# THE HARVARD FOREST 2001-2002

## Harvard University

Front Cover: Walk-up towers erected in numerous locations throughout the Forest provide access for studies at different levels in the forest canopy as well as panoramic views across the landscape.

Back Cover: The Prospect Hill fire tower as seen from the hemlock stand walk-up tower.

Photography by David Foster, John Burk and, Amanda Brown.

**ANNUAL REPORT OF THE HARVARD FOREST 2001-2002**

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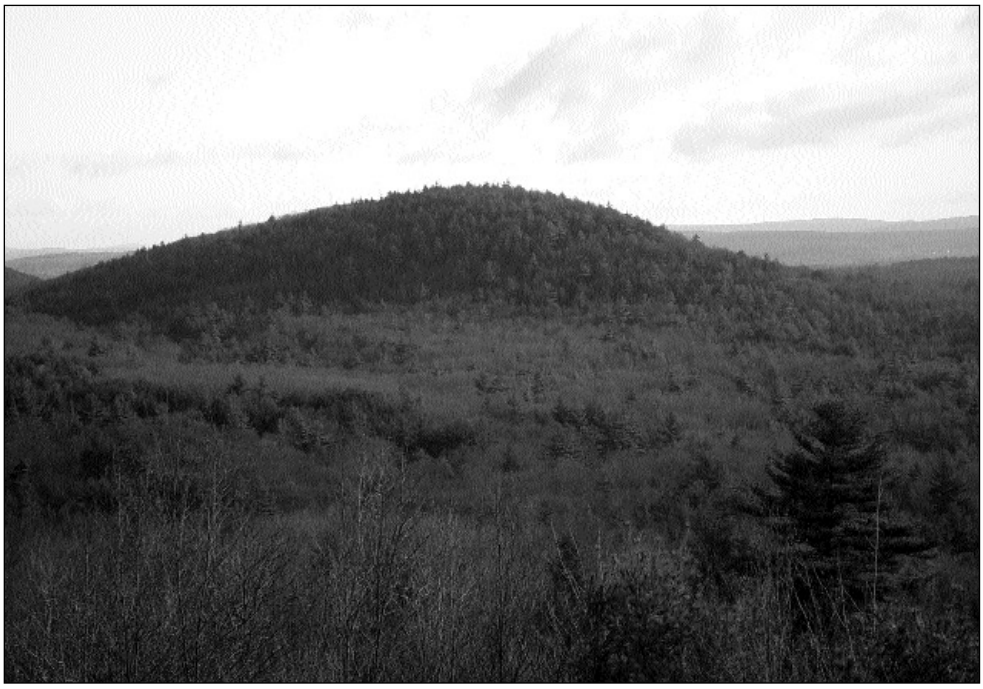
http://harvardforest.fas.harvard.edu



**PERSONNEL AT THE HARVARD FOREST 2001-2002**

| | |
|---|---|
| Audrey Barker Plotkin | Research Assistant |
| Sylvia Barry Musielewicz | Research Assistant |
| Jesse Bellemare | Graduate Student |
| Allison Berry | Bullard Fellow |
| Emery Boose | Information and Computer System Manager |
| Jeannette Bowlen | Accountant |
| John Burk | Archivist |
| Tawana Childs | Laboratory Technician |
| Richard Cobb | Research Assistant |
| Elizabeth Colburn | Bullard Fellow |
| Willard Cole | Woods Crew |
| Elaine Doughty | Research Assistant |
| John Edwards | Forest Manager |
| Edythe Ellin | Administrator |
| Aaron Ellison | Bullard Fellow and Senior Ecologist |
| Adrian Fabos | Facilities Manager |
| Samantha Farrell | Laboratory Technician |
| Barbara Flye | Librarian/Secretary |
| Charles H. W. Foster | Associate Director |
| David Foster | Research Associate |
| Donna Francis | Secretarial Assistant |
| Kelli Graves | Woods Crew |
| Lucas Griffith | Ecophysiologist |
| Julian Hadley | Research Assistant |
| Brian Hall | Research Assistant |
| Julie Hall | Secretarial Assistant |
| Linda Hampson | Assistant Schoolyard Coordinator |
| Teresa Jones | Forest Policy Analyst |
| David Kittredge | Graduate Student |
| Matt Kizlinski | Woods Crew |
| Oscar Lacwasan | Research Assistant |
| Dana MacDonald | Summer Cook |
| Lisa Marselle | Plant Ecologist |
| Glenn Motzkin | Museum and Schoolyard Coordinator |
| John O'Keefe | Bullard Fellow |
| Colin Orians | Forest Ecologist |
| David Orwig | System and Web Administrator |
| Julie Pallant | Graduate Student |
| Sarah Parnes | Post-doctoral Fellow |
| Tim Parshall | Bullard Fellow |
| Akile Pite | Staff Assistant |
| Dorothy Recos-Smith | Research Assistant |
| Jessica Schedlbauer | Summer Program Assistant |
| Laura Schreeg | Woods Crew |
| Michael Scott | Bullard Fellow |
| Kimberly Smith | Bullard Fellow |
| Navjot Sodhi | Research Assistant |
| Mindy Syfert | E. C. Jeffrey Professor of Biology, *Emeritus* |
| P. Barry Tomlinson | Woods Crew |
| John Wisnewski | Associate |
| Steven Wofsy | |

## INTRODUCTION TO THE HARVARD FOREST

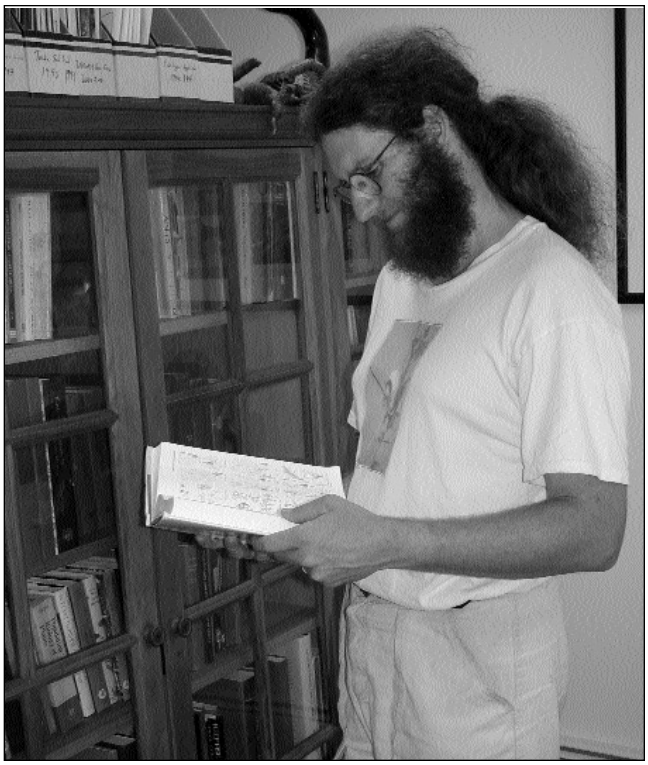
Since its establishment in 1907, the Harvard Forest has served as a center for research and education in forest biology. Through the years researchers have focused on silviculture and forest management, soils and the development of forest site concepts, the biology of temperate and tropical trees, forest ecology, forest economics, landscape history, conservation biology, and ecosystem dynamics. Today, this legacy of research and education continues 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, which include mixed hardwood and conifer forests, ponds, 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 laboratory space, computer and greenhouse facilities, and a lecture room for seminars and conferences. Nine additional houses provide accommodations for staff, visiting researchers, and students. Extensive records, including long-term data sets, 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 master's 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), and the Graduate School of Design (GSD) at Harvard and with the Department of Natural Resource Conservation at the University of Massachusetts, the Ecosystems Center of the Marine Biological Laboratory at Woods Hole, 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 for an infusion of outside perspectives. The five-member Woods Crew and Forest Manager undertake forest management and physical plant activities. The Coordinator of the Fisher Museum oversees many educational and outreach programs.

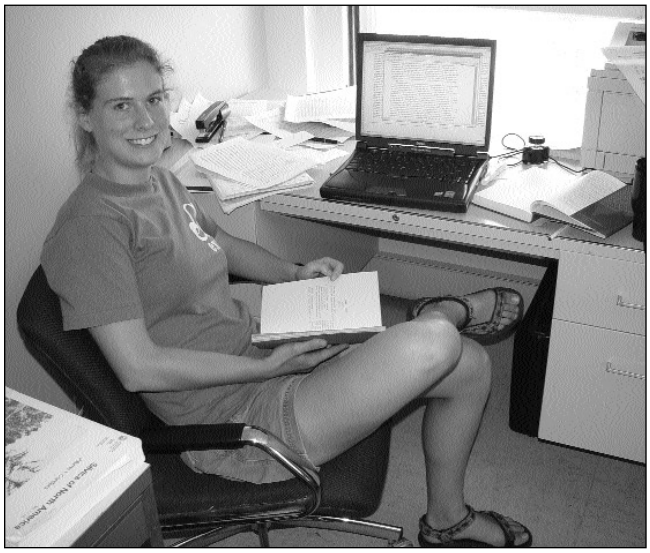
Funding for the Harvard Forest is derived from endowments and FAS, whereas major research support comes primarily from the National Science Foundation, Department of Energy (National Institute for Global Environmental Change), U.S. Department of Agriculture, NASA, Andrew W. Mellon Foundation, and other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



Aaron Ellison.

**NEW STAFF**

Aaron Ellison, a recent Bullard Fellow and Marjorie Fisher Professor of Environmental Studies at Mt. Holyoke College, accepted a position as Senior Ecologist at Harvard Forest. Aaron, who received his B.A. from Yale University and Ph.D. from Brown University, will continue his research in population, community, and statistical ecology.



Sarah Parnes.

Adrian Fabos, a graduate of Carnegie Mellon University and the Yale School of Forestry, replaced John Edwards as Facilities Manager and became immediately involved in supervising the Woods Crew, contractors, and facilities operations.

Sarah Parnes arrived this summer to begin her studies in the Master's in Forestry Science program. Sarah, a recent graduate of the University of Virginia with a B.A. in environmental science, will be working closely with David Foster and Glenn Motzkin in researching the history of white pine and hemlock forests in Petersham.

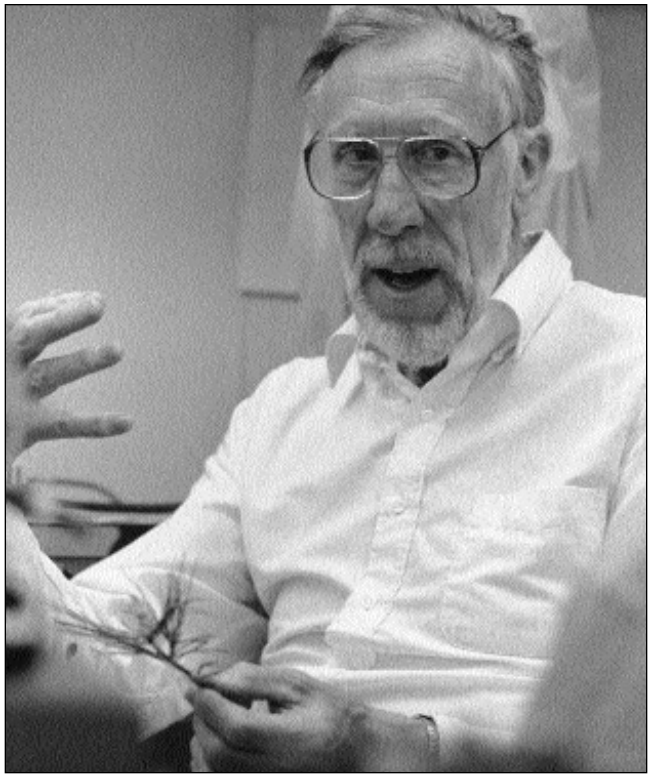
Julie Hall, a new research assistant, is working closely with Dave Orwig, Glenn Motzkin, and Brian Hall on a series of remote sensing and (Geographic Information System (GIS) projects. Lucas Griffith and Michael Scott joined the Woods Crew, replacing retirees Donald Hesselton and Pete Spooner.

