THE HARVARD FOREST 2002-2003

Harvard University

Front Cover: Sunset from the Prospect Hill FireTower

Back Cover: Leap O' Faith

Photography by David Foster, Jakara Hubbard, Ava Foster, John O'Keefe, and Betsy Colburn

ANNUAL REPORT OF THE HARVARD FOREST 2002-2003

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http://harvardforest.fas.harvard.edu

PERSONNEL AT THE HARVARD FOREST 2002-2003

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Leann Barnes	Laboratory Technician
Sylvia Barry Musielewicz	Research Assistant
Emery Boose	Information and Computer System Manager
Jeannette Bowlen	Accountant
John Burk	Archivist and Librarian
Philip Burton	Bullard Fellow
Jessica Butler	Research Assistant
Richard Cobb	Research Assistant
Elizabeth Colburn	Bullard Fellow
Willard Cole	Woods Crew
Anthony D'Amato	Graduate Student
Elaine Doughty	Research Assistant
Ashley Eaton	Landscaper
Edythe Ellin	Director of Administration
Aaron Ellison	Senior Ecologist
Adrian Fabos	Facilities Manager
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Betsy Von Holle	Post-doctoral Fellow
John Wisnewski	Woods Crew
Steven Wofsy	Associate

INTRODUCTION TO THE HARVARD FOREST

Since its establishment in 1907 the Harvard Forest has served as Harvard Univerisity's rural laboratory and classroom for research and education in forest biology and ecology. Through the years researchers have focused on forest management, soils and the development of forest site concepts, the biology of temperate and tropical trees, plant ecology, forest economics, landscape history, conservation biology, and ecosystem dynamics. Today, this legacy of activities is continued as faculty, staff, and students seek to understand historical and modern changes in the forests of New England and beyond resulting from human and natural disturbance processes, and to apply this information to the conservation, management, and appreciation of natural ecosystems. This activity is epitomized by the Harvard Forest Long Term Ecological Research (HF LTER) program, which was established in 1988 through funding by the National Science Foundation (NSF).

Physically, the Harvard Forest is comprised of approximately 3,000 acres of land in the north-central Massachusetts town of Petersham that include mixed hardwood and conifer forests, ponds, streams, extensive spruce and maple swamps, fields, and diverse plantations. Additional land holdings include the 25-acre Pisgah Forest in southwestern New Hampshire (located in the 5000-acre Pisgah State Park), a virgin forest of white pine and hemlock that was 300 years old when it blew down in the 1938 Hurricane; the 100-acre Matthews Plantation in Hamilton, Massachusetts, which is largely comprised of plantations and upland forest; and the 90-acre Tall Timbers Forest in Royalston, Massachusetts. In Petersham a complex of buildings that includes Shaler Hall, the Fisher Museum, and the John G. Torrey Laboratories provide office and experimental space, computer and greenhouse facilities, and lecture room for seminars and conferences. Nine additional houses provide accommodations for staff, visiting researchers, and students. Extensive records, including long-term datasets, historical information, original field notes, maps, photographic collections, and electronic data are maintained in the Harvard Forest Archives.

Administratively, the Harvard Forest is a department of the Faculty of Arts and Sciences (FAS) of Harvard University. The Harvard Forest administers the Graduate Program in Forestry that awards a masters degree in Forest Science and faculty at the Forest offer courses through the Department of Organismic and Evolutionary Biology (OEB), the Kennedy School of Government (KSG), and the Freshman Seminar Program. Close association is also maintained with the Department of Earth and Planetary Sciences (EPS), the School of Public Health (SPH), the Graduate School of Design (GSD) at Harvard, and the Department of Natural Resource Conservation at the University of Massachusetts, the Ecosystems Center of the Marine Biological Laboratory, and the Complex Systems Research Center at the University of New Hampshire.

The staff and visiting faculty of approximately fifty work collaboratively to achieve the research, educational, and management objectives of the Harvard Forest. A management group meets monthly to discuss current activities and to plan future programs. Regular meetings with the HF LTER science team, weekly research seminars and lab discussions, and an annual ecology symposium provide an infusion of outside perspectives. The six-member Woods Crew and Facilities Manager undertake forest management and physical plant activities. The Coordinator of the Fisher Museum oversees many educational and outreach programs.

Funding for the Harvard Forest is derived from endowments and FAS, whereas major research support comes primarily from the National Science Foundation, Department of Energy (National Institute for Global Environmental Change), U.S. Department of Agriculture, NASA, Andrew W. Mellon Foundation, and other granting sources. Our summer Program for Student Research is supported by the National Science Foundation, the A. W. Mellon Foundation, and the R. T. Fisher Fund.

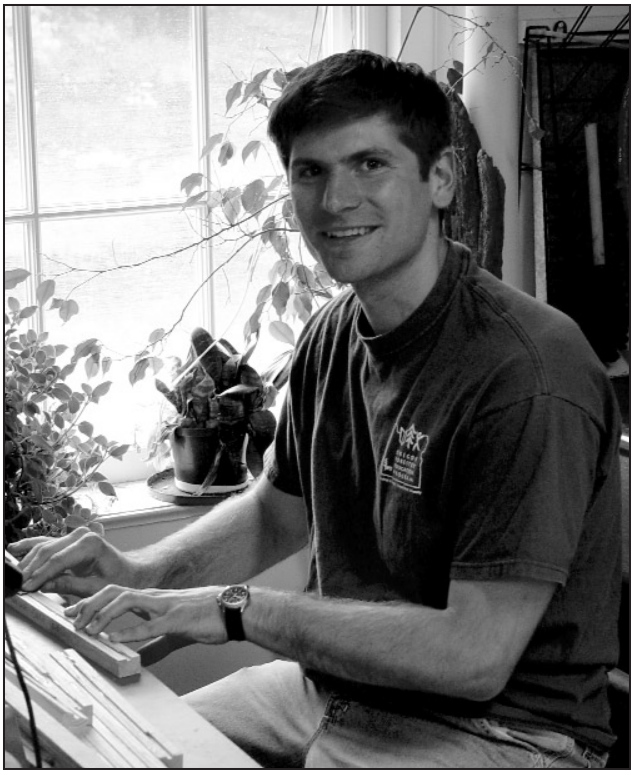
NEW STAFF

Betsy Von Holle began a three-year post-doctoral position working with David Foster, and Glenn Motzkin supported by a National Parks Ecological Research fellowship. Her research focuses on the link between disturbance history and habitat invasibility by exotic plants at Cape Cod National Seashore. Betsy received her B.S. from the University of California at San Diego and her Ph.D. from the University of Tennessee.

Jess Butler and Dan Atwater

Five new research assistants began work at the Forest. Jessica Butler, who recently received an MS from Oregon State University and has a B.S. from the University of Montana, will be conducting research on pitcher plant ecosystems with Aaron Ellison. Edward Faison who recently completed a M.S. in Botany from UVM and has a B.A. from Connecticut College, will be documenting the long-term history of hemlock in New England with David Foster.

Sultana Jefts and Laura Pustell will be conducting research on the hemlock woolly adelgid with Dave Orwig. Sultana has an MS from the University of Maine and B.S. from Evergreen State College. Laura has a B.S. from the University of Connecticut. Paul Kuzeja, who is conducting research on forest carbon exchange with Julian Hadley, received a M.S. from the University of Vermont, a M.Ed. from UMass-Amherst, and a B.A. from Amherst College.



Tony D'Amato

Tony D'Amato, a Ph.D. student in the Forestry program at University of Massachusetts as an advisee of Dave Orwig, is conducting research on the dynamics of old-growth forests in western Massachusetts. Tony received his M.S. at Oregon State University and a B.S. from the University of Maine. Richard Shulhoff, currently Deputy Director of the Arnold Arboretum at Harvard University, was accepted into the M.F.S. program working with David Foster and Dave Orwig.

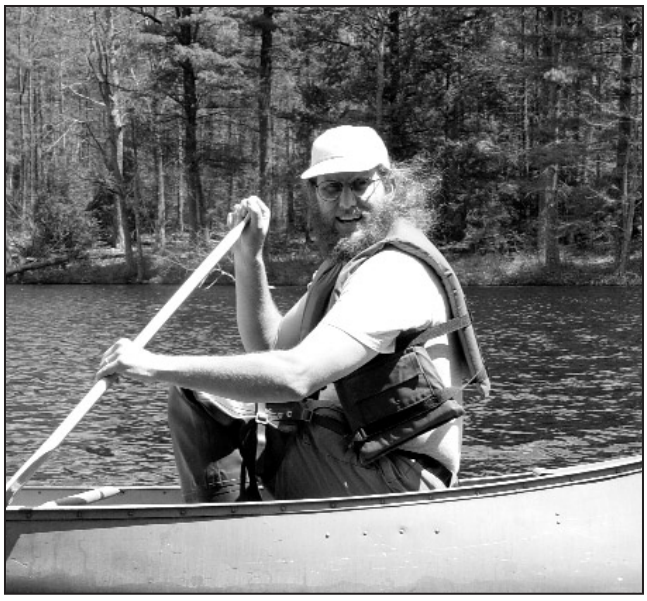
Club Paleo: Dana MacDonald, Ed Faison, Elaine Doughty, Sylvia Barry Musielewicz

RESEARCH ACTIVITIES

Community Assembly in a Changing World

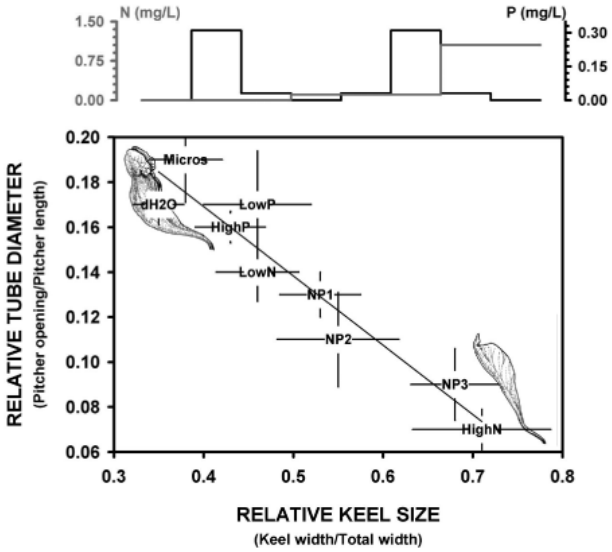
Pitcher Plant

With new support from NSF, Aaron Ellison is expanding his research on wetland community assembly, disassembly, and reassembly following large-scale disturbance. One project focuses on the structure of invertebrate communities inhabiting the northern pitcher plant, *Sarracenia purpurea* (*see photo*), a carnivorous plant that grows in bogs from Florida to Canada. The plant's pitcher-shaped leaves fill with rainwater into which ants, flies, moths, and spiders fall and drown. Unlike its congeners, *S. purpurea* relies on a small aquatic food web consisting of bacteria, protozoa, rotifers, mites, and larvae of mosquitoes, midges, and flesh flies to digest the arthropod prey that it captures and to mineralize the nitrogen locked up in the prey. In the last several decades, as concentrations of nitrogen in rainfall have increased, pitcher plants in New England have come to rely less on carnivory as their needs for nitrogen are met more and more by nitrogen in rainfall (*see graph*). Currently, Aaron, Jess Butler, and REU student Dan Atwater are investigating experimentally how much nitrogen plants obtain from prey verus how much they obtain from precipitation. This project is aimed at developing a complete nitrogen budget for *S. purpurea,* and understanding the consequences of this shift for the assembly and dynamics of the aquatic food web in the face of long term, persistent environmental change.



Aaron Ellicson

Pitcher plants in the western United States face a different challenge. In the Siskiyou Mountains of southern Oregon, the endemic *Darlingtonia californica* is restricted to serpentine fens. During the summer of 2002, the Biscuit Fire, one of the largest wildfires in



Response of the northern pitcher-plant, *Sarracenia purpurea*, to direct nutrient additions. Shape changes are expressed as two correlated characters: relative tube diameter (an indication of how large an opening the leaf has in which it can capture prey) and relative keel size (an indication of the relative size of the pitcher tube itself, in which prey are digested). The joint changes in shape are illustrated with line drawings of a normal pitcher (no nutrients added) with a relatively large mouth and small keel (*top left*) and a flattened leaf (phyllode) with a relatively small mouth and large keel (*bottom right*). Joint means are labeled with the nutrient addition treatment. The plot at the top illustrates the N and P concentrations added for each of the nine treatments (N added in gray; P in black). These results illustrate that leaf shape is sensitive to added N, but not to added P. Figure from Ellison & Gotelli (2002) PNAS 99: 4409–4412.

Flower of Garlic Mustard (*Alliaria petiolata*)

the history of the Pacific Northwest, burned nearly 500,000 acres in the center of the *Darlingtonia*'s range in southwestern Oregon and northern California. Building on three years of pre-fire data, Aaron and his colleagues Nick Sanders (Humboldt State), and Erik Jules (Humboldt State) received funding from NSF to begin a study of the re-assembly of these fen communities.

Population and Community Studies of Invasive Plant Species in New England

A group including Kristina Stinson and Kathleen Donohue from OEB and Betsy Von Holle from the Harvard Forest are investigating population, community, and landscape-level interactions between native and invasive plants in Massachusetts. The major objectives are to: identify links between land use and the presence/abundance of non-natives; develop predictive models of invasion based on historical and present-day levels of anthropogenic and natural disturbance; test the direct impact of invasive plant cover on the survival and performance of native flora; and identify evolutionary potential for further spread within invading populations. Major results to date have focused on the biennial herbaceous plant, garlic mustard (*Alliaria petiolata*) (*see photo*). This Eurasian exotic is a persistent invader in New England forests where it threatens native understory and tree seedling species. We have documented negative relationships between *A. petiolata* and important native tree seedlings, such as sugar maple and ash, in western Massachusetts.

