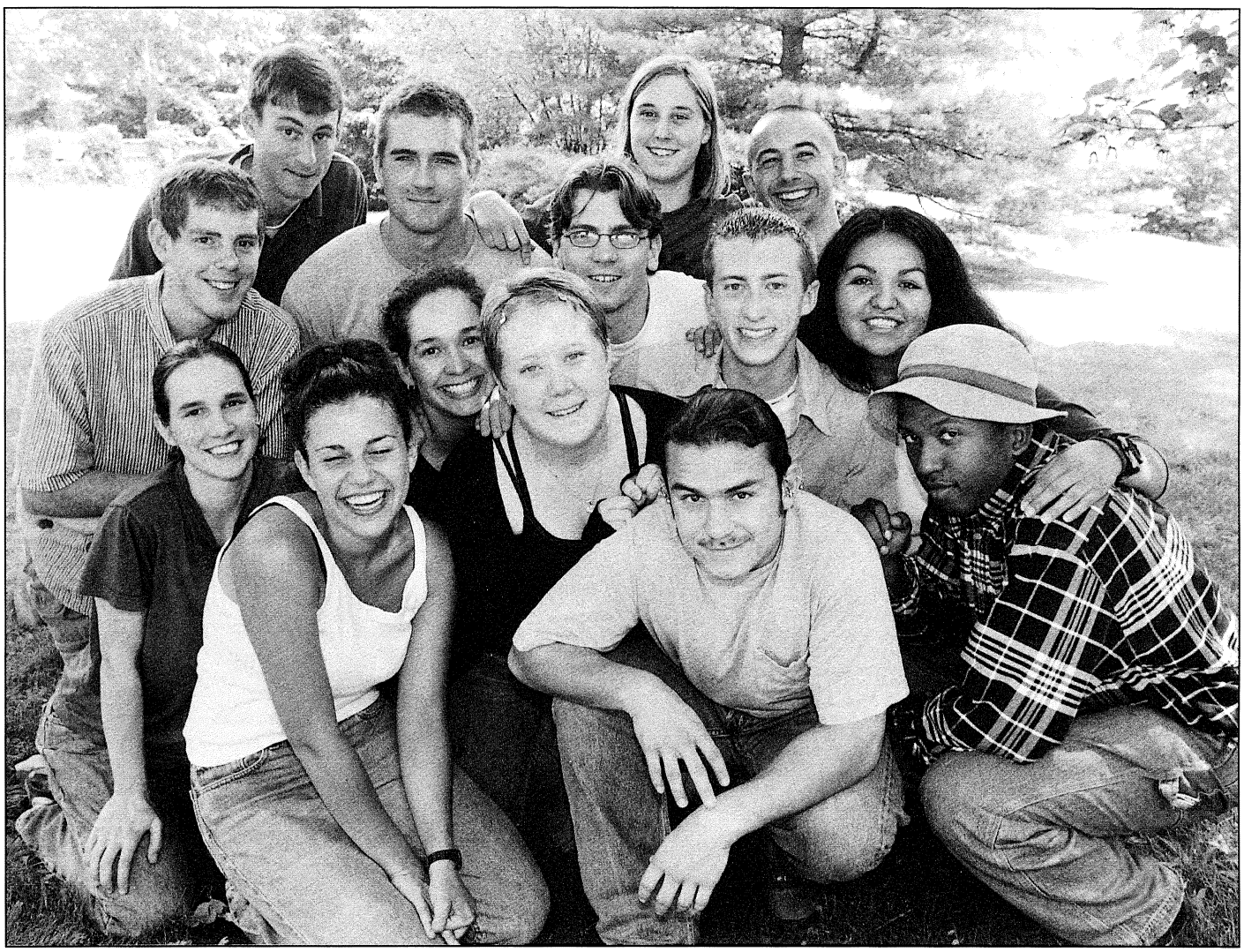
THE HARVARD FOREST 1999–2000
Harvard University