Michael Scott.

**TRANSITIONS AND ACCOLADES**

On July 1, 2001, Barry Tomlinson retired with the title "E. C. Jeffrey Professor of Biology *Emeritus,*" but continued his research at Harvard Forest. This represents a continuation of an association with Harvard Forest that began with a visit to Petersham in December 1961. Concomitant with his retirement Barry was appointed Eleanor Crum Professor of Tropical Botany at the National Tropical Botanical Garden, Kalaheo, Hawaii and will divide his time between the Forest and Hawaii. In April 2002 the

Smithsonian Institution, Washington, D.C., awarded Barry Tomlinson the José Cuatracasas Medal at its convention on Biological Diversity. The medal is awarded for Excellence in Tropical Botany.



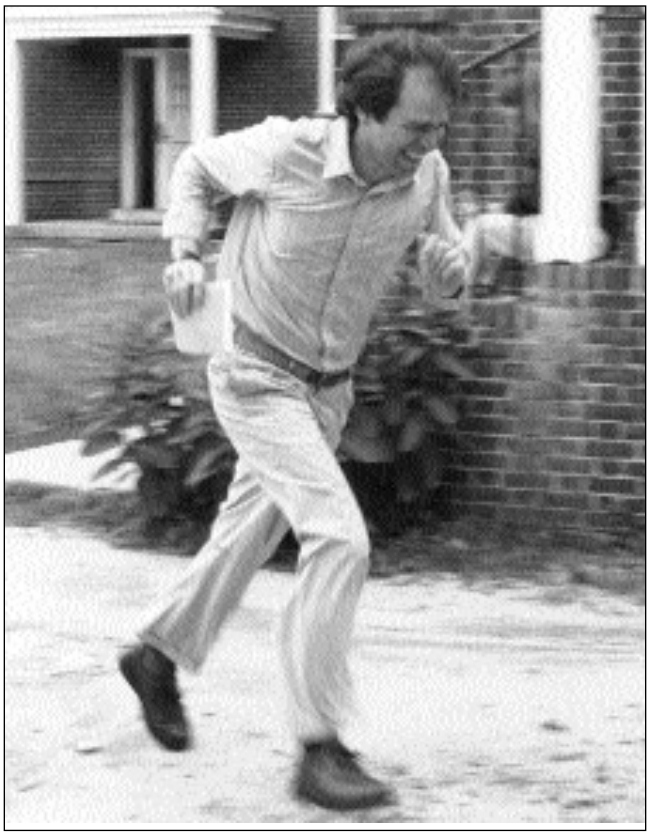
Barry Tomlinson.

John "Jack" Edwards retired after eighteen years as Facilities Manager and Forest Manager at the Harvard Forest, where he dedicated himself to improving the working and living conditions for all staff and visitors. Just a few of his accomplishments include: overseeing the complete renovation of Fisher House into housing for visiting researchers and summer students; construction of the Pole Barn and recycling shed; renovation of the garage into modern archival space and the Torrey Laboratory into a multi-user facility; erection of the Environmental Monitoring Station (EMS) one mile into the woods; major landscaping projects around and significant renovation projects within Shaler Hall; and structural improvements to every residence and building owned by the Forest. Jack's impact on the Forest will be evident for many years to come.

## RESEARCH ACTIVITIES

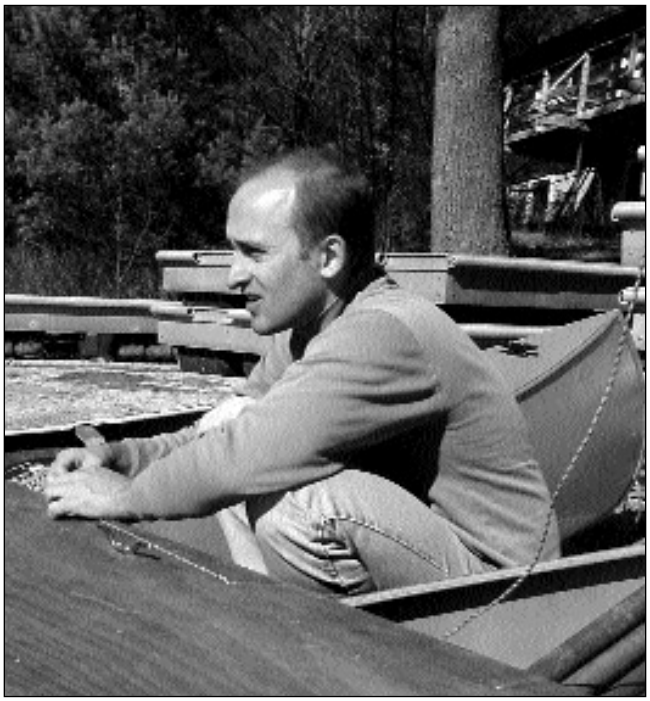
### An Historical Approach to Understanding and Conserving the Coastal Region

Following up on our previous studies in central Massachusetts, the Connecticut Valley, and Martha's Vineyard, we are conducting a comprehensive investigation of the history and vegetation of the coastal region that includes Cape Cod, Martha's Vineyard, Nantucket, Block Island, and Long Island. This region is a high priority for conservation because it supports numerous rare or uncommon plant and animal species and communities and is highly threatened by development. With support from the National Science Foundation, Andrew Mellon Foundation, Massachusetts Biodiversity Initiative, and The Nature Conservancy's Ecological Research Program, we are investigating the link between the landscape history of the coastal region and the modern abundance and distribution of upland plant communities, including grasslands, heathlands, barrens, and woodlands. Although the region has a long history of settlement and intensive use, there has been no prior attempt to rigorously evaluate the impact of



John Edwards.

historical land use on species distributions, community assemblages, or biodiversity in this region. Such an understanding is critical in order to understand modern vegetation patterns, to identify appropriate goals for conservation, and to develop management approaches for achieving those objectives.



Tim Parshall.

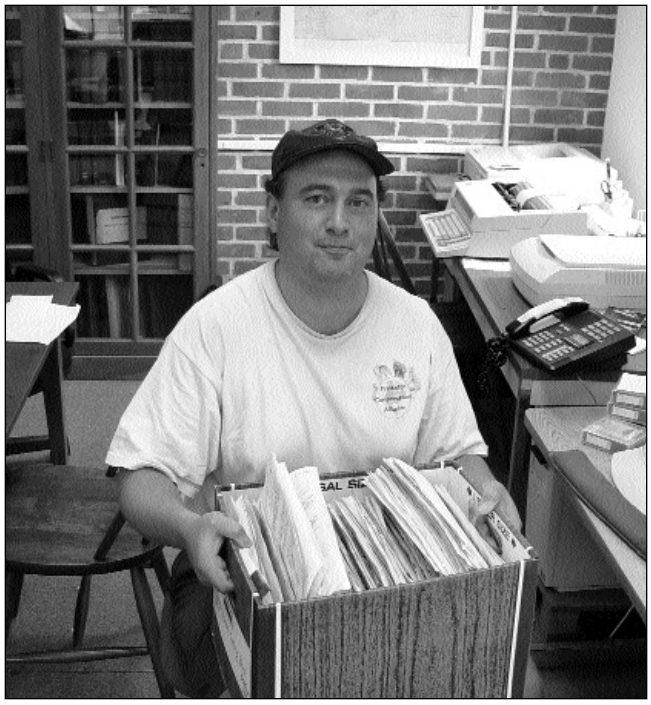
Current work emphasizes integrated paleoecological, historical, (GIS), and field studies throughout the coastal region. Tim Parshall and David Foster led paleoecological studies to reconstruct the long-term vegetation and disturbance history of the region, and Brian Hall is gathering a wide range of historical data, including excellent historical maps that are being incorporated into a growing coastal GIS data base. Julie Hall developed maps of the coastal region from the 1930s, enabling us to evaluate the timing and rate of reforestation after abandonment of agricultural lands. Dana MacDonald and Rob Eberhardt worked closely with David and Glenn Motzkin to evaluate the relationship between modern vegetation variation, site factors, and disturbance history.

Results to date suggest that despite considerable variation in environmental conditions and fire, the pattern and intensity of historical land-use activities continue to influence modern species distributions, even many decades after these activities have ceased. In particular, several species are slow to recolonize former agricultural lands even in cases where modern site conditions appear suitable for these species.

**Forest Composition and Distribution in the Historical Period: Providing the Context for Ecological and Biodiversity Assessments for Massachusetts**

Because the Massachusetts landscape has a long history of human settlement, ecological study, conservation, and long-term planning must incorporate an understanding of the history of human landscape modification. However, to date, most ecological and planning studies have failed to evaluate this history effectively, primarily due to a lack of information. With support from the Massachusetts Natural Heritage and Endangered Species Program, David Foster, Glenn Motzkin, Mindy Syfert, and Brian Hall developed GIS data layers to assess land-use history throughout the Commonwealth. Using maps generated for each town in Massachusetts in 1830, we developed maps depicting the historical extent of forest land, open land, meadows, and cultural features, including roads, mills, meeting houses, etc. Because 1830 was near the period of maximum agricultural land clearance for many towns in the Commonwealth, the resulting data layers will provide a reasonable approximation of the Massachusetts landscape during the agricultural period. Such information is valuable for a wide range of research, planning, and management efforts, including establishing objectives for conservation, restoration, long-term ecological management, and archaeological and cultural resource assessment. Interestingly, our results

Brian Hall.



John Burk.

indicate that the greatest extent of forest land in Massachusetts in 1830 occurred in southeastern Massachusetts, where large portions of Plymouth and Bristol counties and the inner portion of Cape Cod remained forested. In contrast with the modern landscape, the uplands of central and western Massachusetts supported numerous small and isolated woodlands in a predominantly agricultural landscape.

John Burk worked with David, Glenn, and Brian to gather data on forest composition in southern New England at the time of European settlement. In combination, these historical sources have greatly increased our understanding of forest composition in southern New England in the early historical period and the changes that resulted from intensive agricultural clearing through the mid-nineteenth century. We also collaborated with Charlie Cogbill from the Hubbard Brook research program, who has similar data for northern New England to evaluate early historical forest composition across all of New England.

**Historical Land Cover and Land-use Patterns**

Much past research at Harvard Forest has investigated the links between historical land use and modern vegetation characteristics at both local and regional scales. Local-scale studies have shown that there is a strong link between historical land-use practices and modern species composition. For example, cultivation eradicates existing woodland vegetation, causing formally plowed fields to lack species that are slow to recolonize, even though these species may be abundant in adjacent woodlots. Regional studies have shown that historical land-use practices have reduced much of the climatic control over forest species composition and reduced regional variation in composition. In order to evaluate the relative influence of climate and land use across a region with a greater environmental gradient, Brian Hall, Glenn

Team Paleo preparing to retrieve a sediment core from Lily Pond, New Salem, Massachusetts. *From left:* Elaine Doughty, Sylvia Barry Musielewicz, Kate Musgrove, Gina Yazzie, and Sarah Parnes.

Motzkin, and David Foster are investigating how forests in Massachusetts have changed over more than 300 years of intensive land use. Preliminary results suggest that even though most of the state's forests have at one time or another been cleared and used as cropland or pastureland, climate continues to influence species composition, although land-use has modified the relative abundance of tree taxa. The introduction of non-native pest species within the last eighty years has also had, and will continue to have, a great effect on forest composition.

As part of the coastal project, colonial records for Long Island at the New York State Archives were researched for witness tree and agricultural land-use citations. Data sets of fifty or more trees were collected for six towns, including Hempstead and Oyster Bay in Nassau County. The year range of these records was from the mid-1600s to the 1720s. To help interpret the land-use history of the Hempstead Plain, agricultural resolutions in the town's records from 1655 to 1845 were collated and summarized. During this process, as part of a collaboration with visiting researchers from Belgium, early Dutch records from the Albany area including maps and proprietor data were added to the Archives.