Current research is focused on competition between native species and two important exotic invaders, garlic mustard and barberry (*Berberis thunbergii*), using experiments in which the exotic species are fully or partially removed from forest habitats. We have also begun conducting demographic surveys and evolutionary studies of garlic mustard populations in forested, intermediate, and sunny habitat types in newly invading populations at Harvard Forest. Our preliminary data suggest that seedling numbers are much higher in sunny habitat, but that transition rates between seedling, adult, and reproductive stages are higher in intermediate and forest habitat than in open habitat. However, plants in sunny habitat are much larger, have higher photosynthetic rates and seed productivity than plants in the other two habitats. These results indicate that garlic mustard populations in high-light habitats are more likely to spread than those in low-light habitats, an important consideration for population dynamics in forests with different levels of canopy openness. New reciprocal transplant studies at Harvard Forest are underway that will address the role of maternal habitat on the germination, development, and fitness of offspring in garlic mustard in different sites. Combined with long-term, statewide data on land-use history and habitat characteristics, this research will enable us to understand how evolutionary and population dynamics may contribute to invasion from population-to-landscape scales.

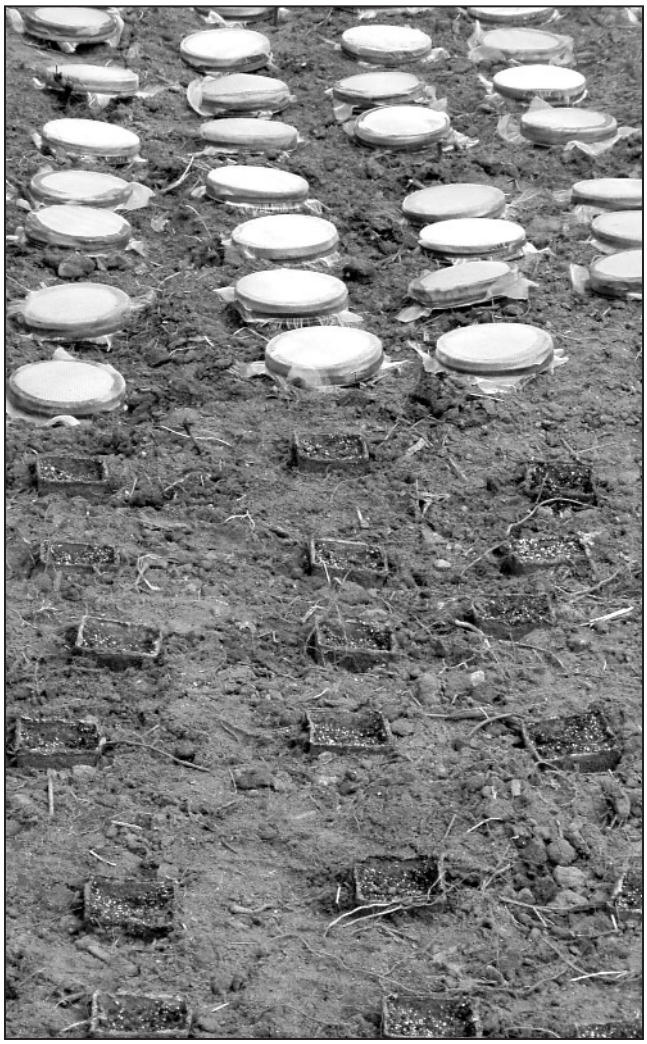
Student Gui Woolston counts seedlings, rosettes and reproductive individuals in a plot

This summer, EunSuk Kim, a graduate student in OEB, and Kathleen Donohue set up an experiment in the new experimental garden plot with the help of many of the REU summer students. This experiment will measure the influence of the season of seed maturation on the germination timing and life-history expression of five weeds. These weeds are known to exhibit variation in life-history schedules in ways that may influence their generation time and consequent population growth rates. The studies are aimed at identifying the contributions of maternal environmental effects, germination timing, and life-history expression to weedy behavior.

Alex Sanchez-Sierra, Christian Foster, Luke Durbin

Kathleen Donohue and Deberat Perez-Rivera

Prepping the site



The planted garden

Vegetation Dynamics of Ridgetop Pitch Pine and Red Pine Communities

Dave Orwig

Dave Orwig, Glenn Motzkin, and David Foster are conducting a study of the vegetation and long-term dynamics of ridgetop sites in southern New England that support uncommon pitch pine or red pine communities. The object of this study is to understand the long-term history and dynamics of these unusual habitats and vegetation types in order to guide their protection and conservation into the future. This past year, we focused our efforts on several summits in the southern Taconic Mountains with dwarf pitch pine vegetation, as well as sites in western Massachusetts with native red pine. In our previous work on Mt. Everett in southwestern Massachusetts, we found that the dwarf pitch pines ranged up to ~ 170 years old, although the average age was substantially younger. The pitch pine "trees" on these summits are frequently only 1–3 m (3–10 feet) tall, and often exhibit highly contorted shapes. Occasionally the trees are completely prostrate. The importance of hardwoods, the proportion of dead versus live pitch pine, and evidence of past fire varies greatly across the sites. Interestingly, although we could find no evidence of fire in the historical record or soils on Mt. Everett, a fire that occurred east of the summit in summer 2002 smoldered for approximately seven weeks before finally being extinguished by rains. To date, all ridgetops that we've visited in the region with native red pine have evidence of past fire, and several sites have extensive recent red pine morality from undetermined causes.

Patterns of Forest Harvesting in Massachusetts

Timber harvesting is the most widespread and important form of disturbance to New England forests and yet relatively little is known about the frequency, type, spatial distribution, or ecological consequences of this activity. Assessing forest harvesting as an ecological process is especially difficult in this region due to the large proportion of private land ownership, the small size and selective nature of many logging operations, and the general inability to identify harvested areas through satellite imagery or other forms of remote sensing. In order to evaluate the ecological and conservation implications of modern forest cutting activities David Foster, Dave Kittredge, and Glenn Motzkin have initiated a statewide research project across Massachusetts. With the cooperation of staff from the Massachusetts Department of Environmental Management (DEM) and assistance from Sweetwater Trust, John Burk gathered data this year on harvesting patterns across the Commonwealth since 1984 using regulatory data collected on all commercial logging operations by DEM.

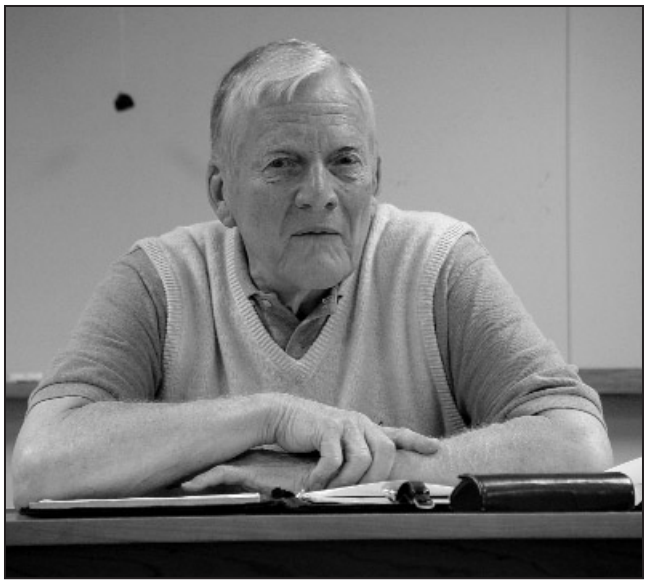
Glenn Motzkin

In collaboration with Frank Lowenstein, Andy Finton, and Mark Anderson from The Nature Conservancy, we will use these data to: (1) document the temporal and spatial variation in forest harvesting across the state; (2) analyze the distribution of logging with regard to important conservation values and physical, cultural, and environmental factors; (3) evaluate harvesting impacts on critical ecological characteristics, including invasive species distribution, native plant species richness and composition, and soil characteristics; and (4) compare harvesting patterns and intensity with natural disturbance regimes across the region. Methodologies and results from this study will advance conservation planning across the eastern U.S., and will have broad relevance to global forest policy and conservation efforts addressing such issues as carbon dynamics and the invasion of exotic species. For instance, in a pilot study of the North Quabbin region, Dave Kittredge, Andrew Finley, and David Foster found a surprisingly high frequency and unexpected pattern of cutting: approximately 1.5% of the forest area was logged annually in a spatially random pattern that has left few large forest blocks undisturbed over the past twenty years.

Forest Policy

Dave Kittredge finished his sabbatical year away from the University of Massachusetts by completing his study of private forest owner cooperation in countries with developed economies and temperate forests. He identified examples of successful cooperation in over nineteen countries, involving millions of owners and hectares. Many examples of cooperation have been ongoing for decades. These were compiled in a report to the Ford Foundation's Community-Based Forestry Project, and have been condensed into a manuscript for journal publication. Additionally, Dave wrote an article on his 2002 visit to Sweden, where he studied formal, private, forest owner cooperatives.

Dave Kittredge



C. H. W. Foster

In the summer of 2002, Kittredge and summer student Katy Nicholson began a study of the patterns of timber harvesting throughout Massachusetts. Based on the statewide compilation of timber harvest regulatory data, this study seeks to identify the locations where harvesting ceases to occur in otherwise forested communities. What combination of factors (e.g., population density, amount of forest, level of affluence, road density, parcel size) leads to the absence of harvesting as an activity in communities, that are otherwise as much as 40–50% forested? The study is being expanded in the summer of 2003 through the efforts of REU student Joanna Bate, to include data from New Hampshire.

Temperate Forest Interactions with the Atmosphere

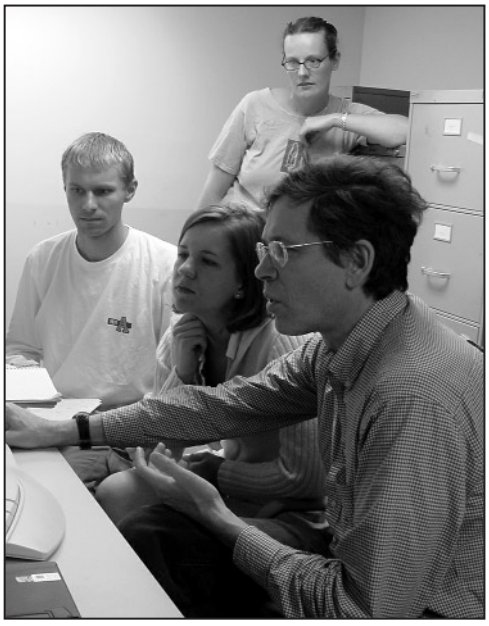
The forest and other ecosystems exchange gases and other materials with the atmosphere; understanding the relative amounts of material entering and leaving terrestrial ecosystems is a critical aspect of the environmental research undertaken at the Harvard Forest. A major part of these investigations is under-

taken at the Harvard Forest Environmental Measurement Station (HFEMS), which consists of an instrumented tower and an array of ecological plots. Trace gas concentrations and fluxes between the atmosphere and the forest are measured at the tower. At the plot sites we measure biomass increment, collect foliar and litter samples, and track changes in coarse woody debris (CWD).

2002 marked the beginning of the second decade of carbon (CO_2) flux measurements. Although the Net Ecosystem Exchange (NEE) of carbon has remained fairly steady at 2.2 ton C ha^{-1} y^{-1}, the Gross Ecosystem Exchange (GEE), or uptake, and Ecosystem Respiration (R) have been generally increasing as the forest biomass increases with time.

During 2002 we began a new study with colleague Neil Pedersen at Lamont Doherty Observatory to compare tree-ring cores from the plots with diameter increment and eddy flux measurements.

As a part of her Senior Thesis at Harvard College, Wendy Liu, measured the flux of CO_2 from downed CWD with direction from Postdoctoral Fellow David Bryant. She found that total CO_2 flux from CWD was nearly equal to soil respiration. Residence time of carbon in the CWD pool was estimated at 8.3 to 10.5 years for the Simes Tract. Inputs of CWD from normal tree mortality and minor disturbance such as windthrow, lightning, ice damage, and insects are currently being measured and will provide additional information on turnover rates for this important portion of the carbon budget.



Zachary Liscow, Kathryn McKain, Lucy Huytra, and Steve Wofsy

Results from investigations by REU student Greg Santoni suggest that soil respiration follows a daily trend, responding to soil temperature and moisture. This temporal variation in CO_2 flux and spatial variation in the driving variables prompted collaboration with Patrick Crill and Ruth Varner of the University of New Hampshire. Eight automated CO_2 measurement chambers were installed in spring 2003 at the margin of the Bigelow swamp northwest of the HFEMS tower. Soil moisture and temperature are also being measured every two hours at each chamber.

David Bryant is managing the network of autochambers and is taking manual respiration measurements weekly within the swamp. The combined dataset will allow landscape level analysis of the spatial and temporal pattern of soil respiration in wetland, upland, disturbed and undisturbed forests.

Air quality measurements are a major focus of studies at the HFEMS. An automated gas chromatograph, one of several similar instruments in a U.S. National Oceanic and Atmospheric Administration (NOAA) global network, is used to track changes in the concentration of chlorofluorocarbons (CFC) now that their production and use has been stopped. Although the concentration of this important greenhouse gas is trending downward as expected, our observations suggest that emissions are still occurring, presumably from residues in old equipment, landfills, and stockpiled material.

Measurements of ozone and other air pollutants have been made at HFEMS since 1990. During the summer of 2002 we observed an unusual event with very high carbon monoxide (CO) concentrations along with thick haze from a group of forest fires in northern Quebec in early July. Peak concentrations of CO approached 800 ppb, which greatly exceeds the typical summertime values. In August the Harvard Forest experienced a multi-day episode of high ozone.