PERSONNEL AT THE HARVARD FOREST 1999-2000

Rebecca Anderson	MFS Candidate
Audrey Barker Plotkin	Research Assistant
Sylvia Barry	Research Assistant
Gutram Bauer	Post-doctoral Fellow
Jesse Bellemere	MFS Candidate
Emery Boose	Information and Computer Manager
Jeannette Bowlen	Accountant
Nick Brokaw	Bullard Fellow
Jessica Brown	Laboratory Assistant
Matthias Burgi	Post-doctoral Fellow
John Burk	Research Assistant
Alexis Calvi	Laboratory Assistant
Jiquan Chen	Bullard Fellow
Susan Clayden	Research Assistant
Richard Cobb	Research Assistant
Willard Cole	Woods Crew
Thia Cooper	Summer Program Assistant
Steven Currie	Research Assistant
Edythe Ellin	Adminstrator
Claire Dacey	Research Assistant
Peter Del Tredici	Bullard Fellow
Elaine Doughty	Laboratory Technician
Robert Eberhardt	MFS Candidate
John Edwards	Forest Manager
Ed Faison	Research Assistant
Barbara Flye	Librarian
Charles H. W. Foster	Associate
David Foster	Director
Donna Francis	Post-doctoral Fellow
Janice Fuller	Post-doctoral Fellow
Alexander Golub	Bullard Fellow
Julian Hadley	Research Associate
Brian Hall	Research Assistant
Linda Hampson	Staff Assistant
Paul Harcombe	Bullard Fellow
Jon Harrod	Post-doctoral Fellow
Donald Hesselton	Woods Crew
Eric Huber	Research Assistant
Malcolm Hughes	Bullard Fellow
Susan Johnson	Research Assistant
David Kittredge	Forest Policy Analyst
Matt Kizlinski	MFS Candidate
Takashi Kohyama	Bullard Fellow
Oscar Lacwasan	Custodian
Erin Largay	Research Assistant
Deborah Lawrence	Post-doctoral Fellow
Dana MacDonald	Research Assistant
Lisa Marselle	Summer Cook
Glenn Motzkin	Plant Ecologist
John O'Keefe	Museum Coordinator
David Orwig	Forest Ecologist
Julie Pallant	Assistant Information and Computer Manager
Tim Parshall	Post-doctoral Fellow
Diego Perez-Salicrup	Post-doctoral Fellow
Richard Primack	Bullard Fellow
Dorothy Recos-Smith	Staff Assistant
Emily Russell	Visiting Scholar
Stephen Scheckler	Bullard Fellow
Robin Sievers	Summer Program Assistant
Ben Slater	Research Assistant
Charles Spooner	Woods Crew
Mindy Syfert	Research Assistant
P. Barry Tomlinson	E. C. Jeffrey Professor of Biology
Claire Williams	Bullard Fellow
John Wisnewski	Woods Crew
Steven Wofsy	Associate

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 at the Forest have focussed on silviculture and forest management, soils and the development of forest site concepts, the biology of temperate and tropical trees, forest ecology, forest economics 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 forest ecosystems. This activity is epitomized by the Harvard Forest Long Term Ecological Research (LTER) program, which was established in 1988 through funding by the National Science Foundation.

Physically, the Harvard Forest is comprised of approximately 3000 acres of land in Petersham, Massachusetts that include mixed hardwood and conifer forests, ponds, extensive spruce and maple swamps, 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 provides office and laboratory space, computer and greenhouse facilities, and a lecture room and lodging for seminars and conferences. 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. Residences include Fisher House with room for groups of twenty, and four houses and ten rental apartments for visiting researchers, students and postdoctoral fellows.

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), and the Graduate School of Design (GSD) at Harvard and with the Department of Natural Resources 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.