**Hemlock Woolly Adelgid Impacts on New England Forests: Stand Dynamics, Ecosystem Function Changes and Landscape Patterns**

A large research effort led by Dave Orwig is investigating the impact of the introduced insect, the hemlock woolly adelgid (HWA) on forests across southern New England. HWA is spreading from southern Connecticut, where it killed many thousands of acres of forest, and it has the potential to eliminate eastern hemlock across its now native range. Vegetation dynamics have been monitored for six years in eight hemlock stands with varying levels of HWA damage in Connecticut to examine patterns of hemlock mortality and subsequent community reorganization following infestation. Since 1995, overstory and understory mortality has risen 5% to 15% per year to overall values of 50% to 99%. There has been no tree recovery and the health of remaining trees deteriorated in all infested stands, although on some sites hemlocks can remain alive for over ten years following initial infestation and remain standing for six to eight years following mortality. Rapid establishment and growth by black birch occurred at most sites along with lesser amounts of red maple and oak species. The few hemlock seedlings found contained HWA infestation. Shrub cover remains low following infestation while herbaceous cover, consisting primarily of hay-scented fern, gradually increases over time. Tree-ring analysis of hardwood and declining hemlock trees, coupled with age-structure analysis of newly established birch saplings was effective in determining the timing of initial HWA impact in stands of unknown infestation date. Over the last ten years, radial growth of hemlock declined precipitously in most stands, while oak and maple growth exhibited concomitant, large annual increases (see figure page 12). Results suggest that dramatic stand structure and composition changes accompany heavy HWA infestations that continue long after hemlock mortality.

During the summer of 2002, Dave Orwig, Richard Cobb, and summer student Brandon Burke resampled permanent plots established in 1997 to examine the effect of hemlock decline and mortality on nitrogen cycling. Soil analyses including pH, temperature, carbon:nitrogen ratios, texture, and total soil organic matter have been completed and

Impacts of the hemlock woolly adelgid.

David Orwig.

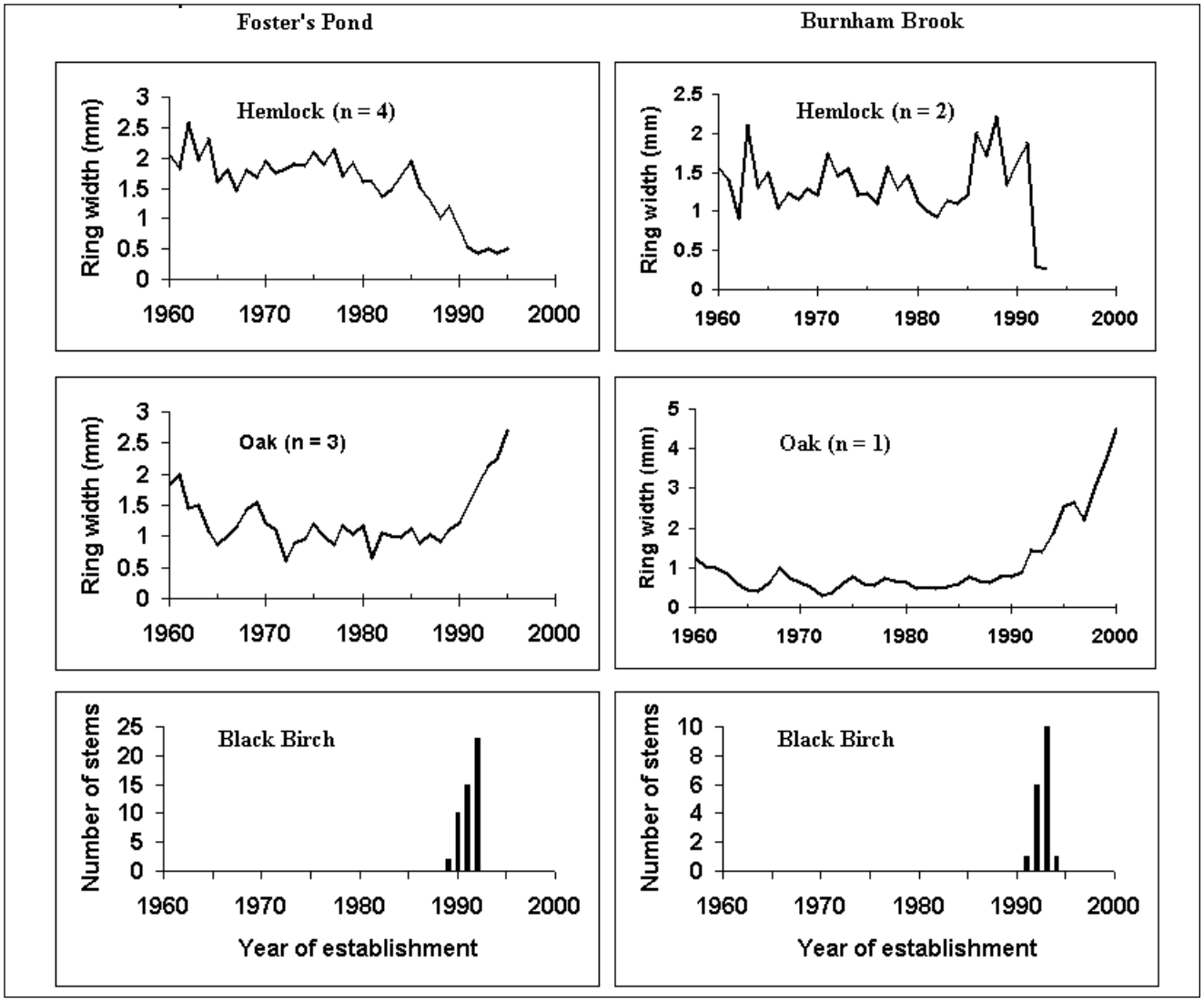
nitrogen mineralization continues to be measured in a subset of sites. Stands with heavy HWA infestation had lower surface soil moisture levels, higher soil temperatures and light, and higher net nitrogen mineralization and net nitrification rates than uninfested stands or stands with low damage. Resin bags buried in the soil at damaged sites also captured higher amounts of ammonium and nitrate than similar bags in 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 hardwoods.

Dave, Richard Cobb, Audrey Barker-Plotkin and summer student, Jacqueline Guzman established a study on vegetation, soil nitrogen cycling, and microenvironments in two hemlock forests on Harvard Forest that lack HWA to collect baseline information in anticipation of the imminent arrival of the adelgid. Although HWA occurs elsewhere in Petersham it has only been found on one tree at the Harvard Forest. In a related effort, Audrey Barker Plotkin and summer student Jackie Guzman gathered detailed baseline information for several hemlock stands that have well-documented, long-term vegetation histories reconstructed via pollen and tree-ring analyses. Audrey and Jackie are rating hemlock tree vigor, surveying regeneration of hemlock and other trees, and compiling species lists of understory vegetation. In these healthy, intact stands, understory plants are sparse, and comprise a suite of shade-tolerant herbs, ferns, and tree seedlings. They are also measuring ecosystem parameters such as organic matter depth and nitrogen cycling. Some of the stands have a remarkably thick organic layer. These measurements will link the long-term history of these hemlock stands to continuing studies of hemlock stand response to adelgid infestation. The proximity of these sites to Harvard Forest research facilities and scientists makes them excellent areas to expand research on the forest ecosystem impacts of this invasive pest.

Under the direction of Richard Cobb, we continue to compare the rates of decomposition at the soil surface versus the organic-mineral soil interface at twelve sites throughout Connecticut and Massachusetts. We have also begun a reciprocal litter study at a subset of these sites comparing hemlock, black birch, and hemlock-black birch mixed litter decomposition. Black birch is the most prolific tree species establishing on former hemlock stands. The foliar chemistry of black birch is substantially different from that of hemlock and decomposition will most likely be different as well.

Audrey Barker Plotkin.

As a follow-up to our large-scale project examining HWA distribution in Connecticut, Dave Orwig and summer students Matthew Burr and Nicholas Povak have begun sampling hemlock stands in Massachusetts. They are mapping the distribution of hemlock stands $>3$ ha in a region encompassing the Connecticut River Valley and stretching from West




Overstory radial growth patterns in hemlock and oak trees and the patterns of black birch establishment during chronic hemlock woolly adelgid infestations at the Foster's Pond and Burnham Brook hemlock sites in southern Connecticut. N = number of trees used to construct the average growth curve. As hemlock trees deteriorate, hardwood tree growth exhibits dramatic increases and dense birch seedlings rapidly become established.

Springfield to Wales in the south and from Colrain to Royalston in the north. They will obtain 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 the time of its arrival in Massachusetts in 1989. 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.

**Carbon Exchange of Temperate Forests**

Julian Hadley continued to measure the carbon balance of various forest types on the Prospect Hill tract to develop better carbon exchange models and more accurate estimates of carbon balance for central New England forests. New England's forests affect global carbon exchange, atmospheric $CO_2$ concentration, and the greenhouse effect resulting from globally rising atmospheric $CO_2$.

During 2000 and early 2001 work in the old-growth hemlock stand near the Black Gum Swamp

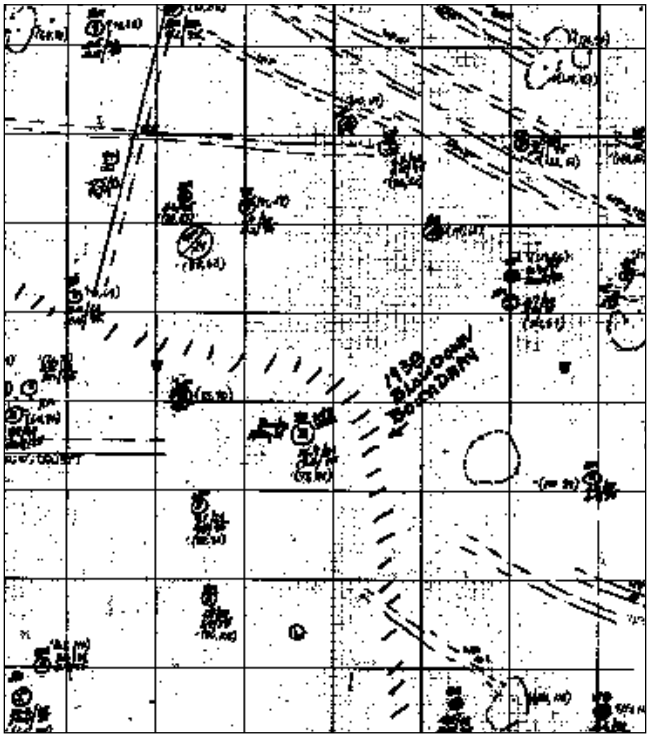
measured carbon exchange above the canopy, as well as soil respiration. The hemlock forest stored 3.0 Mg/ha during the year from November 2000 through October 2001, based on data collected during periods of suitable wind direction and turbulence for carbon exchange measurements. Carbon exchange models based on these measurements were used to estimate storage during other periods. Annual carbon storage of 3.0 Mg/ha is high relative to estimates from a carbon exchange model and it is much greater than annual above-ground carbon storage in wood during the 1990s (1.0 to 1.4 Mg/ha). However, measurements by Steve Wofsy at the Harvard Forest's Enfironmental Monitoring Station (EMS) tower indicated that November 2000 through October 2001 was a year of record high annual carbon uptake; these environmental conditions may have also enhanced carbon storage in the hemlock forest.

The highest monthly estimates of net carbon storage in the hemlock forest occurred during April and May 2001, while slight losses of carbon were estimated for the winter months and August 2001 (see figure page 14). These observations support other measurements and indicate that when soil and air temperatures were very high, total respiration of the forest could exceed photosynthesis, leading to carbon loss. August 2001 was the hottest month of the year, with monthly average soil and air temperatures both about 2ºC hotter than in any other month. The annual pattern suggests that mild spring weather enhances carbon uptake by hemlock forests, but hot summers reduce it.