Variation in Carbon Exchange Among Forests

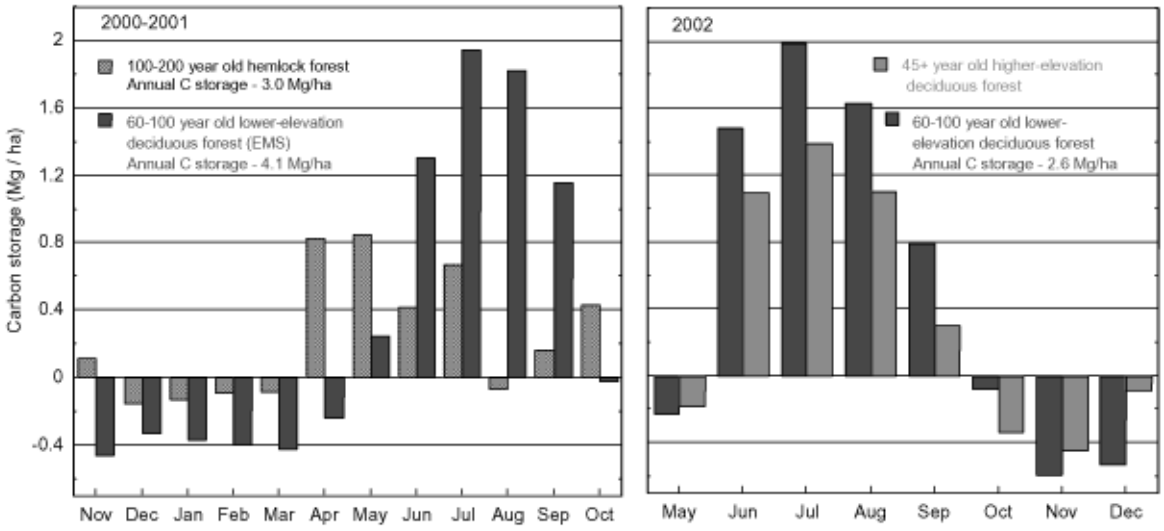
During the past year Julian Hadley and Paul Kuzeja used an eddy flux system similar to that at the HFEMS to complete the first full year of carbon exchange measurements on Little Prospect Hill (LPH), in a red oak and red maple forest that developed after an intense fire in 1957. This site is higher, drier, and supports a much younger forest than the area around the HFEMS tower site. Measurements

at both sites (as well as measurements from the old-growth hemlock stand reported on in last year's annual report) are designed to assess the variation in carbon exchange among different forest types as it relates to forest characteristics as well as climatic variation and change. These issues are important as New England's forests affect global carbon exchange, atmospheric CO_2 concentrations, and the greenhouse effect resulting from globally rising atmospheric CO_2.

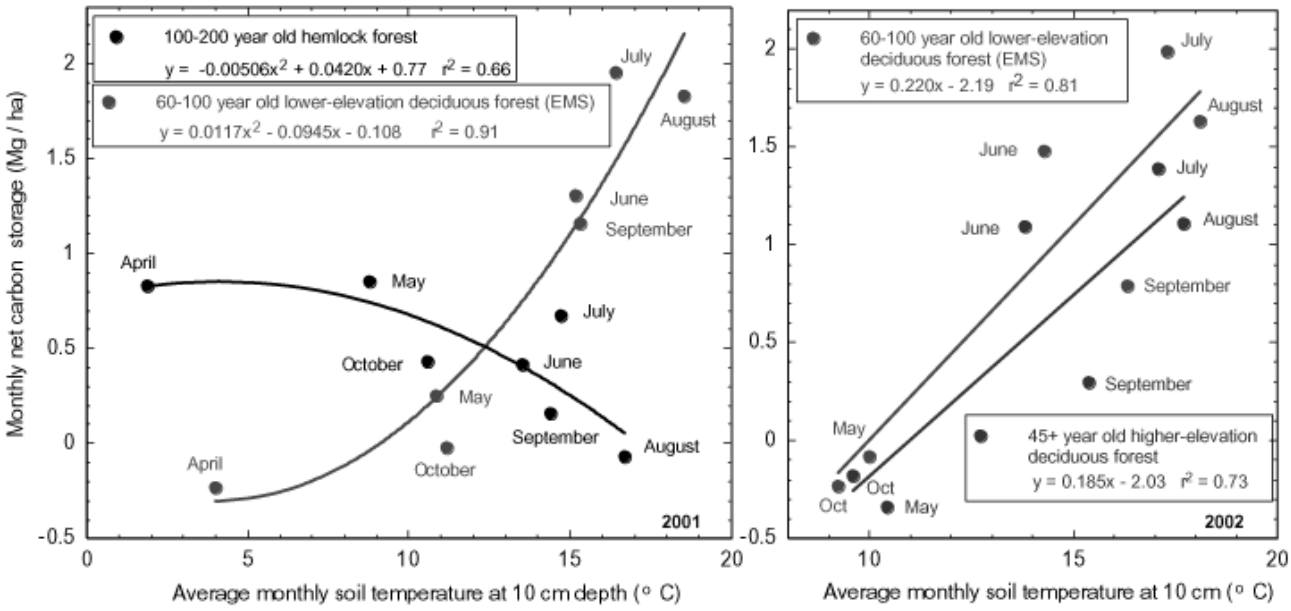
For the months of May through December 2002 for which we have analyzed the data, net carbon exchange followed a similar pattern to the older and lower oak-maple forest near the HFEMS tower, but total carbon storage was lower on Little Prospect Hill. However, the pattern of carbon storage differs strikingly between the hardwood forests and the old-growth hemlock forest. Whereas carbon storage in the hemlock stand fell sharply between May and August, it rose during that period to its highest levels of the year at the HFEMS. Considering the months of May through October, the period when deciduous trees have photosynthetically active foliage, the two deciduous forest sites showed a positive relationship between monthly average soil temperature and carbon storage. In contrast, in the old-growth hemlock forest, monthly carbon storage declined with increasing soil temperature. Because monthly average soil temperature is closely linked to monthly average air temperature (although less variable), the results suggest that carbon storage in oak-maple forests may actually be enhanced by warmer summers. At least, carbon storage in oak-maple forests is unlikely to decline sharply in warm summers, as will probably occur in old hemlock forests.

Chris Graham and Julian Hadley using a Scholander pressure chamber to measure leaf water potentials after a carbon dioxide exchange measurement

Preparing a black birch leaf for water potential measurement



Net monthly carbon exchange of two different forests measured by eddy covariance, compared to the 60–100-year-old forest around the Harvard Forest Environmental Measurement Site (ftp://ftp.as.harvard.edu/pub/nigec/HU_Wofsy/hf_data.) **Left:** an old eastern hemlock forest; **Right:** a younger, deciduous forest on a dry site that developed after a forest fire in 1957. Both deciduous forest sites are dominated by red oak and red maple.



Left: Relationship between monthly average soil temperature and monthly net carbon exchange during April through October in the hemlock forest and the 60–100-year-old deciduous forest around the HFEMS. **Right:** The same relationship for the two deciduous forests during May through October 2002.

Analytical Web – Collaboration between Ecologists and Computer Scientists

In order to develop the values for carbon exchange from the eddy flux towers, researchers combine many thousands of measurements and estimates through a complex series of computations. Documenting such analyses in order to preserve the methodology and to provide a means of replicating the procedure is a major, though generally underappreciated, challenge in ecological science. In 2002 Harvard Forest scientists joined with colleagues in the Department of Computer Sciences at the University of Massachusetts to develop tools for capturing and facilitating sequences of complex data transformations. Working with new computer software developed at UMass we have begun to record the models and data through a process and product referred to as the "Analytic Web." Using the Analytic Web, other scientists will be able to precisely replicate the process of model development, and to quickly and easily test the effects of changes in input data or in the structure of models that convert raw data into higher-level information such as regional forest carbon exchange estimates. Carbon exchange modeling is but one of numerous potential uses of the Analytic Web, since most scientific studies involve sequences of data manipulation and analysis. The National Science Foundation's Information Technology Research (ITR) program is supporting the Analytic Web project, including data collection and carbon exchange modeling work at the Harvard Forest, and computer software development at the University of Massachusetts.

Soil Warming Experiments

During the past year we activated our latest warming experiment in the Slab City Tract of the Harvard Forest – *The Barre Woods Megaplot*. This long-term experiment funded by the National Institute for Global Environmental Change (NIGEC) and LTER is designed to analyze some of the consequences of global climate change on the soil environment. After twelve years of warming the soil in the Prospect Hill tract, we have expanded the scope of our experiment from a replicated set of 6 x 6m plots to a pair of 30 x 30m plots – one heated and one control. At this new site, we are exploring the possible fates of increased carbon and nitrogen moving through the northern hardwood forest system and potentially into the atmosphere. The past decade plus of warming on Prospect Hill suggests that both the carbon and nitrogen cycles are stimulated by warming, but that these effects are transient. With our new experiment, we hope to answer the question: Does the forest make use of the additional nitrogen mobilized in the system and store more carbon as a result?

Heidi Lux

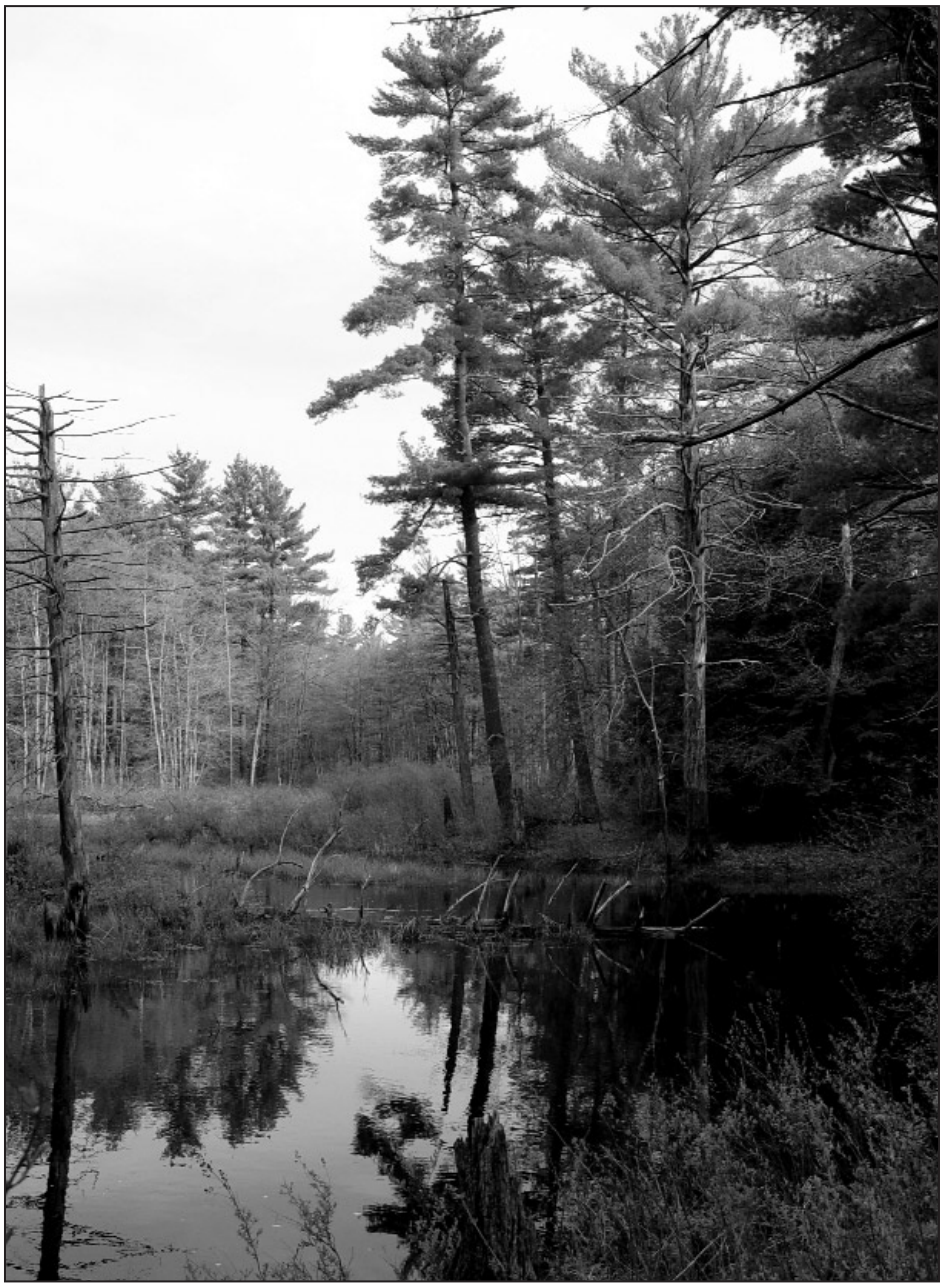
Mapping and experimental installation took place in 2001, and a year of baseline measurements of soil nutrient dynamics and tree growth began in the spring of 2002. Heating began in May of 2003 and sampling continues. Early soil respiration measurements reveal similar increases due to heating to what we observed on Prospect Hill.

Jerry Melillo and Paul Steudler presented preliminary data from the new experiment as well as results from our twelve-year study at meetings of the Ecological Society of America and the American Geophysical Union in 2002, and at the annual Harvard Forest Symposium in 2003. In December of 2002, we published a paper in *Science,* "Soil Warming and Carbon-Cycle Feedbacks to the Climate System" (Melillo *et al.,* 2002), presenting a synthesis of our work at the Prospect Hill Soil Warming Site. In the summer of 2002, REU student Nicole Nowinski, from Carleton College, worked with us on a nitrogen budget for the new site. Margaret Graham, from Dartmouth College, is working with the group for the summer of 2003.

Long-term Climate Change – Signals for the Little Ice Age in New England?

The "Little Ice Age," ca. A.D. 1450 to 1850, was an apparently global climatic period characterized in the Northern Hemisphere by highly variable conditions, frequent long winters, and short, cool summers. In northwestern Europe environmental signals of this period are recorded in glacial activity, coastal sediments, tree rings, and historical documents, which indicate a period of cool and variable weather including shorter growing seasons and increased storminess. More recently, glacial, tree ring, lake level, and historical data indicate coincident changes in terrestrial and aquatic ecosystems in North America.

The low-resolution and poor temporal control of most pollen and stratigraphic data has restricted reconstructions of subtle paleoclimatic changes in New England. Furthermore, the end of the "Little Ice Age" coincides with the period of European settlement and broad-scale deforestation, which lead to major changes in pollen abundances. However, some studies suggest that significant environmental and vegetation changes occurred prior to settlement. For example, our recent studies of the southern New England landscape determined that the major



Outflow from Harvard Pond

changes since European settlement, including the decline in beech and hemlock and the regional homogenization of vegetation composition, were actually initiated some 300–500 years before European arrival.

In the current study, we combine pollen data from many new sites and the Harvard Forest archives with detailed historical land-use and land cover maps to analyze vegetation and environmental change in Massachusetts over the past 2,000 years. Massachusetts is a particularly good study region because it was colonized early, is covered by unique historical records, and embraces a wide range of vegetation, environments, and cultural conditions. We analyzed records from over twenty ponds arrayed across the state's gradients in physiography, climate, geology, and natural disturbance. Chronological control was provided through lead-210 and radiocarbon dating and sediments were sampled at high-resolution intervals. Small (<10 ha) and primarily spring-fed kettle lakes were selected to emphasize the local to subregional vegetation signal. Historical data include archaeological information and pre-settlement vegetation derived from witness trees records in early land surveys.

