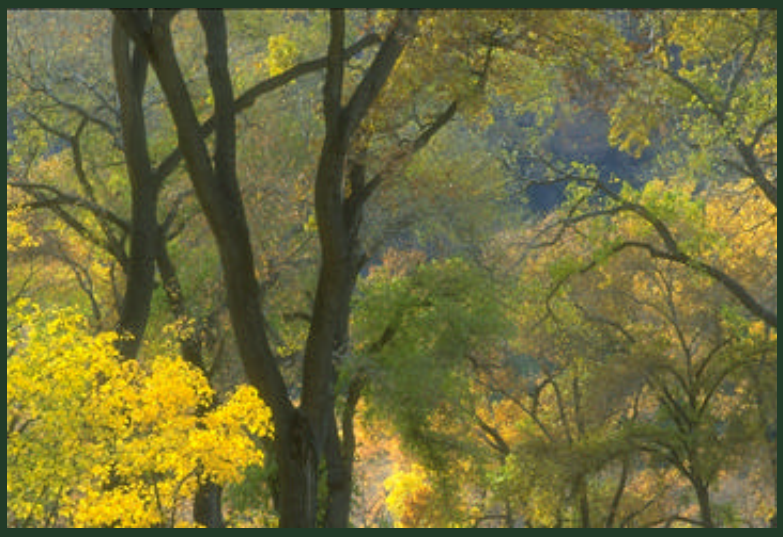

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