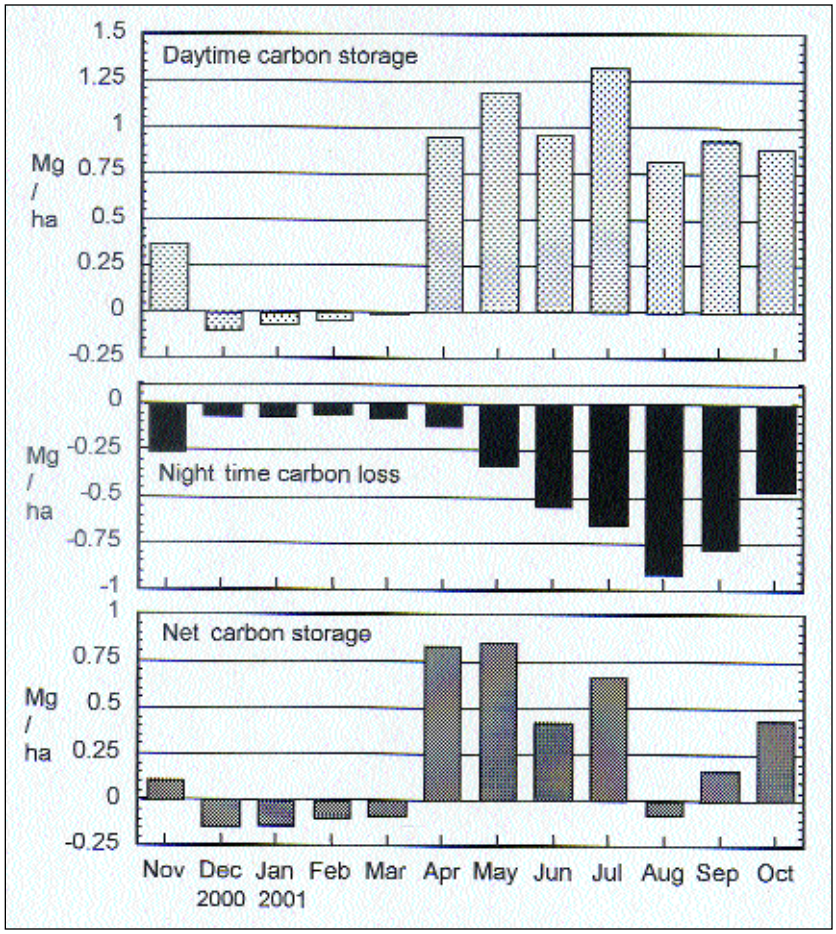
Carbon exchange measurements in a new area, the west slope of Little Prospect Hill, began in May 2002. This area is dominated by red oak, red maple, and birch, with a red pine plantation about 250 m SSW of the measurement tower. The area within about 200 m of the tower to the SW, and 300 m to the NW, is covered by forest only about forty-five years old, originating after a severe fire in 1957. These upper slopes are also very dry. Carbon exchange data from this site will provide a valuable contrast to the hemlock forest and the area around the EMS tower, which has forest of similar species composition 70 to 100 years old. The EMS tower is also in a lower slope position where water stress is less likely, particularly to the NW where there is a large bog. The Little Prospect Hill site will provide an opportunity to test the general applicability of the observation from the EMS tower that drought results in higher than average carbon storage, because soil respiration is reduced more than photosynthesis. This may not hold true at the new drier site.

**Long-term Forest Measurements and Historical Carbon Sequestration**

Permanent plots provide an empirical understanding of forest change over time, and are an invaluable part of forestry and ecological research. Such studies provide information on stand development and can address numerous ecological questions, including many which could not have been anticipated when the study was initiated. Walter Lyford began measurements of a seven-acre area of red oak-red maple forest on the Prospect Hill tract of Harvard Forest in 1969 when he mapped all trees greater than two inches diameter at a very large-scale (1 inch = 5 feet). The maps include live and dead trees, stumps, windthrows and other features such as stonewalls, boulders, soil moisture, and a damage boundary from the 1938 hurricane. Last summer, Audrey Barker Plotkin and summer student Kristin Wilson relocated and remeasured all trees, completing the



Detail of one of Walter Lyford's original maps showing tree species and sizes, stumps, windthrown trees, boulders and a boundary between forest severely damaged by the 1938 hurricane (above dashed line) and lightly damaged areas (below dashed line). Each grid square represents 5 x 5 feet on the ground.




Monthly carbon exchange in the old-growth hemlock forest from November 2000 through October 2001. Positive numbers indicate carbon uptake by the forest, negative numbers show carbon lost to the atmosphere.

fourth measurement in the site's thirty-two-year history. They also digitized all of Lyford's original maps on GIS.

The role of temperate forests as a major carbon sink is currently a focus of much research at Harvard Forest, centered on the Environmental Monitoring Station run by Steve Wofsy in the Department of Earth and Planetary Sciences. The Lyford data can be used to provide an independent estimate of carbon sequestration as one stand ages from 70 and 100 years. Carbon stored in the above-ground live woody biomass at the Lyford Grid area rose from 71 metric tons of carbon per hectare in 1969 to 114 tons per hectare in 2001, mostly in red oak. Over the 32-year period, an average of 1.3 tons of carbon per hectare were stored each year in live woody biomass. Additional pools of carbon include the soil, dead wood and roots.

**Population Ecology**

Kathleen Donohue of the Department of Organismic and Evolutionary Biology conducted several studies on the evolutionary ecology and genetics of natural plant populations. The first project investigates the genetic basis and adaptive significance of germination responses to seasonal cues in *Arabidopsis thaliana*. The field component of this large quantitative genetics experiment has been completed, and results presented at the meetings of the American Society of Naturalists. In addition, two summer Research Experience for Undergraduates (REU) students, Joseph Seggio and Naomi Wender, are conducting independent projects to investigate the genetic basis of germination in *Arabidopsis*. Another major project addresses the phenotypic and genetic basis of seed dispersal in *Arabidopsis thaliana*. The data collection for this study is nearing completion, and the summer

REU students and Kathleen are participating in this endeavor. The third project concerns seed dispersal in a group of mustards that have evolved to inhabit marine strands. A trip to the European Synchrotron Radiation Facility provided high resolution 3-dimensional X-ray images of fruit morphology, which revealed structural features that may have contributed to the ability of these species to inhabit marine habitats and to expand their ranges globally.

Kristina Stinson's research is centered mainly on the population biology and ecophysiology of the invasive plant species, garlic mustard (Alliaria petiolota) and its spread in and around Harvard Forest, as part of LTER investigations on invasive species. She is investigating the role of source-sink dynamics in the invasion process and possible management implications. Seeds will be collected from garlic mustard populations from southern New Jersey to Ontario with the objective of including a latitudinal transect in ongoing comparisons of different light and moisture habitats. In addition, similar techniques will be applied to investigate the role of source-sink interactions for setting plant species' range limits in other study systems, such as alpine snowmelt gradients. Research also involves two summer students, Jimmy Tran and Jen Petzold in a collaborative project with Fakhri Bazzaz on the genetic component of intraspecific competition in ragweed populations grown at ambient and elevated carbon dioxide levels.

Garlic mustard (*Alliaria petiolata*):
Exotic invader of temperate deciduous understories.

**Vegetation Dynamics of Ridgetop Pitch Pine and Red Pine Communities**

Dave Orwig, Glenn Motzkin, and David Foster are conducting a study of the vegetation and long-term dynamics of ridgetop sites that support uncommon pitch pine or red pine communities. Over this past year, we focused our efforts on investigating the summit of Mt. Everett in the town of Mt. Washington, Massachusetts. We are using a combination of dendroecological, historical, and field studies to

Tree form near the summit of Mt. Everett, southwestern Massachusetts.

Mt. Tom, a southern Massachusetts trap rock ridge with white pine, red pine and pitch pine.

address several questions: 1) What is the historical fire and disturbance history of the region and how has this influenced vegetation composition and structure? 2) What is the history of land use and how has this influenced vegetation composition and structure? 3) What is the age structure of the current stand and how is this related to disturbance history? 4) How do the composition, structure, and dynamics of Mt. Everett compare with other sites in the southern Taconics and elsewhere in central New England?

Mt. Everett supports unusual dwarf pitch pines that are up to ~ 170 years old, but are typically 1–3 m (3–10 feet) tall, and occasionally are completely prostrate. The site experiences frequent damage from ice storms, which presumably contributes to the unusual growth forms. Interestingly, unlike other dwarf pitch pine barrens, we found little evidence of recent fire on Mt. Everett, and no evidence of serotinous (closed) cones. Pitch pine has established continuously since the 1830s. Diameter is a poor predictor of age in this forest as trees with diameters of only 10 cm differ in age by more than 100 years. Many pines exhibit multiple stems, prostrate growth forms, and evidence of terminal branch damage. Pitch pine ring-width patterns displayed extremely slow growth, with many individuals averaging $< 0.40$ mm yr.$^{-1}$, and a few growing only 0.08 to 0.30 mm yr.$^{-1}$ for periods of up to fifty years. The unusual structure, extremely slow growth rates, and continuous recruitment in the absence of recent fire suggest that weather and harsh site conditions continue to maintain this unique community of disturbance–adapted species.

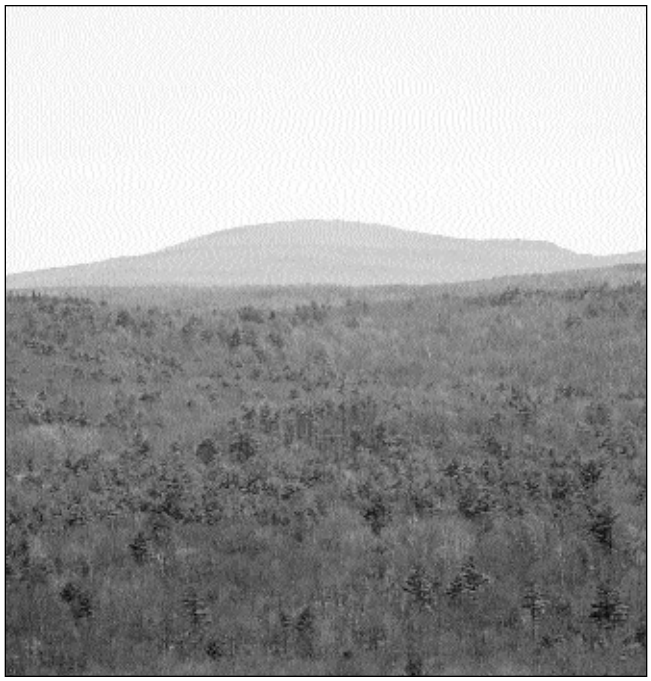
We will continue to examine additional ridgetop communities (such as Mt. Tom) to place the results of this site into a broader landscape context and to make comparisons with forests that have been influenced by fire and other factors.

**Historical and Environmental Controls of Vegetation Composition**

Jesse Bellemare (M.F.S. student) completed work on his master's thesis investigating the influence of historical land-use on the Rich Mesic Forest community in western Massachusetts. Rich Mesic Forests are an unusual forest type characterized by sugar maple dominated canopies and species-rich herb layers. These forests typically occur on moist, east-facing slopes over calcium-rich bedrock, such as marble. Results from sites in the towns of Conway and Shelburne in Franklin County indicate that the widespread forest clearance and agricultural land use of the eighteenth and nineteenth centuries has had significant long-term impacts on the species composition of Rich Mesic Forests. Forest stands that have developed on abandoned agricultural land typically have lower herb species richness than forest stands that were never cleared, due in part to the limited seed dispersal ability of forest herbs associated with this community.

**Forest Policy**

Dave Kittredge was on sabbatical from the University of Massachusetts this year, and worked at the Harvard Forest investigating examples of private forest landowner cooperation in other countries with temperate forests and developed economies. He spent two weeks in Sweden visiting several cooperatives, and traveled to Oregon with graduate student and former REU intern Andrew Finley to present results of their study of Massachusetts private landowners. Working with several student interns, Dave brought to closure an updated map of protected open space in the north Quabbin region, which forms the basis of a study of conservation potential among neighboring landowners and agencies. He has also been involved in the data collection of commercial timber harvesting throughout Massachusetts, in an effort to characterize its extent and pattern. Dave collaborated with David Foster and Mary Berlik on a Harvard Forest paper that examines the disparity between wood consumption and production in the heavily forested state of Massachusetts (The Illusion



The view to Mt. Wachusett from the Prospect Hill fire tower, illustrating the expanse of forest in central Massachusetts.

of Preservation: a global environmental argument for the local production of natural resources).