Preliminary results suggest that the effects of the "Little Ice Age" varied geographically, with the magnitude and nature of vegetation changes differing by vegetation type and ecoregion. A decrease in beech and hemlock is most evident in high-elevation sites, while low-elevation sites of oak-hardwood forest composition show relatively little change during the past 1,000 years. In many cases, changes in forest composition dynamics are accompanied by coincident changes in aquatic vegetation and percent organic matter, presumably reflecting changes in water balance and lake levels.

Integrated Hemlock Studies

At the Harvard Forest, we are anticipating witnessing the disassembly and reassembly of our hemlock forests as the hemlock woolly adelgid continues its relentless northward march. This year, we found the adelgid for the first time in the hemlock stand on Prospect Hill as well as on scattered trees around Shaler Hall. A major research thrust focused on the biological, hydrological, and physical changes associated with the loss of hemlock and its replacement by birch has begun with support from NSF (to Dave Orwig and David Foster) and from the Harvard

Prospect Hill hemlock forest

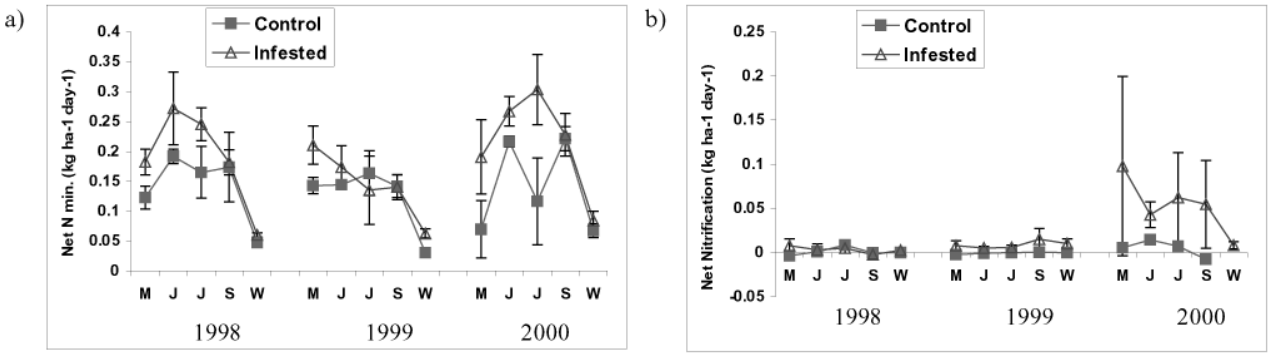
University Center for the Environment (to a large group of scientists from the Department of Organismic and Evolutionary Biology, Earth and Planetary Sciences, Kennedy School of Government, and the Harvard Forest).

Various studies led by Dave Orwig are investigating the various impacts of the introduced hemlock woolly adelgid on New England forests. This effort expanded with new NSF funding in 2003 supporting two new research assistants, Sultana Jefts and Laura Pustell. This summer Dave, Sultana, and summer student David Franklin continued to sample permanent plots established at eight sites in Connecticut during 1997 to examine the effect of hemlock decline and mortality on the timing and extent of changes in the nitrogen cycle. After several years of HWA infestation, tree crowns continue to deteriorate, allowing more light to reach the forest floor. In addition, infested stands have lower surface soil moisture levels, higher soil temperatures, and higher net nitrogen mineralization and net nitrification rates than uninfested stands or stands with low damage. Resin bags

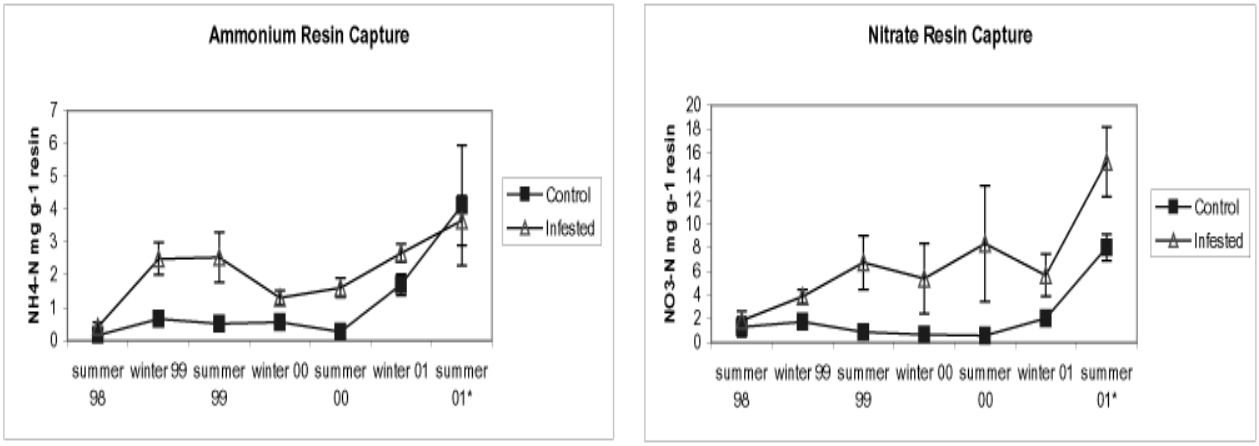
buried in the soil at damaged sites also captured higher amounts of ammonium and nitrate than at uninfested stands, indicating that nitrogen is becoming more available as a result of the microenvironmental changes associated with HWA damage. We will continue to sample these stands to examine the long-term changes in N cycling associated with hemlock deterioration and eventual replacement by hardwood species such as black birch and oak. Local high school student Leann Barnes, assisted with many of the laboratory activities associated with these labor-intensive studies.

Dave, Sultana, and Audrey Barker Plotkin continued to collect baseline information on soil nitrogen cycling and microenvironments in the Prospect Hill long-term hemlock grid in anticipation of the arrival of HWA. The many past research projects and the rich data that exist for this site provide an unusual opportunity to document the current and future forest changes with the detailed knowledge of past forest dynamics.

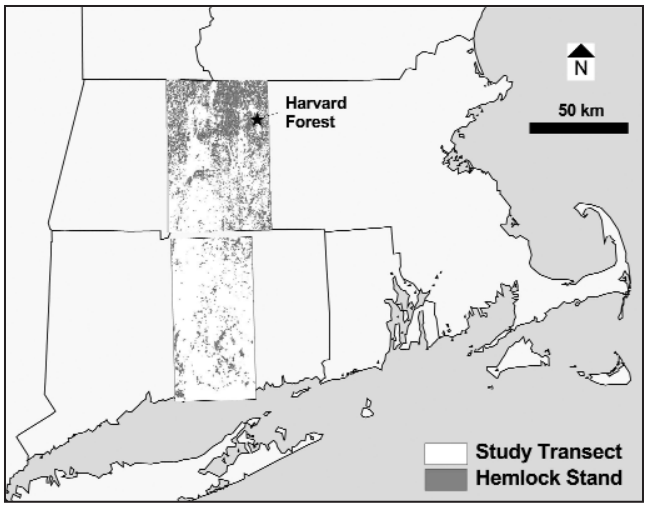
Over the last four years we have been interested in changes in decomposition associated with the decline of hemlock due to HWA, because these may be closely linked to observed changes in nitrogen cycling. Under the direction of Richard Cobb, we have studied three potential drivers of decomposition associated with HWA arrival and the decline of hemlock: (1) changes in the chemistry in leaf litter; (2) changes in microclimate; and (3) hemlock replacement by black birch. Foliar carbon and lignin did not appear to be affected by HWA infestation, but foliar nitrogen (% N) was higher in infested stands. In turn, this increased the rate of N immobilization in decomposing foliage, likely leading to the increased N availability mentioned above. Microclimatic changes, involving increased light and temperature led to more rapid sub-surface decomposition and initially slower decomposition on the forest floor. Finally, results after six months show that black birch litter decomposed more rapidly than hemlock or mixed litter. We will continue this study for another year to



Soils in infested hemlock sites in Connecticut typically had higher net n-mineralization rates than control stands (a), and as stands continued to deteriorate, higher net nitrification rates (b).



Resin bags incubated in soils captured higher amounts of ammonium and nitrate in infested versus control hemlock stands, indicating greater N availability.



Transect through southern New England for the study of hemlock woolly adelgid. The extent of hemlock forest increases dramatically in Massachusetts.

examine longer-term dynamics as these substrates break down over time.

A new project was initiated by Dave, Laura Pustell, and summer student Amanda Park to examine the vegetation and ecosystem consequences of hemlock removal by logging, the primary management response to the HWA. Permanent plots are being established in logged hemlock sites in Massachusetts to compare the vegetation, microenvironment, and nitrogen cycling responses to those triggered by HWA infestations.

As a expansion of a large-scale project examining HWA distribution in Connecticut, Dave Orwig and summer students Nick Povak and Don Niebyl have begun sampling hemlock stands across Massachusetts. We have now mapped the distribution of hemlock stands in a broad transect across Connecticut and Massachusetts (*see map*). During the summers of 2002–3, we sampled over seventy of these stands in Massachusetts and collected information on forest structure and composition, crown vigor, site characteristics, presence of HWA, and the extent and spatial patterns of damage generated by this insect since its arrival in 1989. Almost 50% of stands sampled had HWA, although overstory hemlock mortality remained low. This information will be incorporated into a GIS analysis of landscape-level, biological, edaphic, and historical factors that control the damage patterns observed in hemlock. Summer student Joe Brown, under the direction Dr. Scott Costa from the University of Vermont, visited many of the Massachusetts sites and conducted detailed sampling of hemlock branches to provide accurate estimates of HWA densities and to help develop a protocol for sampling HWA populations.

Bernhard Stadler initiated an experiment with David Orwig and Richard Cobb to study the effects of trophic interactions between HWA and epiphytic bacteria on the spatial and temporal variability in energy and nutrient flow through the hemlock canopy at sites varying in HWA infestation level. Uninfested hemlock showed a significant decline in canopy foliar biomass from the center of a tree to the periphery. In contrast infested trees, had significantly less canopy biomass, exhibited no trend in canopy biomass, and produced less new foliage. Infested trees had significantly higher foliar % N, with N highest in young foliage where HWA was at the highest density. Epiphytic microorganisms showed little difference in abundance on needles growing in different parts of the canopy, but bacteria, yeasts, and filamentous fungi thrived on medium and heavily infested compared to uninfested trees. The amount of rain collected in throughfall varied spatially beneath unin-

Dead hemlock trees on Mt. Tom

Audrey Barker Plotkin

fested trees, with most throughfall passing in the periphery of the canopy and least close to the trunk. No gradient occurred beneath infested trees, through which relatively more precipitation was percolating. Throughfall chemistry was strongly affected by HWA infestation, as higher concentrations of different nitrogenous compounds and carbon as well as different ion species were leaching from infested canopies to the forest floor. We intend to continue these investigations in the future to help identify and understand the chain of mechanisms that lead to changes in decomposition and nutrient availability as forests respond to invasive pests.

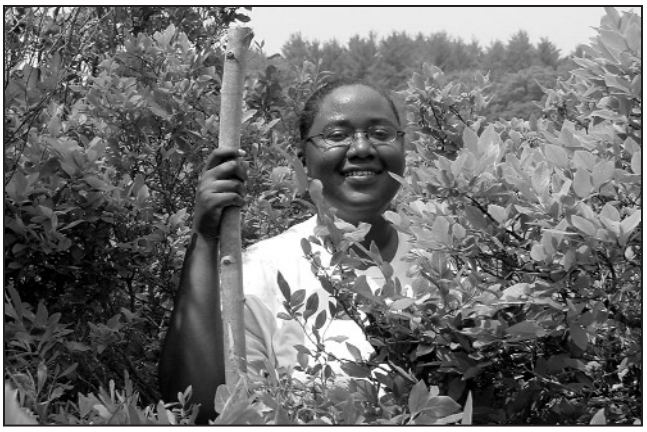
In a related effort last summer, student Jackie Guzman and Audrey Barker Plotkin studied seedling bank dynamics of eastern hemlock at two contrasting sites in the Forest. The study sought to document the age structure of the hemlock seedling bank, compare growth rates between sites, and determine whether recruitment into the seedling bank is episodic or continuous. Seventy seedlings less than 4.5 feet in height were collected in both an old hemlock forest and a 50-year-old mixed hardwood forest. Height, basal diameter, and age were determined for each seedling. Average ages differed between sites: thirty years old in the hemlock stand and fourteen years old in the hardwood forest. The oldest individual was forty-six years old. Both sites displayed an exponential growth rate, suggesting that seedlings slowly and continuously grow into larger size classes. Analysis of age structure indicates that recruitment into the seedling bank is continual but episodic. These results suggest that hemlocks use a seedling bank as a regeneration strategy and that further study of hemlock seedling bank dynamics might aid future restoration projects.

Long-term, Large-scale Hemlock Experiment

To complement Dave's regional studies David Foster, Aaron Ellison, and Audrey Barker Plotkin have established a set of eight, 90 x 90m experimental plots in the Simes Tract in southern Petersham. Six of these plots are dominated by hemlock; two plots will be logged (a typical treatment for many hemlock stands across the region); all the hemlocks in another two plots will be girdled (to simulate some aspects of adelgid infestation, including generation of coarse woody debris); and the remaining two plots will serve as controls. Two additional plots already support mature hardwood forests and thereby represent post-adelgid "controls." We plan to collect pre-treatment (and pre-adelgid) baseline data for two summers before we log or girdle the plots. During the summer of 2003, Eric Davidson and Kathleen Savage from the Woods Hole Research Center began to measure soil respiration in the plots; Dave Orwig and his team began studies of litter decomposition and nutrient fluxes; and Aaron Ellison and two REU students, Jonathan Chen and Matt Lau, inventoried the diversity and structure of ant communities in the hemlock and hardwood stands.

Hydrological Studies

We received funding from NSF and Harvard University to begin long-term hydrological measure-



Alana Belcon

ments on two small headwater streams in the Prospect Hill Tract. The first stream drains the Black Gum Swamp and adjacent woodlands and flows near Shaler Hall on its way to Nelson Brook, the Millers River, and ultimately the Connecticut River. The second stream drains the steep valley to the west of Prospect Hill and flows through the wetland north of the HFEMS Tower on its way to Bigelow Brook, the Swift River, the Chicopee River, and the Connecticut River. Separating the two streams in the middle of the Prospect Hill Tract is the watershed boundary between the Millers River and Chicopee River basins.