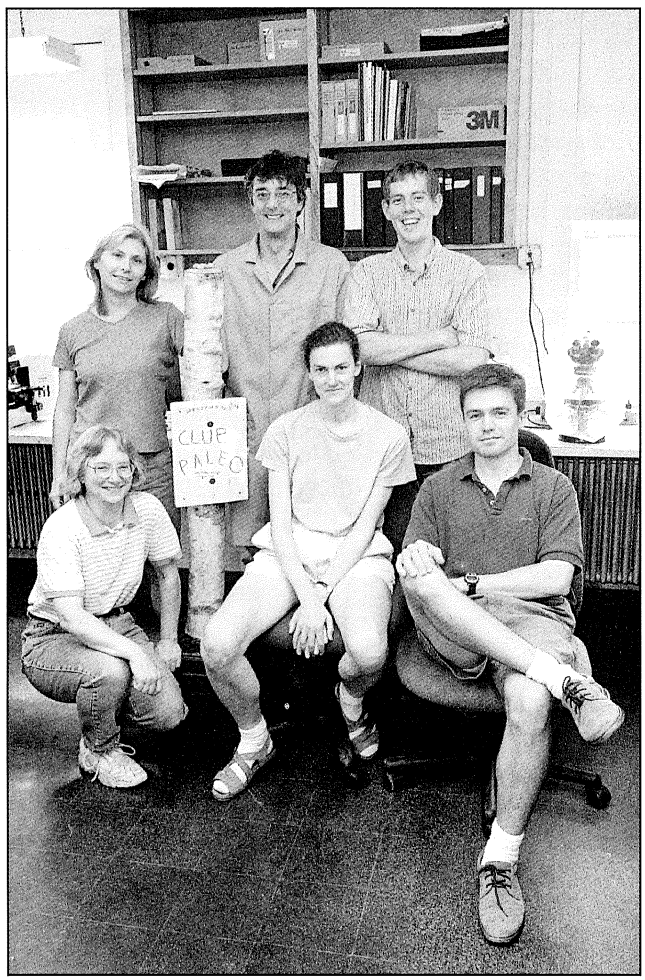
The staff and visiting faculty of approximately 50 work collaboratively to achieve the research, educational and management objectives of the Harvard Forest. A management group comprised of the Director, Administrator, Coordinator of the Fisher Museum, and Forest Manager meets monthly to discuss current activities and to plan future programs. Regular meetings with the HF LTER science team provide for an infusion of outside perspectives. Forest management and physical plant activities are undertaken by our four-member Woods Crew and directed by the Forest Manager. The Coordinator of the Fisher Museum oversees many of our educational and outreach programs.

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

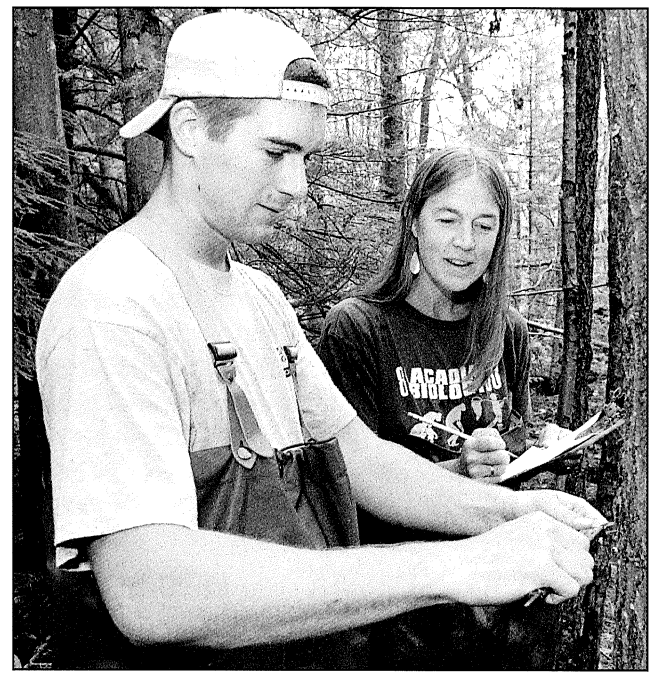
NEW STAFF

Sylvia Barry who received her M.S. degree from the University of Minnesota is working as Laboratory Coordinator for the paleoecology research group, which includes new research assistants, Dana MacDonald, who received an M.S. from the University of Michigan, and Ed Faison who graduated from Connecticut College.

Susan Johnson is a part-time research assistant working with John O'Keefe on a phenological research project and the Wofsy group on carbon sequestration, and helping the administrative staff. Eric Huber, a graduate of UC Berkeley, worked as a research assistant for Julian Hadley on the NIGEC project. Mindy Syfert, a recent graduate of Clark University, is a research assistant working with Glenn Motzkin and David Foster on a historical biodiversity project.