**Timber Harvesting in Massachusetts**

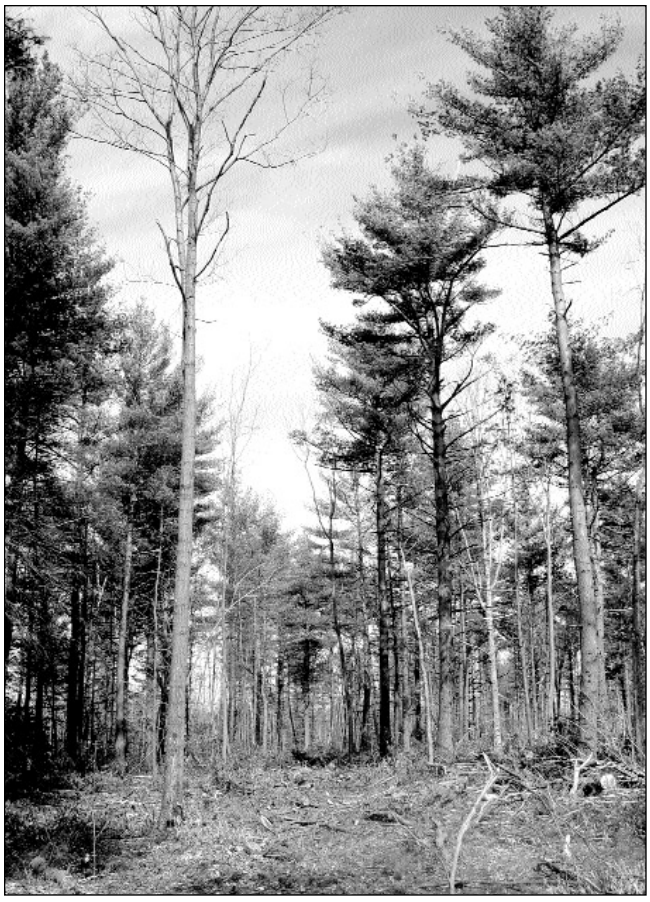
To expand the original North Quabbin timber harvesting study to a statewide level, John Burk has been mapping and collecting data from Chapter 132 (the Forest Cutting Practices Act) plans at the various Department of Environmental Management (DEM) offices. To date, approximately 5,200 records have been entered from the years 1984–2001, including all state records from 1997–2001 and virtually all of eastern Massachusetts records for the entire seventeen-year period. Data recorded for each map includes landowner information, species harvested, acres reported, wetland crossing, and stand treatments.

Of the 5,200 plans, approximately 84% were filed by private landowners and 6% by the Metropolitan District Commission, while the remaining 10% were divided among local and federal agencies, conservation groups, sawmills, and the Department of Environmental Management (DEM). The total acreage reported as harvested was just over 190,000, an average of 37 acres per plan. White pine was the most heavily harvested species, followed by red oak. Harvests generally occurred at similar densities from the Berkshires through Worcester County, and tapered off strongly as one moved inside the Route I-495 region toward Boston. The next step will be to complete the map by adding the rest of the data from western Massachusetts.

Summer student Katie Nicholson has been working on a preliminary analysis of the data in conjunction with her work on socio-economic impacts of logging. Once collated and analyzed, we intend to use the data gathered from this study to explore the effect of timber harvesting as a form of disturbance in Massachusetts, including impacts in highly populated areas and heavily forested areas.

**Botanical Studies**

Barry Tomlinson's research developments include discoveries on two broad fronts. Calamus is the largest genus of palms (350 species) and is important as the natural source of the cane material rattan. Research collaboration with graduate students Renée Richer and Russell Spangler, and with Jack Fisher at the Fairchild Tropical Garden, Miami, shows that



A forest harvest in western Massachusetts.

although these climbing palms can develop stems up to 200 m long, their vascular system is discontinuous. This puzzling observation questions assumptions about long-distance water transport in plant stems and is being extended to other climbing palms. This has given the opportunity to resurrect unpublished analyses carried out by Martin Zimmermann in the 1970s.

Stem form in woody plants has long been known to foresters to include the ability of mature stems to reorient opportunistically by forming peculiar reaction fibers ("tension wood fibers") that have contractile properties. A broadened basis for understanding this mechanism is provided by unusual distribution of these fibers in a number of tropical plants, often with direct ecological implications. These include extra-xylary fibers in the tropical gymnosperm Gnetum that maintain crown form, concentrically developed fibers in the aerial roots of Ficus that make the "strangling" habit possible, and eccentric fiber development that erects the seedlings of mangrove Rhizophoraceae. The last may explain the distinctive viviparous condition that characterizes many plants of mangrove communities.

**Harvard Forest LTER Program**

The Harvard Forest is one of twenty-five sites in the Long Term Ecological Research (LTER) program sponsored by the National Science Foundation (NSF). 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. Foster, D. Kittredge, G. Motzkin, D. Orwig, A. Ellison) at Harvard University, as well as the Ecosystems Center–MBL, Woods Hole (J. Melillo, K. Nadelhoffer, P. Steudler), the Complex Systems Research Center at the University of New Hampshire (J. Aber) and the University of Massachusetts (M. Mulholland). 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 measurements of forest structure and function; (3) experimental manipulations; and (4) synthesis and modeling. The LTER science group meets approximately monthly. The Harvard Forest Ecology Symposium is held to present current research with abstracts published annually. The program for the 2001 symposium is included in this report.

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.

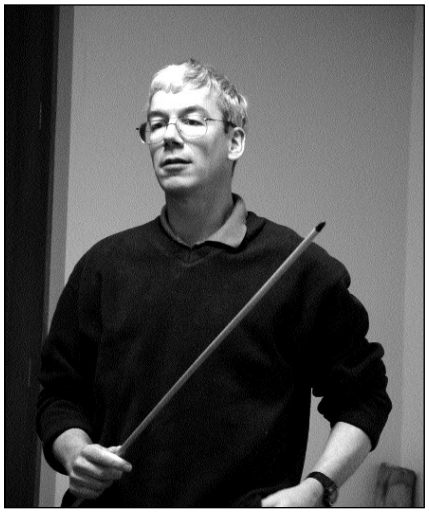
**National Institute for Global Environmental Change (NIGEC)**

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 (Bazzaz, Foster, Melillo, Nadelhoffer, Wofsy) 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).

**HARVARD FOREST ECOLOGY SYMPOSIUM 2002 – ABSTRACTS AND PRESENTATIONS**

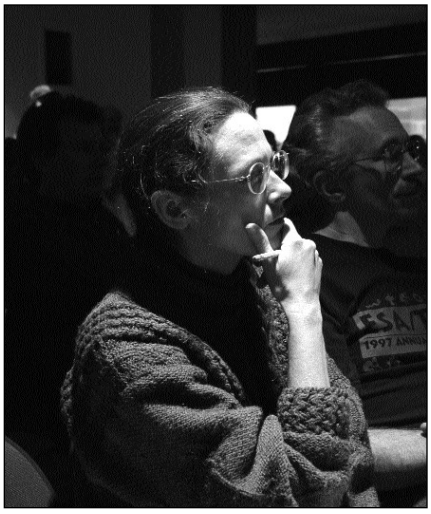
Titles of Abstracts and Presentations (*summer undergraduate student)

*C. Arabia,* E. Davidson, K. Savage, and P. Steudler.* Suppression of Soil Respiration by N Deposition.
*A. Barker Plotkin and D. Foster.* Carbon Storage Over 32 Years in a Temperate Deciduous Forest.
*A. Barker Plotkin, Kristin Wilson,* and D. Foster.* Stand Development After Hurricane Disturbance.
*D. Barnes, J. Elkins and M. McElroy.* Greenhouse and Ozone-Depleting Gases in Rural New England.
*J. Bellemare.* An Assessment of Historical Land-Use Effects on Rich Mesic Forests.
E. *Boose, D. Foster, A. Barker Plotkin, and B. Hall.* Hurricane Impacts Across the Yucatan.
*W. Borken, E. Davidson, K. Savage, P. Steudler, and E. Sundquist.* Drought and Snow Effects on Soil Methane Oxidation.
*R. Cobb and D. Orwig.* Studies of Hemlock Woolly Adelgid Infestation on Decomposition.
*D. Fitzjarrald, R.. Staebler, R. Saka,i and M. Czikowsky.* Forest-Atmosphere Exchange Processes.
*D. Francis, E. Doughty, and E. Drew.* Distribution of Midge (Chironomidae) Remains in New England Lakes.
*J. Hadley.* Old Growth Hemlock: The Annual Pattern of Carbon Exchange.
*B. Hall, G. Motzkin, D. Foster, M. Syfert, and J. Burk.* Historical Land Cover and Land Use in Massachusetts.
*L. Hutyra, C. Barford, E. Pyle, D. Bryant, B. Curry,* J. Silvis,* and R. Wofsy.* Harvesting and Carbon Stocks.
*S. Kaufman and F. Bazzaz.* The Effect of Nitrogen Deposition on Alliaria petiolata and Indigenous Species.
*D. Kittredge.* Forest Preservation to Management: Conservation in a Landscape with Diverse Ownership.
*D. Kittredge, J. Burk, D. Foster, and G. Motzkin.* Timber Harvest as a Form of Disturbance in Massachusetts.
*M. Kizlinski, D. Orwig, and D. Foster.* Vegetation and Ecosystem Response to Hemlock Decline and Logging.
*K. Lewis.* Defense Chemistry in Invasive Plant Species: What Role Does it Play in Invasiveness?
*H. Lux, F. Bowles, S. Morrisseau, J. Melillo, and P. Steudler.* Warming and Ecosystem Carbon Balance.
*A. Magill and J. Aber.* Chronic Nitrogen Additions to Two Forest Stands.
*P. Micks and K. Nadelhoffer.* Soil Respiration and Response to Soil Temperature.
*Q. Min.* Impacts of Aerosols and Clouds on CO2 Uptake over Harvard Forest.
*Q. Min and B. Lin.* Microwave Land Surface Emissivities over Harvard Forest.
*S. Morrisseau, H. Lux, J. Melillo, P. Steudler, and F. Bowles.* Eleven Years of Soil Warming on Prospect Hill.
*G. Motzkin, D. Foster, B. Hall, and D. MacDonald.* Regional-Historical Perspectives into Conservation of Uncommon Plant Communities: a Study of the Northeastern Coastal Region.
*J. Munger, C. Horii, A. Bright, J. Budney, et al.* Reactive Nitrogen at Harvard Forest: Update for 2001.
*J. O'Keefe.* Regeneration Following Clearcutting of Red Pine Overstory – Year 12.
*J. O'Keefe and T. Jones.* Woody Species Phenology, Prospect Hill Tract, Harvard Forest – 2001.
*D. Orwig.* Forest Dynamics with Chronic Hemlock Woolly Adelgid Infestations in Southern New England.
*D. Orwig, G. Motzkin, and D. Foster.* Ridgetop Pitch Pine and Red Pine in Southern New England.
*D. Orwig, R. Cobb, M. Kizlinski, and D. Foster.* Ecosystem Consequences of Hemlock Woolly Adelgid.
T. *Parshall, D. Foster, S. Barry Musielewicz, E. Faison, D. MacDonald, and E. Doughty.* Fire History in New England from Charcoal and Pollen in Lake Sediments.
*L. Sack and N. Holbrook.* The "Hydrology" of Temperate Deciduous Leaves.
*K. Savage, W. Borken, and E. Davidson.* Drought Effects on Soil Respiration in a Temperate Forest.
*K. Stinson and F. Bazzaz.* Ecology, Evolution and Physiology of the Invasive Plant Species, Alliaria petiolata.
*M. Tingley,* D. Orwig, G. Motzkin, R. Field, and D. Foster.* Avian Response to Hemlock Decline.
*S. Trumbore, W. Borken, E. Davidson, and K. Savage.* Respired Soil Carbon During Severe Summer Drought.
*A. Uraguchi.* Relationship Between Pattern of Growth/Allocation and Life History of Deciduous Trees.
*S. Urbanski, C. Barford, J. Munger, and S. Wofsy.* Factors Controlling C Exchange: Hourly to Annual Scales.