Permanent weirs are planned for each stream, whose watersheds, though adjacent and comparable in size, differ significantly in topography, soils, hydrology, land-use history, stream biota, and forest vegetation (including the abundance of hemlock).

Debarat Perez-Rivera

Field work in Tom Swamp

Each station will be provided with electricity and a communications link to Shaler Hall. Heating cables and hoods will be used to prevent ice buildup at the instrumented sites in winter. Measurements, including surface discharge and water temperature, will be posted on the Harvard Forest Web page in near-real time and submitted monthly to the LTER Network HydroDB database. Piezometers and soil moisture sensors will be deployed above the weirs to measure soil moisture and subsurface water flow.

Botanical Studies

Comparative studies of the biology of palms have emphasized the distinctiveness of those with a climbing habit, most familiar in the rattans, the source of canes used widely in the furniture industry. Continuing with this research, an earlier analysis by Martin Zimmermann was resurrected, completed, and published, dealing with the South American genus *Desmoncus,* a rattan analogue. It demonstrates the considerable structural constraints on axial and appendicular water supply. This research is the structural compliment to extensive field research by graduate student Alex Cobb, working in Malaysia and Queensland.

Having demonstrated unusual cytological properties of tension fibers in the tropical genus *Gnetum,* further research is aimed at establishing if these properties extend to the tension wood fibers of dicotyledons. These cells demonstrate remarkable dynamic aspects of anatomy in woody plants that are of concern to the timber industry. The cells develop tensions that can re-erect bent stems in trees.

Additional research, in part using the collections

of the Arnold Arboretum, has centered on the distinctive cone morphology of the "taxads," a group of conifers, most familiarly represented by *Taxus,* all of which have fleshy animal dispersed seeds. Clearly the reproductive anatomy of these conifers represents considerable reduction so that the presumed ancestral coniferous cone is difficult to discern. The genus *Torreya,* which includes several threatened species, in particular has been very incompletely analyzed. A review of conifers overall demonstrates the diversity of reproductive mechanisms in a lineage often overlooked because of their constant wind-pollination.

Other research with Dr. Usher Posluszny at the University of Guelph, Ontario, Canada has demonstrated first, that flowers of the New Caledonian genus *Amborella,* considered to be the basal-most lineage of flowering plants has, in fact, a floral morphology that can scarcely be seen as "ancestral" to other flowering plants. Secondly, attention has been drawn to establishment growth in seedlings of seagrasses (marine angiosperms) as an important biological phase that has remained unexplored by morphologists and ecologists. How do the seeds of such plants become established in shallow but tidal environments, amidst shifting sediments? The axis in one example (*Zostera*) seems to act like a kedge anchor.

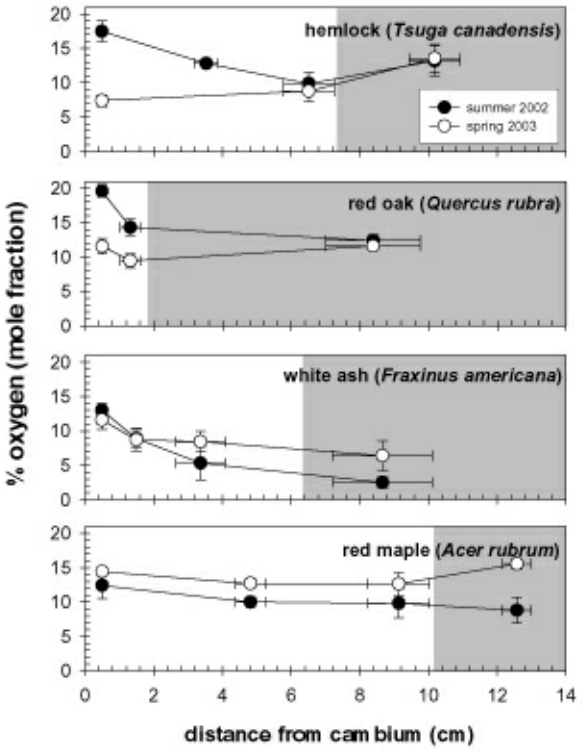
Xylem Physiology of Forest Trees

N. Michele Holbrook of the Department of Organismic and Evolutionary Biology (OEB) and members of her lab are continuing studies of the structure and function of trees, with an emphasis on water flow through the xylem. Cavitation sets a hydrodynamic limit to water transport and thus is a critical process affecting tree function. Studies underway this year address the link between xylem structure and vulnerability to cavitation, from the level of single bordered pits to the hydraulic architecture of whole trees. A project led by Maciej Zwieniecki and Brendan Choat focuses on the biophysics of cavitation and repair. This work involves detailed studies of water flow through stems in response to increasing xylem tension. Summer REU students Nora Lahr and Chris Petit are conducting independent projects related to xylem function. Nora's project investigates how the cavitation thresholds of individual xylem vessels vary as a function of age and position within large sugar maple trees; meanwhile Chris is comparing water flow through healthy and adelgid-infected hemlock branches to test the hypothesis that hemlock wooly adelgid infection reduces the water transport capacity of the xylem. A second major line of work focuses on the ability of changes in xylem sap ion concentrations to alter xylem hydraulic resistance through their effect on the pectin hydrogels in pit membranes. Studies ongoing this year are designed to test the hypothesis that recirculation of K^+ ions from phloem to xylem may allow plants to dynamically affect their hydraulic architecture, providing plants with a mechanism to enhance water movement to the most productive branches.

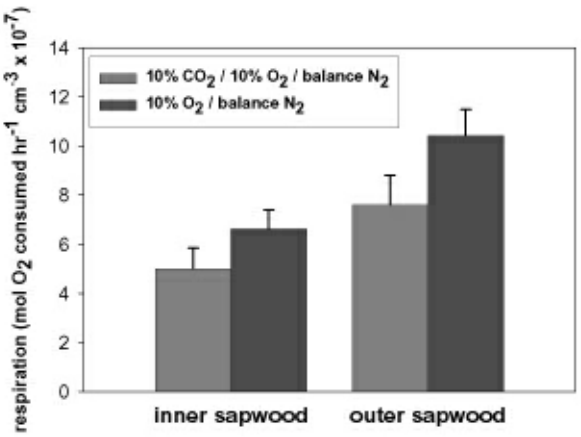
Brady Hardiman using the canopy lift (aka Bucky) to take leaf measurements

Rachel Spicer, a Ph.D. student in OEB, has been studying the process of sapwood senescence that leads to heartwood formation in forest trees. A major question in sapwood physiology is how the living cells within woody stems are supplied with oxygen. The respiration of these cells is an important determinant of total stem respiration. In order to test whether internal stem conditions are ever limiting to these cells, Rachel has been measuring oxygen concentrations at different radial depths within stems. She is also measuring rates of sapwood respiration under different O_2 and CO_2 environments, and comparing this response across different ages of sapwood. Results suggest that heartwood formation is unlikely to be driven by anoxia, or oxygen deprivation, both because oxygen contents in the oldest sapwood rarely get that low, and because respiration remains unaffected by decreasing oxygen down to about 2%. Summer REU student Teresa Abbott is working with Rachel to determine how CO_2 concentrations influence sapwood respiration.

A NSF and U.S. Depatment of Agriculture



Oxygen contents within stems at different radial depths, measured in spring and summer.



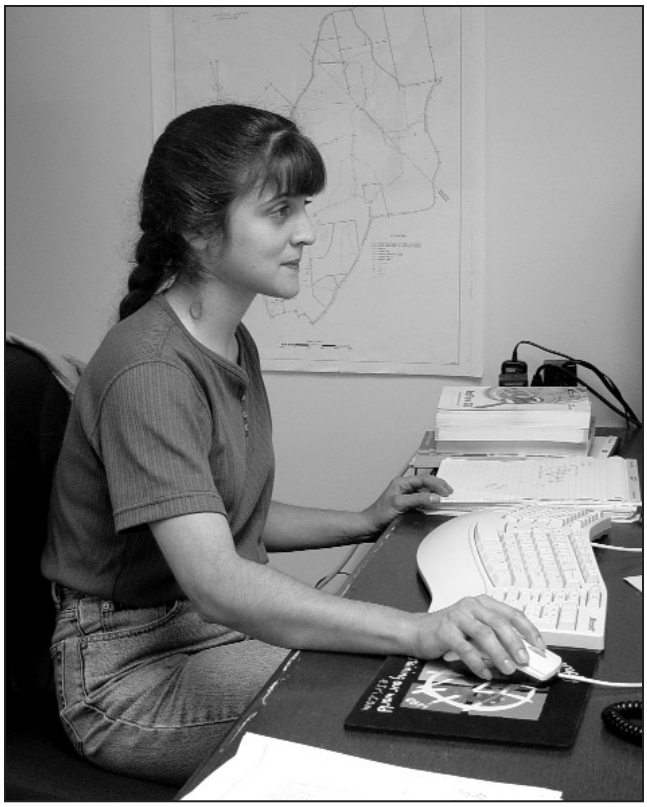
The effect of high CO_2, which is known to be elevated within stems, on parenchyma cell respiration in white pine (*Pinus strobus*) sapwood. Inner sapwood is about ten years older than outer sapwood.

(USDA) supported workshop on "Long Distance Transport Processes in Plants" was held at the Harvard Forest during October 2002. Organized by Missy Holbrook and Maciej Zwieniecki, this three day work shop was attended by over seventy participants from more than ten countries. Proceedings from the workshop will be published by Academic Press as part of their Physiological Ecology series.

Harvard Forest Tract Maps

Since 1908, researchers at Harvard Forest have mapped and conducted inventories of the forests on its three largest tracts approximately every 10 to 20 years. Features such as soils, elevation, damage from the 1938 hurricane, and silvicultural treatments were mapped. Over the past several months, Brian and Julie Hall have been involved in digitizing these maps in a standardized and readily usable format. These data will be useful in the selection and description of study sites and will be important in documenting the influence of past forest management activities and environmental conditions on Harvard Forest properties.

Brian Hall



Julie Hall

1830 Map Series

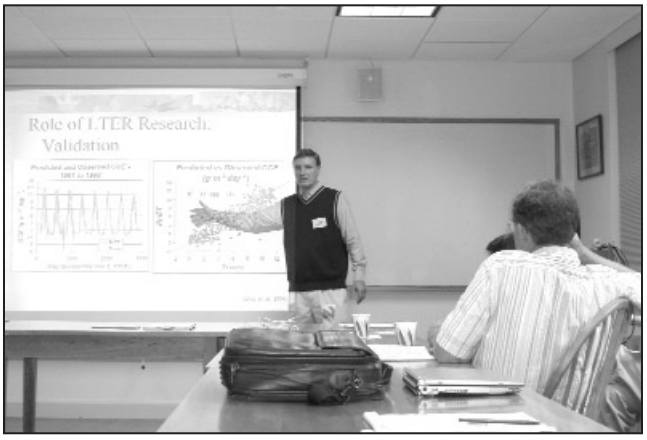
We have finished digitizing and compiling the 1830 map series, which documents the landcover and cultural features in Massachusetts near the peak of agricultural land use. Features shown include forests, roads, and major buildings (including forest-related types such as sawmills and tanneries). These data have been widely distributed to research and conservation groups and have been incorporated into the state-wide conservation plans by the Commonwealth of Massachusetts.

Both the 1830 and Harvard Forest Tract datalayers will be available for viewing and downloading from the Harvard Forest Web site.

Harvard Forest LTER Program

The Harvard Forest is one of twenty-four sites in the Long Term Ecological Research (LTER) program sponsored by the National Science Foundation. Each site addresses questions of a long-term nature; collectively the sites undertake comparative studies across ecosystems. Representatives from each site and NSF meet twice annually to coordinate network-wide activities and to collaborate. The central theme of the Harvard Forest LTER is interpretation of the structure, composition, and function of forest ecosystems in terms of their history of natural and human disturbance and environmental change. This research is being addressed at the stand, landscape, sub-region (e.g., Central Massachusetts), and regional (New England) scale.

The research program involves soil scientists, atmospheric chemists, and ecologists studying physiological, population, community and ecosystem processes. Investigators represent the Department of Biology (F. Bazzaz, K. Donohue), Earth and Planetary Sciences (S. Wofsy, B. Munger), and Harvard Forest (D. R. Foster, D. Kittredge, G. Motzkin, D. Orwig, A. Ellison, B. Colburn, E. Boose, J. Pallant) at Harvard University as well as the Marine Biolbogical Laboratory (MBL)-Ecosystems Center (J. Melillo, P. Steudler), University of New Hampshire (J. Aber, A. Magill, S. Ollinger. S. Frey), University of Massachusetts (M. Mulholland, E. Chilton), and Brandeis University (B. Donahue). Emery Boose is the LTER Data Manager with assistance from Julie Pallant. The research is organized to maximize the interactions among scientists from different disciplines. Four major scientific approaches include: (1) retrospective studies of historical changes in the environment and ecosystems; (2) long-term and intensive measurements of forest and plant structure, function, and dynamics; (3) experimental manipulations; and (4) synthesis and modeling. The Harvard Forest Ecology Symposium is held to present current research of the LTER and National Institute for Global Environmental Change (NIGEC) programs, with abstracts published annu-



John Aber provides an overview to the LTER visiting committee

ally. Each year, in addition to results generated by Harvard Forest researchers, we highlight studies by our collaborators in the HF LTER Symposium program that underscore the value of long-term studies.

National Institute for Global Environmental Change

Harvard University is the Northeastern Regional Center for the NIGEC program sponsored by the Department of Energy. NIGEC research seeks to improve the understanding of mechanisms of global environmental change, to develop experimental and observational programs that enhance the understanding of ecosystem and regional scale processes contributing to global change, and to provide educational opportunities in global environmental change research. The Center is administered by the Division of Applied Sciences at Harvard and most of the field studies are conducted at the Harvard Forest. Researchers include many of the LTER scientists in addition to faculty from the State University of New York (D. Fitzjarrald), Woods Hole Research Center (E. Davidson), University of California (S. Trumbore), U.S. Geological Survey (E. Sundquist), and Harvard Forest (J. Hadley).