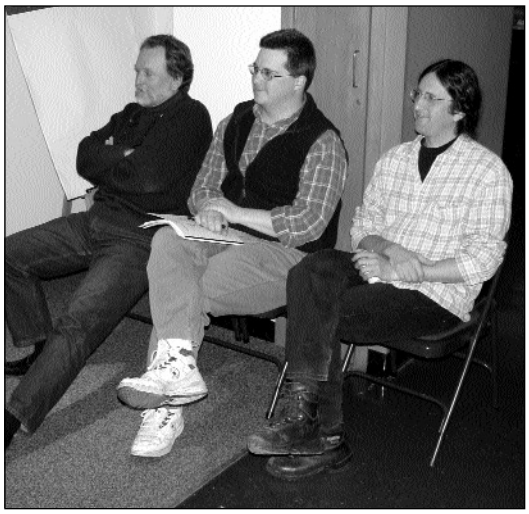
Dave Hollinger.

Mike McElroy.



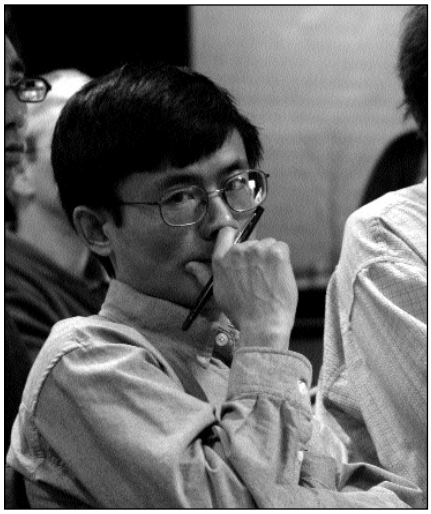
Kathleen Donohue.

Charlie Cogbill, Neal Scott, Neil Pederson.

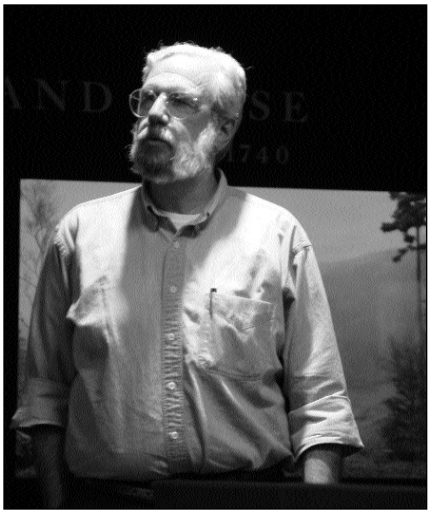


Kim Smith, Dave Orwig, Glenn Motzkin.

Ruth Reck.



Xihui Lee.

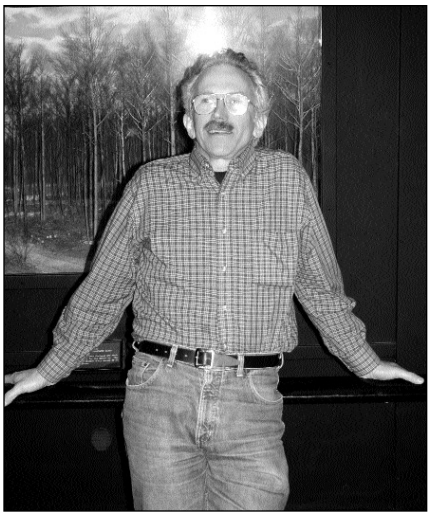


Paul Steudler.

# ANNUAL SYMPOSIUM

Joe Elkins.

Dave Fitzjarrald.



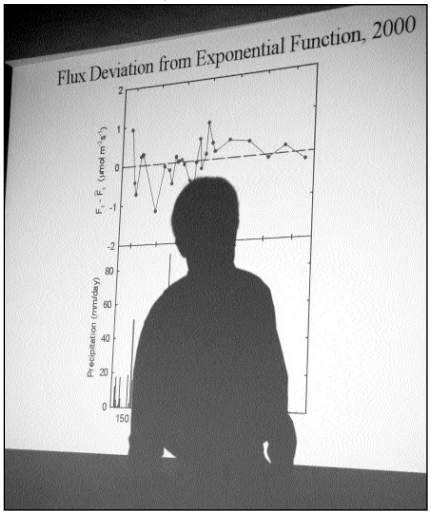
Julian Hadley.

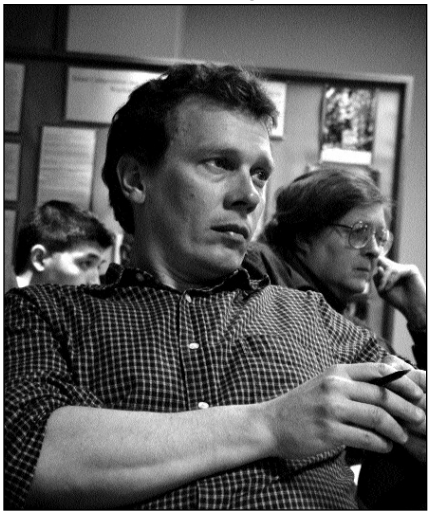

Lucy Hutyra.

Eddy Flux Tower.

Bill Munger.

Steve Wofsy.



Neil Pederson.

**BULLARD FELLOWS**

Alison Berry (University of California at Davis) focused her investigations on the effects of intensive urbanization on natural ecosystem functioning, from both scientific and policy perspectives. Her main emphasis was on soil ecology in relation to urbanization. In collaboration with the paleoecology group at Harvard Forest, she initiated studies to characterize changes in soil microbial communities accompanying land-use changes. She participated in a roundtable sponsored by the Institute for Cultural Landscape Studies at the Arnold Arboretum on science, policy, and management for urban landscapes.

Betsy Colburn initiated a study on intermittent headwaters as habitat for stream salamanders and aquatic invertebrates and began developing a research program in collaboration with David Orwig and others on potential effects of hemlock woolly adelgid on stream ecology. She continued her vernal pool research by processing field samples from prior collections, identifying specimens, and verifying identifications at the Harvard University Museum of Comparative Zoology and through consultation with specialists. Betsy wrote several research papers for publication, revised a book manuscript, and gave four scientific presentations. She served as consultant to the Mass. Natural Heritage Endangered Species Profram (NHESP) and The Nature Conservancy (TNC) on issues associated with conservation of aquatic biodiversity, U.S. EPA on wetlands bioassessment, and MA DEM on vernal pool conservation and management. Betsy served on one graduate student committee, provided informal mentoring to three other graduate students, served as judge of student presentations at North American Benthological Society's (NABS) annual meeting, and mentored two REU summer students at Harvard Forest

Betsy Colburn.

Aaron Ellison (Mt. Holyoke College) spent the majority of his sabbatical year writing. With colleague Nick Gotelli (University of Vermont), he completed seven papers on the evolutionary ecology of pitcher plants and the invertebrates that live in association with these otherwise carnivorous plants. Notable among these was a paper in Proceedings of the National Academy of Sciences on the effects of nitrogen deposition on pitcher plants, in which they proposed a simple biological indicator for nitrogen deposition and saturation rates in bogs. He also began work on a biostatistics textbook to be published by Sinauer Associates.

Colin Orians (Tufts University) initiated a project examining how xylem vascular architecture constrains the response of forest trees to environmental heterogeneity. In general, trees are thought to be highly sectorial – composed of multiple autonomous sectors. As a consequence, nutrients captured by one sector are unlikely to travel to other sectors. However, we have found differences among tree species in sectoriality. Preliminary evidence shows that *Betula* is not sectorial (resources travel easily throughout the plant), *Fraxinus* and *Quercus* are highly sectorial, and *Acer* shows moderate sectoriality. In addition to quantifying patterns of sectoriality, Colin is examining the ecological consequences of sectoriality to nutrient capture and transport. The availability of soil resources is often patchy and Colin is testing the hypothesis that less sectorial species are better able to move nutrients from resource-rich patches to the most rapidly growing leaves and branches.

Dr. Akile Pite (Albania) evaluated management policies for protected areas in Albania. To examine U.S. policies, he had contact with the Adirondack Park Agency, the Environmental Conservation Commission in New York State, The Trustees of Reservations, Quabbin Reservoir's Massachusetts District Commission (MDC) staff, and Friends of Quabbin. He prepared one manuscript "For Better Management of the Protected Areas in Albania."

Kimberly Smith (University of Arkansas) worked on two edited volumes, *Conservation Priorities for Birds at Risk in Latin America* and *Current Knowledge and Future Needs for Research on Migratory Birds of*

Akile Pite.

*Southeastern United States*. He also began work on a third volume, *The Arkansas Breeding Bird Atlas*. He completed manuscripts on habitat mapping for bird conservation in North America, zoogeography of mammals of the Korean Peninsula, genetic analysis of black bears in the southeastern United States, home range and habitat selection in southern flying squirrels, human population growth in counties surrounding federal lands, and potential impacts of the current red oak borer infestation in the Ozarks on bird community structure. A proposal was submitted to NSF on the last topic in December and resubmitted in July. With Glenn Motzkin, he started a research project on the history of periodical cicada emergences in Massachusetts and the demise of one brood due to land-use changes in the early to mid-1800s. He presented seminars at the Harvard Forest, Boston University, and Providence College and wrote four short historical pieces for the ornithological journal, *The Auk,* for which he currently is editor-in-chief.

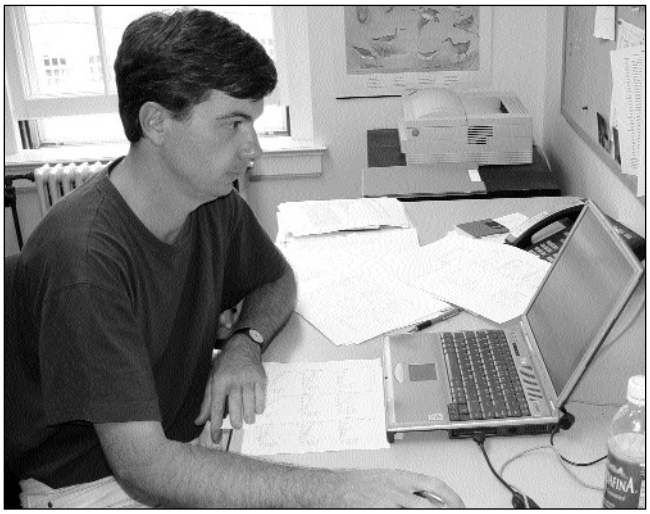
Bernhard Stadler (University of Bayreuth, Germany) initiated an experiment to study the effects of trophic interactions between hemlock woolly adelgids and epiphytic bacteria on the spatial and temporal variability in flows of energy and matter through the canopy of hemlock. At each of three sites showing different degrees of infestation (Harvard Forest=uninfested, Devils Hopyard=medium infested, Seldom Neck=heavy infested) throughfall solutions are collected underneath four trees, each about 5 meters tall. To investigate the within tree variability in infestation rates, litter production, microorganism abundance/diversity, and throughfall chemistry three throughfall samplers were placed beneath each tree; one close to the trunk, the second close to the periphery of the canopy, and the third in between. The study will be linked to litter decomposition experiments by manipulating the quantity and composition of wet and dry (e.g., wax) input. The goal is to understand the effects of an introduced pest species on transforming small-scale ecosystem processes and landscapes.

Navjot Sodhi (National University of Singapore) wrote two manuscripts and a review of avian extinctions in tropical forests. As tropical forests are being lost at an alarming rate, his review shows that species with large or heavier bodies and those foraging on insects, fruits, or both are particularly extinction prone.

Bullard Fellows for 2002–2003 include Philip Burton (Symbiois Research and Restoration, Canada), Peter Franks (James C. Cook University, Australia), Alice Ingerson (Arnold Arboretum, Harvard University), Matthew Kelty (University of Massachusetts), David Lindenmayer (Australian National University), Francis Putz (University of Florida) and Bernhard Stadler (University of Bayreuth, Germany)

**EDUCATIONAL ACTIVITIES**

David Foster, John O'Keefe, Dave Orwig, Glenn Motzkin and other staff members led the Harvard Forest Freshman Seminar of eight students in the



Bernhard Stadler.

Harvard Forest Freshman Seminar.

spring. Barry Tomlinson was facilitator in a course at the National Tropical Botanical Garden, Kalaheo, Kauai, Hawaii in July 2001, funded by the Kenan Foundation. The course objective was to enhance the teaching of botany in introductory biology courses, with an emphasis on tropical plants and was attended by instructors from ten colleges and universities in North America.

**Summer Research Program**

The Harvard Forest Summer Student Research program, coordinated by Edythe Ellin and assisted by Laura Schreeg, attracted a diverse group of students to receive training in scientific investigations, and experience in long-term ecological research. Students work closely with researchers and many conduct their own independent studies. The program includes weekly seminars with 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 is made to the Institute of Ecosystem Studies (Millbrook, N.Y.) to participate in a Forum on Careers in Ecology. Students present major results of their work at the Annual Summer Student Research Symposium.

*Summer Students 2002*

| | |
|---|---|
| Brent Berger | Oklahoma City Univ. |
| Amanda Brow | Eastern Kentucky Univ. |
| Brandon Burke | University of Florida |
| Matthew Bur | Harvard University |
| Elisabeth Dietrich | Yale University |
| Jacqueline Guzman | St. Edwards University |
| Jeffrey Law | Edinboro University |
| Kate Musgrove | Ulster County Community College |
| Nicole Nowinski | Carleton College |
| Sarah Pears | Dickinson College |
| Jennifer Petzold | Trinity College |
| Nicholas Povak | Virginia Polytechnic Inst. & State Univ. |
| Gregory Santoni | Harvard University |
| Joseph Seggio | Skidmore College |
| Sigrid Smith | Tufts University |
| Christopher Streeter | Harvard University |
| Jimmy Hung At Tran | Pennsylvania State Univ. |
| Naomi Wender | Harvard University |
| Eugenia Yazzie | Northern Arizona Univ. |

# HARVARD FOREST SUMMER STUDENT PROGRAM

Laura Schreeg, Proctor.

Kristina Stinson and Jen Petzold.

Jackie Guzman.

Kate Musgrove.


Maggie Dietrich.

Chris Streeter
and
Maggie Dietrich.

## 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.

In late August 2001 the long-awaited exhibit bringing the diorama story up to the present was installed opposite the 1930 land-use diorama. This exhibit, consisting of a large, back-lit photograph of the modern forest landscape and an adjacent panel illustrating and discussing the many changes in our vegetation and wildlife that have resulted from the land-use history depicted in the dioramas, was formally unveiled at our Annual Meeting in September.

In November the Museum volunteers celebrated the completion of another successful weekend schedule at our eleventh Volunteer Recognition Dinner, at which Mary Ann Walker received special thanks for her continuing, enthusiastic work as volunteer coordinator. A familiar group, including Bill and Marianna Berry, Hector Cameron, Walt Davidson, Bob Lane, and Martha Siccardi, received special recognition for being the most active volunteers during the season. In December the group was saddened by the death of Dr. Richard Riley, one of our original volunteers and a long-time friend of Harvard Forest.

During the year the Museum provided programs for nineteen elementary and secondary schools, thirty-three college and university classes, and twenty-two community and professional groups. In December the Forest hosted a joint workshop with the Massachusetts Executive Office of Environmental Affairs and the Massachusetts Land Trust Coalition to strategize protection of the Massachusetts landscape, and in June the Museum and Forest hosted the Massachusetts Department of Environmental Management's training for summer interpreters.

### Meetings, Conferences, Seminars

The Thirteenth Annual Harvard Forest Long-Term Ecological Research Symposium was held in the Museum on March 28 followed by the National Institute for Global Environmental Change meeting on March 29. Other meetings at Harvard Forest included meetings of the Massachusetts Executive Office of Environmental Affairs, Massachusetts Extension Service Coverts Project, Massachusetts Department of Environmental Management Logging Workshop, Massachusetts Land Trust Coalition, Massachusetts Audubon Society Staff Workshop, Massachusetts Forestry Association, New England Forestry Foundation, Mount Wachusett Community College, National Canon Envirothon Planning Group, North Quabbin Regional Landscape Partnership, Vegetation Control Service, and the Society of American Foresters Yankee Division. 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:*

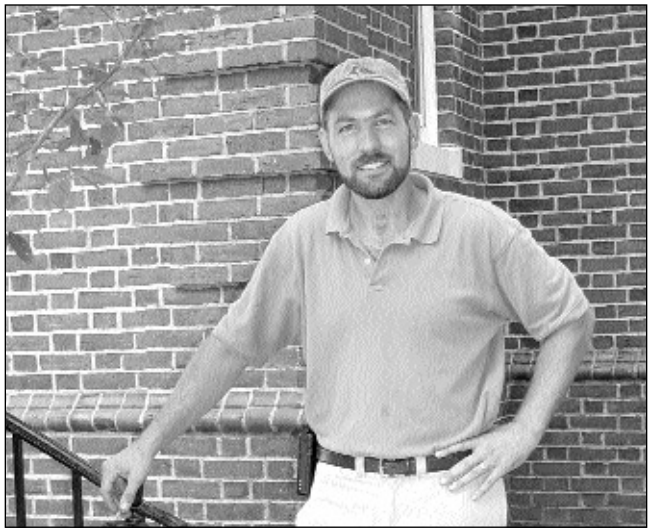
| | |
|---|---|
| John F. Ahern | U. Mass., Amherst |
| Marco Albani | Università di Parma, Italy |
| Anna Axelsson | Swedish University of Agricultural Sciences |
| Jesse Bellemare | Harvard Forest |
| Alison Berry | University California at Davis |
| Aaron Ellison | Mount Holyoke College |
| Elizabeth Farnsworth | New England Wild Flower Society |
| Richard Forman | Harvard University |
| Nick Gotelli | University of Vermont |

The boardwalk through Black Gum Swamp provides museum visitors and classes delightful access to an interesting forested wetland.

| | |
|---|---|
| Matt Kizlinski | Harvard University |
| Matthew Landis | Middlebury College |
| John Lichter | Bowdoin College |
| Andrea Lloyd | Middlebury College |
| Paul Moorcroft | Harvard University |
| Diana Muir | Newton, Massachusetts |
| Robert O'Connor | MA Executive Office of Environmental Affairs |
| Colin Orians | Tufts University |
| Lisa Park | University of Akron |
| Dylan Parry | SUNY, Syracuse |
| Peter Paton | University of Rhode Island |
| Akile Pite | Bullard Fellow, Albania |
| Karen Searcy | U. Mass., Amherst |
| Kimberly Smith | University of Arkansas |
| Navjot Sodhi | National Univ. of Singapore |
| Jay Stager | Paul Smiths College |

**FOREST MANAGEMENT AND MAINTENANCE**

The most important mission of the Woods Crew is to provide research support. This year, major projects included purchasing a Scanlift mobile bucket lift vehicle capable of reaching seventy-nine feet up into tree canopies with funding from NSF, HU OEB and HF endowment funds; building an equipment shed for Julian Hadley's new tower; and completely renovating the research scaffold towers, some of which were over ten years old. Another highlight of the year was the major renovation to the facilities portion of the basement including creation of a spacious new research equipment room and a spacious woodworking area with new lighting, an excellent air quality system, and new machinery. This project required

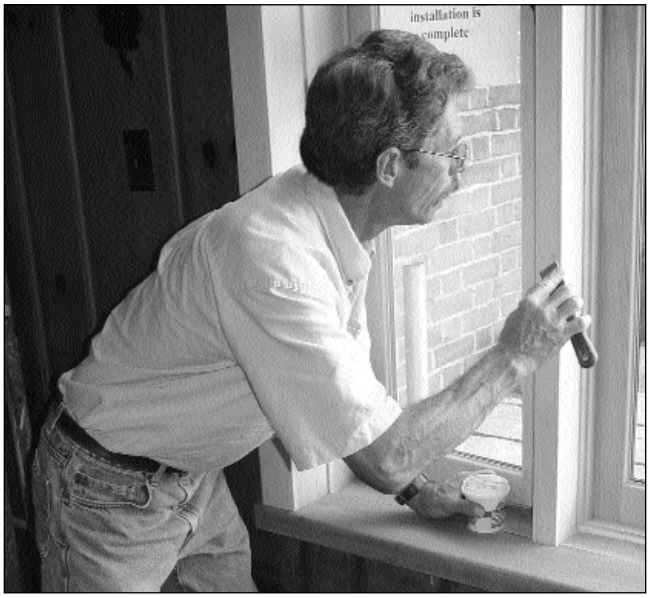


Adrian Fabos, New Facilities Manager.


Lucas Griffith.

the removal of decades of accumulated old fixtures and research equipment from the basement as well as significant asbestos abatement.

Another important project focused on the fronts of Shaler Hall and the Fisher Museum. This project




Woody Cole.

included: expanding and paving the front parking area around Shaler Hall; laying out new cobblestone walkways to the entrances, lighting improvements, and new landscaping including trees, shrub and plants. To maintain these improvements, we have hired a part-time gardener.

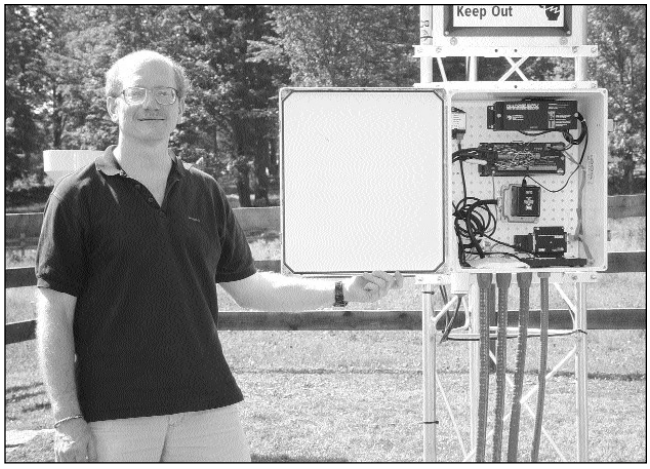
Other significant projects included refurbishing three apartments in the Community House; improvements to the cow pasture including building a new shelter for visiting cows and installing a wooden fence around the meteorological station to protect it from inquiring cows.

## COMPUTERS

Major improvements to our computer facilities continued this year with funding from NSF and Harvard Forest. Four new Windows 2000 servers were installed, including a Web server, a tape backup server, and two general-purpose servers attached to a 360gb RAID disk array. The new servers will provide a home for the Harvard Forest Web page and associated databases, centralized backup for individual computers, and a means to provide application software to users over the network. At the same time, more than fifty desktop computers were converted from Windows NT to Windows 2000, which offers improved networking and security as well as power-saving features. A new Intranet Web page was created for use by staff, students, and visiting scientists. Two general-use computers were installed in the Fisher House. Other improvements included a new voice mail system and conversion by the University of our networking equipment from hubs to switches. New purchases included three laptop computers, a new computer projector for the Seminar Room, and a second color laser printer for the Computer Lab. Plans for the coming year include installing a local Windows 2000 domain, upgrading our Web page for dynamic access to databases, and conversion of our scientific metadata to the new EML (Ecological Metadata Language) standard.

## ACTIVITIES OF THE HARVARD FOREST STAFF

Audrey Barker Plotkin participated in the course, "Forest Resources Management" at the University of Massachusetts and a workshop on upland forest use by vernal pool species. Audrey also updated a map of active research at the Forest and began an inventory of Harvard Forest's plantations. Jesse Bellemare presented a poster detailing the results of his research at the ESA.



Emery Boose.

Emery Boose was elected to serve on the LTER Information Managers Executive Committee (IMEXEC). He attended the LTER Information Mangers and ESA meetings in Madison, Wisconsin, and an IMEXEC meeting in San Diego, as well as NSF-funded workshops on scientific metadata (Phoenix) and wireless networking (Sevilleta). John Burk was named a regular contributor to *Natural New England* magazine, continued to serve as the Petersham town coordinator for Massachusetts Biodiversity Days, and assisted the Petersham Historical Society with preparations for the towns upcoming 250th anniversary. Julian Hadley presented research results at an International Union of Forest Research Organizations (IUFRO) meeting, at ESA, and at an American Geophysical Union (AGU) meeting.