David Foster outlines research to the LTER visiting committee

HARVARD FOREST ECOLOGY SYMPOSIUM 2003 (*denotes summer student)

J. Aitkenhead-Peterson et al. Dissolved Organic Carbon and Nitrogen in a Hardwood Forest Floor.
M. Albani and P. Moorcroft. Modeling the Impact of Hemlock Loss on New England Forests.
D. Barnes et al. Greenhouse and Ozone-Depleting Gases in Rural New England.
S. Barry, D. R. Foster and B. Hall. The Little Ice Age in New England.
W. Borken et al. Experimental Drought Effects on Soil Respiration in a Temperate Forest Soil.
P. J. Burton, C. M. Burton et al. Vegetation in a Forest 20 Years After Creation of Small Forest Gaps.
R. Cobb et al. Hemlock Woolly Adelgid Effects on Foliage and Decomposition.
E. A. Colburn. Vernal Pools in the New England Landscape.
E. A. Colburn and H. Jensen-Herrin. Monitoring Freshwater Macroinvertebrates on Cape Cod.
E. A. Colburn and D. A. Orwig. Effects of Hemlock Decline on Forest Stream Communities.
E. A. Colburn, J. Choiniere et al. Headwater Habitat Streams in Central Massachusetts.
B. Dail et al. Results from a Wet NH_4NO_3 Canopy Fertilization in a Maine Spruce-Hemlock Forest.
K. Donohue, S. Takao et al.* QTL Analysis of Parental Effects on Dormancy in Arabidopsis thaliana.
K. Donohue, N. Wender et al.* Genetic Architecture and Dispersal Plasticity in Arabidopsis thaliana.
A. M. Ellison and N. J. Gotelli. Effects of Nutrient Stress on a Co-evolved Food Web.
A. M. Ellison et al.. Biology of Loss and Replacement of a Core Species.
P. Franks, M. Zwieniecki, and N. M. Holbrook. The Regulation of Transpiration Rate in Plants.
S. D. Frey and M. Knorr. Nitrogen and the Structure and Function of the Soil Microbial Community.
J. Gaudinski et al. The Importance of Belowground Plant Allocation for Soil Carbon Sequestration.
J. Hadley. Carbon Exchange in a 55-Year-Old Oak-Maple Forest on a Dry Upland Site in 2002.
B. Hall, G. Motzkin, D. R. Foster, M. Syfert, and J. Burk. 300 Years of Forest Change in Massachusetts.
L. Hutyra, Santoni, S. Pears* et al.* Carbon Cycling at the Harvard Forest, a Bottom-up Approach.
A. E. Ingerson. Using History for Land Management in New England.
D. B. Kittredge, D. R. Foster, J. Burk and G. Motzkin. Logging as Disturbance in Massachusetts.
D. Köste, et al. Paleolimnological Assessment of Human-Induced Impacts on Walden Pond.
X. Lee, H. Wu, J. Sigler, and C. Oishi. Rapid and Transient Response of Soil Respiration to Rain.
W. Liu et al. Respiration of Coarse Woody Debris in Central Hardwood Stands.
P. J. Melcher et al. Vulnerability of Xylem Vessels to Cavitation in Acer saccharum (Marsh).
J. M Melillo, H. Lux et al. Soil Warming: The Fist Decade and the Megaplot Experiment.
G. Motzkin, D. A. Orwig and D. R. Foster. Vegetation and Disturbance in Ridgetop Pine Communities.
G. Motzkin et al. Conservation of Uncommon Plant Communities: the Northeastern Coastal Region.
J. W. Munger, J. Budney, and S. C. Wofsy. Air Quality at the Harvard Forest: Pollution Events in 2002.
K. L. Musgrove and E. A. Colburn.* Distribution of Malacostracan Crustaceans in Vernal Pools.
J. O'Keefe. Woody Species Phenology, Prospect Hill Tract, Harvard Forest – 2002.
S. V. Ollinger and J. D. Aber. Effects of Multiple Environmental Changes on Forest Carbon Exchange.
D. Orwig and D. R. Foster. Landscape-Level Analyses of Hemlock Woolly Adelgid Outbreaks.
D. Orwig, R. Cobb, M. Kizlinski, and D.R. Foster. Ecosystem effects of Hemlock Woolly Adelgid.
S. Parnes. Distribution and Abundance of hemlock and white pine since 1733 in Petersham.
N. Pederson et al. Relation between Eddy-Flux Measurements and Tree-Ring Estimates of Growth.
J. G. Quijano and A. P. Barros. Incorporating Vegetation Dynamics into a Hydrological Model.
L. Sack, P. D. Cowan, N. Jaikumar, and N. M. Holbrook. The 'Hydrology' of Leaves.
J. Sigler et al. Emission and Long-Range Transport of Mercury from a Boreal Fire.
T. W. Sipe. Responses by Herbs and Seedlings to Enriched Carbon Dioxide and Irradiance Regimes.
R. Spicer. Heartwood Formation and Patterns of Cell Death in Woody Stems.
B. Stadler et al. Adelgid impact on Throughfall Chemistry and Microorganism Abundance.
K. A. Stinson. Does Selection on Ecophysiological Traits Facilitate Invasion of Alliaria petiolata?
S. Urbanski et al. Carbon Sequestration at Harvard Forest in 2001. A Banner Year?
B. Von Holle et al. Disturbance Histories as a Predictor of Habitat Invasibility in a Mosaic Landscape.

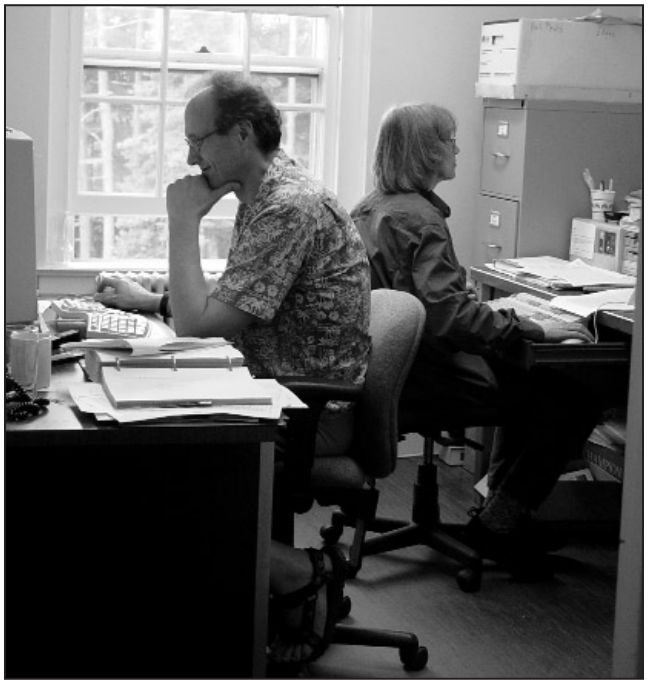
BULLARD FELLOWS

Philip Burton (Symbios Research, Smithers, B.C., Canada), with assistance from his wife, Carla, resampled fifteen experimental canopy gaps (30 m^2 to 720 m^2) on the Prospect Hill Tract. This silvicultural experiment was initiated in 1982 by David Hibbs, and had been sampled previously by Tim Sipe in 1984. Twenty years after logging most gaps were dominated by red maple and red oak stump sprouts and by black birch seedlings. Tree populations had undergone considerable self-thinning from the densities encountered two growing seasons after logging. Many trees greater than 10 m tall were found in the larger gaps, while the understory vegetation was now largely similar to that in the undisturbed forest.

Phil completed editorial work on a book entitled *Towards Sustainable Management of the Boreal Forest*. Forthcoming from NRC Research Press in September 2003, the volume summarizes the first seven years of research conducted under the auspices of Canada's Sustainable Forest Management Network. He also completed a paper on a theory of forest stand edge effects, and book chapters on landscape ecology, conservation biology, and forest restoration in British Columbia. Phil was an active participant in the Harvard Forest Lab Group and Fakhri Bazzaz's lab discussions in Cambridge. During one of the snowiest winters in recent years, the Canadians often broke trail for cross-country skiing enthusiasts at the Forest.

Betsy Colburn (Harvard Forest) analyzed habitat characteristics of Cape Cod wetlands with regards to populations of a rare, northern caddisfly, *Phanocelia canadensis,* a species associated with *Sphagnum*-dominated sites. Betsy sampled *Sphagnum* wetlands elsewhere in Massachusetts in search of other populations of this caddisfly, worked with Emery Boose on planning for installation of permanent weirs on two Harvard Forest streams, initiated research on headwater habitat streams in central Massachusetts, and with colleagues from Wachusett Meadow Wildlife Sanctuary, Mount Wachusett State Reservation, and Antioch/New England Graduate School, mapped eighteen intermittent headwater streams, assessed in-stream habitat, and started biological sampling for salamanders and aquatic invertebrates. She analyzed vernal pool samples from across the state with two summer students in 2002. REU student Kate Musgrove presented a poster at the North American Benthological Society meeting, examining crustacean distributions in vernal pools.

Betsy initiated studies of streams in hemlock- and hardwood-dominated watersheds as baseline for long-term evaluation of the effects of hemlock decline on stream ecology. She participated in discussions with several agencies and interested private parties on how restoration of tidal flow into Pilgrim Lake/East Harbor, Truro, might affect nuisance midge outbreaks from the lake. A long-term monitoring protocol for freshwater macroinvertebrates in lakes, ponds, and vernal pool wetlands in the Cape Cod National Seashore was initiated. With Holly Jensen-Herrin, research assistant, literature reviews were carried out; gradients of chemistry, physical variables, limnological status, and historic land use were evaluated; and preliminary field sampling to evaluate sampling methods and identify appropriate biological indices for long-term monitoring was conducted, and analysis of samples initiated.



Phil and Carla Burton

Betsy conducted public workshops on vernal pools (Cape Cod); intermittent stream hydrology, biology, and sampling (central Massachusetts); and the connections between groundwater, vernal pools, freshwater wetlands, and kettle ponds (Cape Cod). She presented a paper on "History as a habitat variable for aquatic systems" in plenary session of New England Association of Environmental Biologists'

Annual Meeting in Westminster, Mass., and served on the Masters Thesis committee for Salvatore Beatini, Worcester Polytechnic Institute. She also participated in U.S. EPA's New England Biological Assessment of Wetlands Work Group (NEBA-WWG), contributed to deliberations of North American Benthological Society's Science and Policy Committee and Conservation Committee and contributed to planning for Massachusetts Natural Heritage and Endangered Species Program's Aquatic Biomap Project. Betsy focused on revising a book manuscript on the ecology and conservation of vernal pools in northeastern North America, which has been accepted for publication, as well as one peer reviewed manuscript.

Peter Franks (James Cook University) carried out experiments to determine the role of leaf hydraulic conductance in the stomatal control of leaf gas exchange. In collaboration with Missy Holbrook and Maciej Zwieniecki, new techniques utilizing the cell pressure probe were employed to obtain data on the hydraulic conductance between leaf veins and stomatal guard cells. These data have improved the mechanistic modeling of stomatal function. Peter published four research articles and co-authored a book chapter on stomatal control of water loss from trees. He was an invited speaker at the Fifth International Workshop on Field techniques in Environmental Physiology (Organized by the University of Edinburgh, U.K. and held in Tenerife, Spain, March 2003), where he presented two keynote talks on new techniques for studying stomatal function and water flow in woody plants.

Alice Ingerson

Alice Ingerson (Waban, Mass.) conducted over forty-five interviews around New England, to determine whether and how conservationists and land managers were using historical ecology to make and evaluate practical decisions. The interviews suggested that historical ecology is currently used fairly narrowly: to set targets for ecological restoration (usually, the state of the landscape prior to European settlement); and in interpretive programs for the public focused on landscape features as cultural or historic resources (most often cellar holes, stone walls, and abandoned roads). Yet most interviewees themselves also questioned these applications, recognizing that pre-European ecological conditions were not necessarily more stable or preferable to conditions in other periods; and that the entire New England landscape, including the distribution of vegetation and wildlife as well as stonewalls and cellar holes, is a cultural artifact. When discussing these criticisms, many interviewees endorsed very different potential uses of history: as a set of methods for analyzing present and future as well as past landscape change, and as a set of skills that, if taught more widely, could foster more effective public participation in long-term, adaptive management. Alice will organize a researcher/practitioner roundtable at Harvard Forest in the fall of 2003, to explore recommendations and implementation based on these findings.

Alice organized a mini-symposium, "Making It Real: Bridging the Gap Between Historic and Working Farm Landscapes in New England," and spoke on "'Farm' Is a Verb: Interpreting Change in New England's Working Landscapes," Ninth Annual Deerfield-Wellesley Conference on American Culture (Historic Deerfield, Massachusetts). She spoke and led discussions on "A Critical User's Guide to Change and Stability in Cultures and Ecosystems," for students in the University of Massachusetts at Amherst's Department of Landscape Architecture, and for staff of the Trustees of Reservations and the Massachusetts Audubon Society; assisted the New England Small Farm Institute and the University of Massachusetts at Boston with grant proposals on applied farm history and urban environmental citizenship; organized a session, "Research as Activism: Participatory Approaches to Environmental History;" and served as chair and discussant for "Nature Conservation and Historic Preservation: The Landscape as Connection," American Society for Environmental History (Providence, Rhode Island). Alice developed and taught the new course,

"Place, Community, and Time: Social and Environmental History for Landscape Practitioners," Landscape Design Program of the Arnold Arboretum, Harvard University, and spoke as part of a panel on "The Future of Local History," Bay State Historical League (Lowell, Massachusetts).