David Foster spent three days in Madison, Wisconsin, where he gave the keynote seminar to the Ecology Group's annual graduate student symposium, led discussions with the environmental history, restoration ecology, and The Intergrative Graduate Education and Research Traineeship (IGERT) groups, and visited with many colleagues and friends. He joined Bernd Heinrich and Tom Wessels in a two-day symposium at Bowdoin College presenting talks on conservation and landscape history, and gave the keynote seminar at the annual meeting of the Ecotarium in Worcester. In June David was presented with the Goodwin-Niering Center's Environmental Achievement Award at Connecticut College. He gave seminars and led discussions with students at Connecticut College and in Concord, Massachusetts, the latter in conjunction with a talk at the Concord Land Trust. David and Steward Pickett joined together to lead seminars and discussions on ecological and conservation issues in urban-suburban areas for the Arnold Arboretum's Institute of Cultural Landscapes. David represented the Forest at the LTER Coordinating Committee meeting in Albuquerque, participated in a (successful) writing workshop for a NSF biocomplexity proposal, and continued to serve as editor for Ecosystems and Northeastern Naturalist, and on the boards for NIGEC, Highstead Arboretum and Conservation Research Foundation. In July he traveled with his family to the Galapagos where he was a lecturer on a Harvard Alumni Association trip.

A trip to the Big Reed virgin forest in northern Maine by Dave Orwig, Glenn Motzkin, and David Foster was guided by Shawn Fraver and other graduate students from the University of Maine.

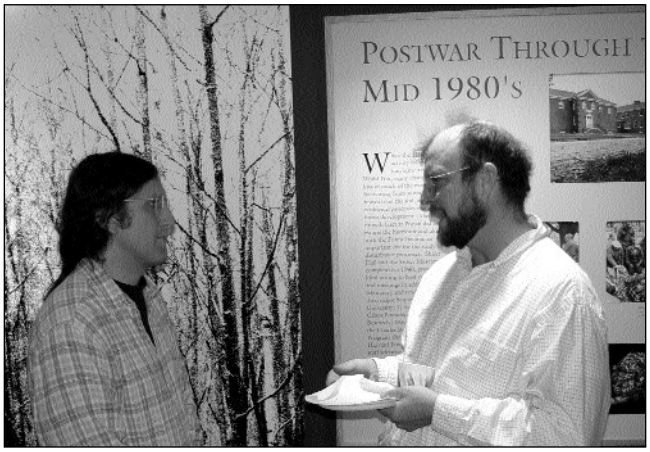
Dana MacDonald led six field trips for the University of Massachusetts Department of Landscape Architecture and Regional Planning, one community outreach woody plant identification trip at the Harvard Forest, and a field trip at the 2001 Pine Barrens Research Forum at Brookhaven National Laboratories, Brookhaven, N.Y. He co-led a field trip for the State of Massachusetts Biodiversity Days in the town of Pelham and worked with Audrey Barker Plotkin to organize the Harvard Forest seminars and lab group meetings.

Glenn Motzkin presented seminars at Bridgewater State College, Pelham Historical Society, New England Botanical Club, and The Nature Conservancy's Hoft Farm on Martha's Vineyard, where he spoke to summer research assistants working for the Marine Biological Laboratory and The Nature Conservancy. Glenn attended conferences on Prescribed Fire in Massachusetts, Rare Lepidoptera in Northeastern Pine Barrens, and the Ecology and Management of Early Successional Habitats in the Northeast. Glenn also led field trips at Mt. Tekoa and Harvard Forest for the Freshman Seminar class, as well as a field trip to Montague Plain for the New England Botanical Club. Glenn served on the thesis committees of Els Malfait and Frederik Debaeke, two undergraduates from Katholieke Universiteit Leuven in Belgium who spent two months at Harvard Forest. He continues to serve as an Ecology Advisor for The Trustees of Reservations, an associate member of the Massachusetts Natural Heritage and Endangered Species Program Advisory Committee, and a member of the Cooper Award Committee of the Ecological Society of America.

John O'Keefe gave talks on Harvard Forest research and the history of northeastern forests at the University of Massachusetts in Amherst and the Eastern Native Tree Society meeting at Mohawk Trail State Forest, and led workshops on forest interpretation at the Massachusetts Department of Environmental Management interpreter's training. John again judged the Mahar High School Science Fair in March, and serves on the boards of the Mount Grace Land Conservation Trust, where he is currently 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 Secretary Durand's Advisory Group on Environmental Education. In May John and his wife, Lynne Stopen, traveled to China to meet and bring home their new daughter, Sara.

Dave Orwig attended and presented two talks at the Hemlock Woolly Adelgid Symposium in East Brunswick, N.J., and presented a seminar at the University of Massachusetts, where he became an adjunct faculty member.

Julie Pallant attended New England Regional Computing Program (NERCOMP) 20002 Annual Conference sponsored by EDUCAUSE, "New Directions in Collaboration: Support, Strategy, Content, Emerging Technologies, and Infrastructure." She also completed "Web Development and Fundamentals," a graduate course at the Harvard Extension School. Kristina Stinson presented a paper at ESA.




Glenn Motzkin and Tom Rawinski.

**VISITING RESEARCH SCIENTISTS AT THE HARVARD FOREST 2001–2002**

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 |
| William Bain | Harvard University |
| Peter Bakwin | Harvard University |
| Carol Barford | University of Wisconsin |
| Diana Barnes | Harvard University |
| Fakhri Bazzaz | Harvard University |
| K. Boering | Harvard University |
| Werner Borken | Woods Hole Research |
| Richard Bowden | Allegheny College |
| Frank Bowles | Ecosystems Center – MBL |
| Alfram Bright | Harvard University |
| David Bryant | Harvard University |
| John Budney | Harvard University |
| Liz Burroughs | Ecosystems Center – MBL |
| Sean Burrows | University of Wisconsin |
| Michael Canfield | Harvard University |
| V. Y. Chow | Harvard University |
| Alan Coleman | Harvard University |
| William Currie | Virginia Polytechnic Univ. |
| Eric Davidson | Woods Hole Research Center |
| Bruce Daube | Harvard University |
| Frederik Debaeke | Kuleuven, Belgium |
| Kathleen Donohue | Harvard University |
| Jim Ehleringer | University of Utah |
| Bob Evans | U.S.D.A. Forest Service |
| Rebecca Field | University of Massachusetts |
| David Fizjarrald | SUNY, Albany |
| Andrew Finley | University of Massachusetts |
| Richard Forman | Harvard University |
| Steven Frolking | University of New Hampshire |
| Julia Gaudinski | UCLA, Irvine |
| Elaine Gottleib | Harvard University |
| Gonzalo Giribet | Harvard University |
| Mark Helmlinger | NASA Jet Propulsion Laboratory |
| Joseph Hendricks | University of New Hampshire |
| Michelle Holbrook | Harvard University |
| David Hollinger | U.S.D.A. Forest Service |
| Cassandra V. Horii | Harvard University |
| Lucy Hutyra | Harvard University |
| Daniel Jacob | Harvard University |
| Christine Jones | Harvard University |
| Sylvan Kaufman | Harvard Unversity |
| Otto Klemm | Univ. of New Hampshire |
| Juri Knjazikhin | Boston University |
| Takashi Kohyama | Hokkaido University |
| Chun-Ta Lai | University of Utah |
| Cathy Langtimm | U.S.G.S.; Holy Cross College |
| Barry Lefer | Univ. of New Hampshire |
| Kristin Lewis | Harvard University |
| Heidi Lux | Ecosystems Center – MBL |
| Alison Magill | Univ. of New Hampshire |
| Lynn Margulis | University of Massachusetts |
| Mary Martin | Univ. of New Hampshire |
| Peter Melcher | Harvard University |
| Jerry Melillo | Ecosystems Center – MBL |
| Patricia Micks | Ecosystems Center – MBL |
| Jacqueline Mohan | Duke University |
| Jennie Moody | University of Virginia |
| Jeff Morisette | NASA |
| Sarah Morisseau | Ecosystems Center – MBL |
| Mitch Mulholland | University of Massachusetts |
| Ranga Myneni | Boston University |
| J. William Munger | Harvard University |
| Knute Nadelhoffer | Ecosystems Center – MBL |
| Tommi Nyman | Harvard University |
| Jeffrey Parker | Smithsonian Environ. Res. |
| Jeri Lynn Parrent | Duke University |
| Jennifer Pontius | U.S. Forest Service |
| Ronald Prinn | M.I.T. |
| Elizabeth Pyle | Harvard University |
| Michael Rogers | GA Institute of Technology |
| Lawren Sack | Harvard University |
| Kathleen Savage | Woods Hole Research Center |
| David Schaub | University of Arizona |
| Tim Sipe | Franklin & Marshall College |
| David Sonnenfroh | Physical Sciences Inc. |
| Rachel Spicer | Harvard University |
| Rolf Staebler | SUNY, Albany |
| Paul Steudler | Ecosystems Center – MBL |
| Britt Stephens | Harvard University |
| Kristina Stinson | Harvard University |
| Eric Sundquist | U.S. Geological Survey |
| Robert Talbot | Univ. of New Hampshire |
| Matt Thompson | Harvard University |
| Susan Trumbore | University of California |
| Mel Tyree | University of Vermont |
| Aya Uraguchi | Hokkaido University |
| Shawn Urbanski | Harvard University |
| Kris Verheyen | Kuleuven, Belgium |
| Maciej Zwienecki | Harvard University |

**PUBLICATIONS**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- Division of Fisheries and Wildlife

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Ecological Restoration Program
Massachusetts Environmental Trust
Massachusetts Natural Heritage and Endangered Species Program
Andrew W. Mellon Foundation
Department of Energy, National Institute for Global Environmental Change
National Science Foundation
- Biological Field Stations and Marine Laboratories
- Digital Government Program
- Ecosystem Studies
- International Programs
- Long-term Studies
- Ecology Program
- Research Experience for Undergraduates

The Family of Richard Thornton Fisher
USDA Competitive Research Grants, Forestry
Southern Taconics Research and Conservation Center

**GIFTS**

Donations to the Harvard Forest library from Jim Baird were a welcome addition to its journal collection. Two years of *The Auk* and *Journal of Field Ornithology* were added. Bob Willhite donated a copy of his Harvard University Master of Forest Science thesis "Structure and Interrelationships of New England Attitudes and Perception Towards Some Aspects of Forest Management." Also Dave Kittredge gave a copy of "Southern Forest Resource Assessment Summary Report."

**NEW FUNDING**

Betsy Von Holle and David Foster. Disturbance histories as a predictor of habitat invasibility in a mosaic landscape: Cape Cod National Seashore. National Park Foundation. $150,000

David Foster and Kathleen Donohue. Harvard Forest REU research program in forest ecology. Harvard University Program for Training and Research in Ecology. National Science Foundation. $237,918.

Julian Hadley and David Foster. Harvard Forest carbon exchange modeling work in connection with digital aerial image analysis by U. Mass., Amherst. National Science Foundation. $10,000.

David Foster and Michelle Holbrook. A mobile canopy access platform for environmental and physiological research at Harvard Forest. National Science Foundation. $55,860.

David Foster and Julian Hadley. ITR/AP: The analytical web. (With U. Mass.). National Science Foundation. $300,000.

David Foster. Harvard University program for training and research in ecology. Andrew W. Mellon Foundation. $500,000.

Elizabeth Colburn and David Foster. Vernal pools in a landscape context: biodiversity and habitat. Massachusetts Environmental Trust. $20,000.

Elizabeth Colburn and David Foster. Monitoring and biological assessment of headwater habitat streams. EOEA-Massachusetts Environmental Trust. $19,924.

Julian Hadley and D. R. Foster. Evaluating the effects of diverse vegetation types and soil drainage classes on net carbon exchange of a landscape mosaic with mobile and fixed eddy covariance systems. NIGEC. $153,335.

David R. Foster
Director

Petersham, Massachusetts
August 2002