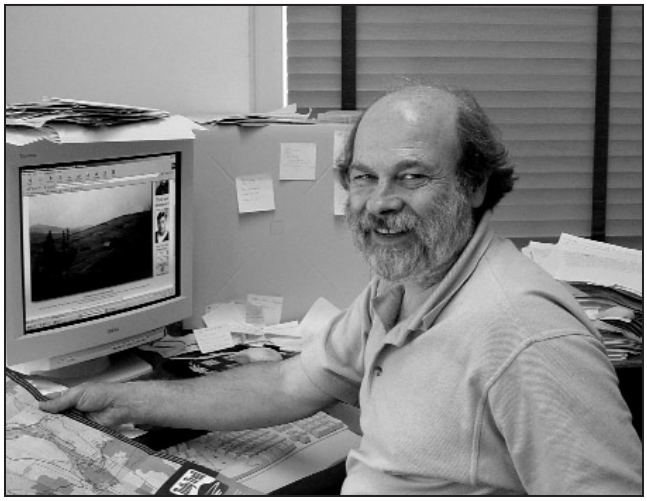
Matthew Kelty (University of Massachusetts at Amherst) spent much of his time working on a new edition of the text *The Practice of Silviculture,* which he is coauthoring with Mark Ashton and Bruce Larson. One of his main efforts in this tenth edition of the book has been to incorporate the idea of using natural forest dynamics as a model for designing silvicultural systems. He also worked on a number of research papers, one of which dealt with the use of sludge from municipal wastewater treatment as fertilizer for red pine. The results of that study support the findings of the Harvard Forest chronic nitrogen deposition project, in that red pine showed reduced growth rates in response to nitrogen fertilization in both cases. Matt began a field project with John O'Keefe and UMass student Helen Johnson dealing with the long-term management plots in Tom Swamp II, which had been established in 1907; this includes designing a thinning that is consistent with the past management practices. Matt presented a seminar at the Harvard Forest "Ecological restoration of forests heavily browsed by deer: the problem of hay-scented fern," and led a two-week field trip for forestry students from Germany and the U.S. to the Northern Rocky Mountain region.

David Lindenmayer

David Lindenmayer (The Australian National University) completed several papers on the impacts of salvage logging on post-disturbance stand recovery and biodiversity response (*Australian Forestry*). He also reviewed the value of natural disturbance-based approaches as guidelines for forest management. Other papers completed included a review of biodiversity conservation in plantation systems (*Biological Conservation*), analyses of landscape supplementation by birds in an Australian plantation landscape (*Conservation Biology*), reptile response to grazing and plantation establishment (*Journal of Applied Ecology*), the value of nestboxes for cavity-dependent fauna (*Wildlife Research*), population recovery of small mammals following a population removal experiment (*Journal of Applied Ecology*), the use of systematic reviews in medical sciences as a model for conservation application (*Biodiversity and Conservation*), and a new landscape model for tracking biodiversity response to landscape change (*Oikos*). He finished coediting a book on the impacts of fire in Australian ecosystems (CSIRO Publishing) and well advanced the major update of a textbook on Practical Conservation Biology (Surrey Beatty and Sons). He presented talks at the University of California, Davis, the Wildlife Conservation Society (New York), Weyerhauser Company (Vancouver), University of Maine, and the Yellowstone to Yukon Conference (Calgary).

Bullard Fellows for 2003–2004 include Drs. Ian Baillie (Bedford, England), Paul Barten (University of Massachusetts), Julia Jones (Oregon State University), John Klironomos (University of Guelph, Ontario, Canada), Antonia Lara (Universidad Austral de Chile), Matts Lindbladh (Swedish University of Agricultural Science), and Thomas Sinclair (University of Florida).

EDUCATIONAL ACTIVITIES



John O'Keefe

David Foster was joined by John O'Keefe, Glenn Motzkin, and Dave Orwig in leading the Harvard Forest Freshman Seminar this spring. The seminar meets over four weekends to provide an overview of Harvard Forest research and an introduction to the landscape and history of New England. It finishes with the students undertaking an independent study. David also taught two sections of Biology 299 Forest Practice and Research, a seminar for advanced undergraduates and graduate students that was originally developed by Ernie Gould.

Sarah Parnes is continuing her master's research on the history and dynamics of hemlock and white pine in southern New England. She is joined in the MFS program by Richard Shulhoff, Deputy Director of the Arnold Arboretum. Richard is beginning a study that examines options for the management of Hemlock Hill at the Arnold Arboretum, a distinctive and historical hemlock grove that is heavily infested by the hemlock woolly adelgid.

For the past two years Barry Tomlinson has been involved in an unusual course, sponsored by the Kenan Foundation, that seeks to facilitate knowledge about tropical plants and how such information may be incorporated into the teaching of introductory biology courses, the participants coming from colleges and universities throughout the United States and Canada. The course is taught on Kauai, Hawaii, in July, with a follow-up in Miami in February.

Summer Research Program

The Harvard Forest Summer Student Research program, coordinated by Edythe Ellin and assisted by Laurie Miskimins and Jakara Hubbard, attracted a diverse group of students to receive training in scientific investigations, and experience in long-term ecological research. All students worked closely with researchers while many conducted their own independent studies. The program included weekly seminars from resident and visiting scientists, discussions on career issues in science, and field exercises on soils, land-use history, and plant identification. An annual field trip was made to the Institute of Ecosystem Studies (Millbrook, N.Y.) to participate in a Forum on Careers in Ecology. Students presented major results of their work at the Annual Summer Student Research Symposium in mid-August.

Freshman Seminar Students

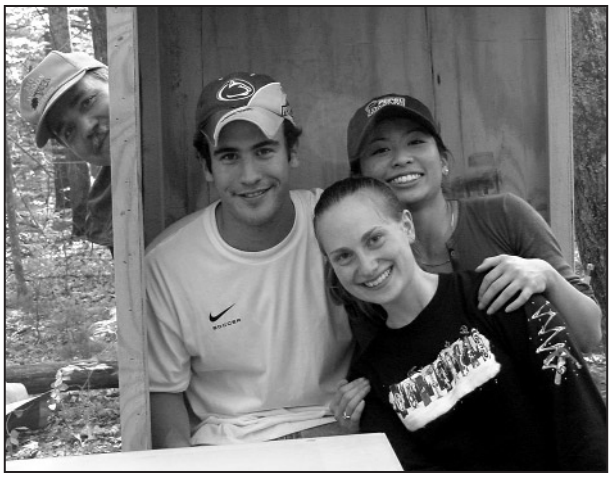
Deberat Perez-Rivera, Alana Belcon, Zachary Liscow

Summer Students 2003

Teresa Abbott	Willamette University
Daniel Atwater	University of Kansas
Joanna Bate	Haverford College
Alana Belcom	Mount Holyoke College
Joseph Brown	Holyoke Community College
Jonathan Chen	Oberlin College
Naomi Clark	W. Virginia University
Jennifer Clowers	Franklin & Marshall College
Luke Durbin	Illinois Wesleyan University
David Franklin	Lehigh University
Christopher Graham	Dickinson College
Margaret Graham	Dartmouth College
Brady Hardiman	Ashland University
Katherine Joseph	Virginia Tech University
Eleanor Lahr	Ithaca College
Erin Largay	Yale University
Matthew Lau	Humboldt State University
Zachary Liscow	Harvard University
Rebecca Lohnes	Yale University
Nick Malizia	Clark University
Kathryn McKain	Mount Holyoke College
Katie Musgrove	SUNY, Ulster
Julia Nelson	Stanford University
Donald Niebyl	Virginia Tech University
Nicole Nowinski	Carleton College
Amanda Park	SUNY, Syracuse
Daberat Perez-Rivera	Metropolitan University, Puerto Rico
Christopher Petit	Carleton College
Nick Povak	Virginia Tech University
Alex Sanchez-Sierra	Franklin & Marshall College
Julie Vuong	Franklin & Marshall College
Kristin Wilson	University of Maine, Orono
William Woolston	Harvard University

Assistant Program Coordinators

Laurie Miskimins
Jakara Hubbard



Tim Sipe, Alex Sanchez-Sierra, Jen Clowers, and Julie Vuong

Matthew Lau and Jonathan Chen

Jakara Hubbard and Laurie Miskimins

Chris Petit

ACTIVITIES OF THE FISHER MUSEUM

The Fisher Museum plays an important role in the educational mission of the Harvard Forest by providing a public outlet for research in forest biology, conservation, and management. The Museum also provides a unique setting for conferences and workshops sponsored by the Forest and outside organizations. Dr. John O'Keefe has primary responsibility for the development of activities and coordination of the use of the Museum.

Just in time for summer visitors in 2003 our new interpretive signs for the Natural History Trail through Jonathan Sanderson's Farm were installed. These striking aluminum signs, designed in collaboration with Michael Connors of the Inform Group in Northampton, combine line graphics and photos with text to enable visitors to interpret the history of the land as well as more recent management and research activity. The interpretation on the signs serves as an excellent extension of the lessons from the dioramas onto the landscape itself.

In November the Museum volunteers celebrated the completion of another very successful weekend schedule at our twelfth Volunteer Recognition Dinner, at which Mary Ann Walker once again received special thanks for her continuing, enthusiastic work as volunteer coordinator. A familiar group, including Walt Davidson, Martha Siccardi, Bill and Marianna Berry, Roger and Barbara Corey, Bob Lane, and Dick Sherwood received special recogni-

tion for being the most active volunteers during the season. The group was deeply saddened in the fall by the death of Bob Reed, a long-time friend and volunteer, with an immense fondness for Harvard Forest, and again in the spring by the loss of friend and volunteer Ed Wierman.

During the year the Museum provided programs for twenty-six elementary and secondary schools, thirty-six college and university classes, and fourteen community and professional groups. In July the Forest hosted the forestry training for the national Canon Envirothon. This high school student competition, hosted by Hampshire College in 2002, brought more than fifty student/teacher teams, representing almost all the states and many Canadian provinces, together for a week of education and examination in a range of environmental disciplines.

Michael Connors, Adrian Fabos, and John O'Keefe following the installation of new trail signs

Meetings, Conferences, Seminars

In October the Forest hosted an international conference on Long Distance Transport in Plants, organized by Missy Holbrook of the Department of Organismic and Evolutionary Biology. The Fourteenth Annual Harvard Forest Long-Term Ecological Research Symposium and National Institute for Global Environmental Change meeting was held in the Museum on February 12. Other meetings at the Harvard Forest included meetings of the Massachusetts Extension Service Coverts Project, Massachusetts Department of Environmental Management Logging Workshop, Massachusetts Forest Stewardship Committee, Massachusetts State Forestry Committee, Massachusetts Forestry Association, New England Forestry Foundation, Mount Wachusett Community College, Northeastern Forest Soils Conference, North Quabbin Regional Landscape Partnership, and Vegetation Control Service. The Forest also hosted a faculty retreat for the Harvard University Department of Organismic and Evolutionary Biology.

Speakers in the Harvard Forest Seminar series included:

Robert Askins	Connecticut College
Barbara Bedford	Cornell University
David Bryant	Harvard University
Carla Burton	Symbios Research and Restoration
Phil Burton	Symbios Research and Restoration
John Confer	Ithaca College
Peter Franks	James Cook University (Queensland, Australia)
Peter Frumhoff	Global Resources and Environment Program, Union of Concerned Scientists
Lauren Howard	University of New Hampshire
Yongsong Huang	Brown University
Matthew Kelty	University of Massachusetts
Thom Kyker-Snowman	Mass. Metropolitan District Commission
Alice Ingerson	Arnold Arboretum
Walt Landgraf	Stone Museum at People's State Forest, Barkhamsted, Conn.
James Levitt	Program for Conservation Innovation, Harvard Forest
David Lindenmayer	Australian National University
Michelle Manion	Global Environment Program, Union of Concerned Scientists
Leslie Mehrhoff	George Safford Torrey Herbarium, University of Connecticut
Christian Messier	Université de Québec à Montréal
Paul Nickerson	U.S. Fish and Wildlife Service
Keith Nislow	USDA Forest Service, Northeastern Research Station
Graeme Patterson	Wildlife Conservation Society
Jan Rowan	U.S. Fish and Wildlife Service
Scott Shumway	Wheaton College
Bill Sobczak	Holy Cross College
Dennis Souto	USDA Forest Service
Bernhard Stadler	University of Bayreuth
Tibor Standovar	Eoetvoes Lorand University, Hungary
Chloe Stuart	Mass. Natural Heritage and Endangered SpeciesProgram
P. B. Tomlinson	Harvard Forest
Betsy Von Holle	National Park Ecological Research Fellow, Harvard Forest
Claudia Zimmermann	Université Laval, Québec

FOREST MANAGEMENT AND MAINTENANCE

Lucas Griffith, Mike Scott, Woody Cole, and John Wisnewski

Adrian Fabos and his talented staff, better known as the "Woods Crew," supported the research efforts of the Harvard Forest community, which included up-

Oscar Lacwasan

grading the two walk-up scaffold towers (providing access to the forest canopy and above); training and supporting a multitude of staff and visiting researchers in the safe operation of Harvard Forest's newly acquired mobile canopy lift – capable of reaching up seventy feet; building a boardwalk into a beaver pond to support research on gas exchange;

Site preparation for the new garage

and converting a field below the Lyford House into a cultivated research garden for botanical studies and experimental research. The greenhouse at Torrey Lab was made operable after many years of inactivity and currently supports several research initiatives.

There were many other support efforts to the educational and research programs during the past year, including improvements to facilities, labs and housing. Lyford House, used for Bullard Fellows and other researcher housing needs, was completely de-leaded over the winter and spring. All wood trim in the house was replaced, new windows were installed where appropriate, the kitchen and upstairs bathroom were completely renovated, and the entire interior was painted. Several laboratories received new high quality countertops along with other minor upgrades.

Additional paving of both driveways to Shaler Hall was completed, including the parking lot for the Harvard Forest fleet, which made snow removal much easier. Lastly, a new Ford F-550 dump truck was purchased to help in woods road improvement efforts and to provide a versatile vehicle for other uses.

A new garage was started along Propsect Hill Road and behind Fisher House. The foundation and slab were excavated and poured and the 30' x 40' two-bay vehicle maintenance facility should be completed by spring of 2004. This new building will contain proper facilities for storing hazardous waste in our ongoing effort to minimize Harvard Forest's environmental impact. Most importantly the new garage will greatly improve our capacity to maintain our growing fleet of vehicles and equipment.

In addition significant improvements were made to the kitchen in Shaler Hall and to the grounds around most of the residential, office, and laboratory buildings.

LIBRARY AND ARCHIVES

A Library Committee consisting of Edythe Ellin, John Burk, Glenn Motzkin, Emery Boose, and Barbara Flye met regularly to discuss and plan the short- and long-term goals of the library. In June, work began on a reorganization project seeking to maximize the space available in the current library and common room areas. Julie Pallant and Kelli Graves have been working to update and consolidate the numerous library databases.

In the Archives, improvements included the addition of a new map cabinet, a large new shelving unit for the sample archives, and reorganization of the historical and photographic collections. John Burk and Barry Tomlinson sorted out a large collection of assorted material from the past research of Drs. Tomlinson, John Torrey, and Martin Zimmermann.

INFORMATION MANAGEMENT AND TECHNOLOGY ADVANCEMENT

The Harvard Forest purchased and installed a comprehensive backup software system that automatically captures PC data and safely stores it on our local servers. Since approximately ninety percent of our critical information resides on individual desktops, this new system provides us with a critical level of data protection that has not been available in the past.

Harvard Forest Web Site

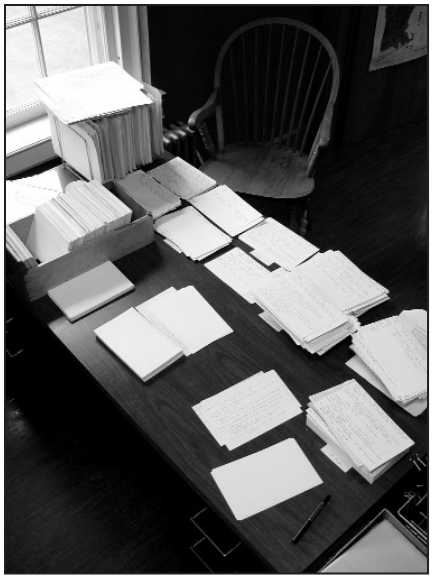
The Harvard Forest Web site underwent a complete redesign this year and was launched this June. The new site features greatly expanded content, a friendlier and more engaging interface, and beautiful pictures. The redesign includes a new name and can be seen at http://harvardforest.fas.harvard.edu. In addition, the launch was concurrent with the move of the Web server and site administration to the Harvard Forest from its previous location at the LTER network office in Albuquerque.

Fisher Museum Web Site

The Fisher Museum at Harvard Forest received a new and improved Web page this year, http://harvardforest.fas.harvard.edu/museum.html. The site, designed by Julie Pallant, features for the first time the dioramas online. A picture of each diorama is accompanied by a text description. A greater audience can be reached with the advent of the Web and if it is not possible to travel to the Harvard Forest to enjoy the dioramas, the on-line feature will provide visitors an appreciation for their workmanship and educational value. In addition, a virtual tour of the Sanderson Farm Natural History Interpretive Trail was added to the Web site: http://harvardforest.fas.harvard.edu/museum/sanderson/sanderson.html. This outreach opportunity coincides with the installation of the new interpretive signs along the trail itself.

Information Management

The Forest's online Data Archive (http://harvardforest.fas.harvard.edu/data/archive.html) was redesigned and expanded by Emery Boose over the past year in preparation for the LTER Site Review in July 2003. Metadata (documentation) for all 105 projects currently posted on the Web was updated and converted to Ecological Metadata Language (EML). A subset of XML (Extensible Markup Language) optimized for use in ecology, EML was developed by researchers in the LTER program and at the National Center for Ecological Analysis and Synthesis (NCEAS). Adopted by the LTER Network as its new standard for scientific metadata, EML will greatly enhance the ability to locate, interpret, and integrate scientific datasets.



ACTIVITIES OF THE HARVARD FOREST STAFF

Audrey Barker Plotkin coordinated a field tour of Harvard Forest for the Fifty-fifth Annual Northeastern Forest Soils Conference. The Conference had held its first meeting at Harvard Forest in 1939. Audrey also attended a Society of American Foresters workshop, "Advances in Forest Health."

Emery Boose and David Foster joined the newly formed LTER Network Information System Advisory Group (NISAG), which brings together information managers and principal investigators and will advise the LTER Network in the development of a strategic plan for information management and tech-

Aaron Ellison

nology. Emery attended the LTER Information Mangers meeting in Orlando, the Information Mangers Executive Committee (IMEXEC) meeting in Santa Barbara, and the NISAG and LTER Coordinating Committee meetings at the Kellogg Biological Station in Michigan.

John Burk gave natural history presentations at several institutions, including the Millers River Environmental Center, the Maine Audubon Society, and the Wildlife Learning Exchange in Concord. He continued as a regular contributor to *Natural New England* and *Worcester County Online* magazines, and as a participant in the state Biodiversity Days program.

Aaron Ellison presented seminars on his research on pitcher plant communities at Harvard University, the University of Pennsylvania, Worcester State College, and to the Concord Land Trust. New statistical models of pitcher plant demography were presented at the Ecological Society of America (ESA) meetings in Savannah. He also participated as the "ant expert" in BioBlitzes at Tully Mountain and Acadia National Park. Aaron presented summaries of his research on ant community structure at a Symposium on Invertebrate Conservation in New England sponsored by the American Museum of Natural History, and at the annual meeting of the Acadian Entomological Society. He continued his stints as associate editor-in-chief for Ecology and Ecological Monographs and as associate editor for *American Journal of Botany*. Aaron represented the Forest at the LTER Coordinating Committee meeting at the Kellogg Biological Station, headed up an external review panel for the biology department at Franklin and Marshall College, and was a judge at the western Massachusetts regional science fair. He led field trips to Hawley Bog for the Hitchcock Center for the Environment, and to Mt. Tom for the New England Wild Flower Society. Closer to home Aaron began a three-year term on the Royalston Conservation Commission, and serves on the Land Protection Committee of the Mt. Grace Land Trust.

David Foster led the Harvard Forest Freshman Seminar in the spring and Biology 299, *Forest Practice and Research,* Ernie Gould's original course in the fall and spring. He participated in a symposium at the American Society of Environmental History in Providence that recognized and discussed the twentieth anniversary of Bill Cronon's book on New England landscape history, *Changes in the Land*. David joined the advisory board for the Conservation Institute of the Trustees of Reservations and he continues to serve on boards and committees for the Conservation Research Foundation, Highstead Arboretum, and Harvard University's David Rockefeller Center for Latin American Studies and Center for Health and the Global Environment. David gave a keynote talk on New England's ecological history at a USDA symposium at the University of Connecticut, an evening gallery talk on the ecological interpretation of Connecticut Valley landscape painting at Mount Holyoke College, and invited lectures at the University of New Hampshire and George Perkins Marsh Institute at Clark University. He participated in a symposium of Landscape Legacies at the Sevilletta LTER site in Albuquerque, the Ag Trans Biocomplexity workshop at Arizona State University, and the LTER Coordinating Committee meeting at Niwot Ridge in Colorado. David and John Aber finished editing the Harvard Forest LTER volume, *Forests in Time – Forest Structure and Function as a Consequence of 1000 years of Change in New England,* and delivered the manuscript to Yale University Press. In August David and his family joined the Harvard Alumni Association on its Baltic trip and in January he led a group from the Harvard Natural History Museums through Chilean and

John Wisnewski

Argentine Patagonia.

Julian Hadley presented research results at the Ameriflux meeting sponsored by the U.S. Department of Energy in October 2002 and at an American Geophysical Union (AGU) meeting in December 2002.

Brian Hall attended the New England Arc Users Conference, Bretton Woods, N.H., and Harvard University GIS Day Symposium, presenting a poster "300 Years of Forest Change in Massachusetts: Forest Cover in 1830."

Holly Jensen-Herrin presented a poster at the North American Benthological Society annual meeting in Athens, Georgia, summarizing the preliminary results for her master's thesis on stream biota in relation to hydrology and other habitat variables in a series of streams at Mt. Wachusett.

Dave Kittredge and David Foster attended the initial meeting of the NSF biocomplexity project on Transitions in Agrarian landscapes in Phoenix in December. This LTER project seeks to identify multi-scale patterns in agrarian landscape dynamics, and the ecological implications of this history for those altered regions.

Dana MacDonald led two field trips for the University of Massachusetts Department of Landscape Architecture and Regional Planning, and one class field trip at the Harvard Forest for students of the Bazzaz Lab at Harvard University. He attended the Pine Barrens Research Forum at Brookhaven National Laboratories, Brookhaven, N.Y., and co-led a one-day Harvard Forest field trip for students of the University of Quebec, Montreal. Dana worked as a volunteer to plan and site a long-term deer browsing experiment at the Nature Conservancy's Mashomack Preserve on Shelter Island, N.Y., worked on a collaborative project with Dr. Alison Berry of University of California at Davis coring Uncas Pond, Mass. and subsequent sub-sampling of sediment, and co-organized the weekly seminar series at the Harvard Forest with Audrey Barker Plotkin.

Glenn Motzkin and Dave Orwig presented their research on ridgetop communities at the annual Ecological Society of America meeting in Tuscon. Glenn received the Massachusetts State Award from the New England Wildflower Society, and David Foster, Glenn, and Ben Slater were awarded the W. S. Cooper Award for 2003 by the Ecological Society of America. Glenn continues to serve as an Ecology Advisor for the Trustees of Reservations, and an associate member of the Massachusetts Natural Heritage and Endangered Species Program Advisory Committee. He served on the thesis committee of Sally Shaw from UMASS, and served as a critic for the Conway School of Landscape Design (CSLD) graduate projects. Glenn led several field trips to Montague Plain, including one with Tim Simmons of the Massachusetts Natural Heritage and Endangered Species Program for the Town of Montague as part of the annual Biodiversity Days.

Harvard Forest Friends Meeting – 2002

Sylvia Barry Musielewicz presented a poster at the International Congress of Limnogeology in Tucson, "2000 years of climate change from pollen records in Massachusetts."

John O'Keefe gave talks on Harvard Forest research and the history of northeastern forests at the University of Massachusetts, the Squam Lake Science Center in Holderness, N.H., and to the

Annual Meeting of the Rhode Island Wild Plant Society. He attended the Agricultural Transitions/ Biocomplexity workshop in Phoenix in December as Harvard Forest's education representative, the American Society for Environmental History/Forest History Society meeting in Providence, R.I., in March, and the first-ever International Forestry Museums meeting at the World Forestry Center in Portland, Oreg., in May. John serves on the boards of the Mount Grace Land Conservation Trust, where he is vice-president, Massachusetts Forestry Association and Millers River Environmental Center, and on the executive committee of the North Quabbin Regional Landscape Partnership. He also continues to serve on the Quabbin Science and Technical Advisory Committee and the Environmental Secretary's Advisory Group on Environmental Education.

Dave Orwig presented talks at Hampshire College, the Notch Visitor Center for the Massachusetts Department of Environmental Management, the Advances in Forest Health Workshop, and the North American Forest Ecology Workshop in Corvallis, Oreg. He presented a poster at the Ecological Society of America Annual Meeting in Tucson, Ariz. Dave served on the thesis committees of Aaron Kimple at Bard College, Sarah Parker at Antioch College, and is the Ph.D. dissertation advisor to former Harvard Forest REU student, Anthony D'Amato at the University of Massachusetts. He led field trips at the Quabbin Reservoir and Harvard Forest for the Freshman Seminar Class.

Barry Tomlinson attended the Annual Meeting of the Botanical Society of America at the University of Wisconsin in Madison in early August presenting research on *Gnetum*. In April he attended the third of the recurrent meetings on the systematics, evolution, and biology of monocotyledons, this time sponsored by Rancho Santa Ana Botanic Garden, Claremont, California, held at the Ontario Convention Center. The winter months were spent at the National Tropical Botanical Gardens headquarters on Kauai, Hawaii, with several visits to their outstation at "The Kampong," Coconut Grove, Miami, Florida, with continued collaborative work with staff of the Fairchild Tropical Garden, Coral Gables, Florida.

In June, Barry served on a panel at the University of Miami, reviewing the place in the university's teaching, research, and outreach programs of the rich campus collections of tropical plants that make this university unique in the continental United States.

Welcome barbecue for the summer students

VISITING RESEARCH SCIENTISTS AT THE HARVARD FOREST 2002–2003

A large number of Harvard University and outside scientists use Harvard Forest facilities and research sites. Many of these scientists are involved in the Harvard Forest LTER or NIGEC programs.

John Aber	University of New Hampshire
Mark Ashton	Yale University
Fakhri Bazzaz	Harvard University
Richard Bowden	Allegheny College
Frank Bowles	Ecosystems Center – MBL
Alfram Bright	Harvard University
Robert Brooks	USDA Forest Service
David Bryant	Harvard University
John Budney	Harvard University
Liz Burroughs	Ecosystems Center – MBL
Elizabeth Chilton	University of Massachusetts
Brendan Choat	Harvard University
V. Y. Chow	Harvard University
Scott Costa	University of Vermont
Patrick Crill	University of New Hampshire
William Currie	University of Michigan
Eric Davidson	Woods Hole Research Center
Kathleen Donohue	Harvard University
Jim Ehleringer	University of Utah
David Fizjarrald	SUNY, Albany
Julia Gaudinski	UCLA, Irvine
Elaine Gottleib	Harvard University
N. Michele Holbrook	Harvard University
David Hollinger	USDA Forest Service
Lucy Hutyra	Harvard University
Christine Jones	Harvard University
Sylvan Kaufman	Harvard Unversity
Alan Kirschbaum	University of Wisconsin
Chun-Ta Lai	University of Utah
Cathy Langtimm	Holy Cross College
Kristin Lewis	Harvard University
Alison Magill	Univ. of New Hampshire
Lynn Margulis	University of Massachusetts
Mary Martin	Univ. of New Hampshire
Jerry Melillo	Ecosystems Center – MBL
Patricia Micks	Ecosystems Center – MBL
Jacqueline Mohan	Duke University
Jeff Morisette	NASA
Sarah Morisseau	Ecosystems Center – MBL
Mitch Mulholland	University of Massachusetts
Ranga Myneni	Boston University
J. William Munger	Harvard University
Knute Nadelhoffer	University of Michigan
Tommi Nyman	Harvard University
Jennifer Pontius	U.S. Forest Service
Elizabeth Pyle	Harvard University
Kathleen Savage	Woods Hole Research Center
Tim Sipe	Franklin & Marshall College
Rolf Staebler	SUNY, Albany
Paul Steudler	Ecosystems Center – MBL
Susan Trumbore	University of California
Shawn Urbanski	Harvard University
Maciej Zwienecki	Harvard University

Fisher House

PUBLICATIONS

Anderson, R. L. 2001. Integrating lateral expansion into models of peatland development in temperate New England. M.F.S. thesis, Harvard University.

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Director

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