Sylvia Barry, Fraser Mitchell, Matt Kirwan, Elaine Doughty, Susan Clayden, Ed Faison



Summer student Shane Heath and Susan Johnson

Steven Currie, a graduate of SUNY–Syracuse, and Jessica Brown, a senior at Northfield Mount Herman, both worked with David Orwig on the hemlock wooly adelgid project as a research assistant and part-time lab technician, respectively. Erin Largay, a graduate of Connecticut College, worked as a research assistant with Jon Harrod, conducting a vegetation survey for the Cape Cod and Long Island project. Linda Hampson started working as a part-time Staff Assistant.

RESEARCH ACTIVITIES

Historical Ecology and Conservation of Coastal New England and Long Island

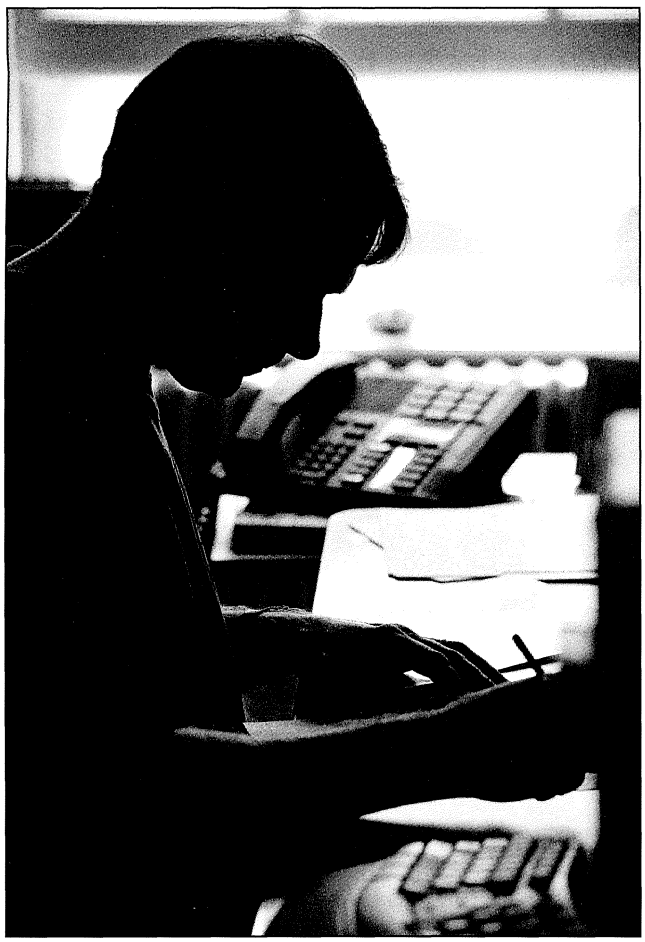
A major goal of plant ecology is to determine the factors that control species distributions and community composition. Although vegetation patterns result in part from species-specific responses to soil conditions and resource availability, actual species distributions at any point in time differ from potential distributions as a result of several factors, especially biotic interactions and historical factors such as natural and human disturbance. Disturbance may influence community patterns by (1) directly altering the environment and resource distributions, (2) creating opportunities for the establishment of new species, or (3) reducing pop-

Mindy Syfert and Glenn Motzkin

ulations of established species. For instance, our previous work has demonstrated that species with slow rates of dispersal or establishment may be absent from a site for decades or centuries, not because the site is inherently unsuitable, but simply because the species were removed by prior disturbance and have not had sufficient time to re-colonize. A major challenge for ecological study is to evaluate the relative contributions of current environmental conditions and historical factors in determining modern vegetation patterns and dynamics.

Following on previous studies in central Massachusetts, the Connecticut Valley, and Martha's Vineyard, David Foster and Glenn Motzkin are leading 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 because it 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 or rigorous attempt to evaluate the impact of historical land-use on species distributions and community assemblages across this region. Such an understanding is critical in order to interpret modern community patterns and species distributions, to identify appropriate ecological goals for conservation, and to develop management approaches for achieving those objectives.

Our current work emphasizes integrated paleoecological, historical, GIS, and field studies throughout the coastal region. Tim Parshall and David Foster are conducting 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. Jon Harrod and Rob Eberhardt are working closely with David and Glenn to evaluate the rela-



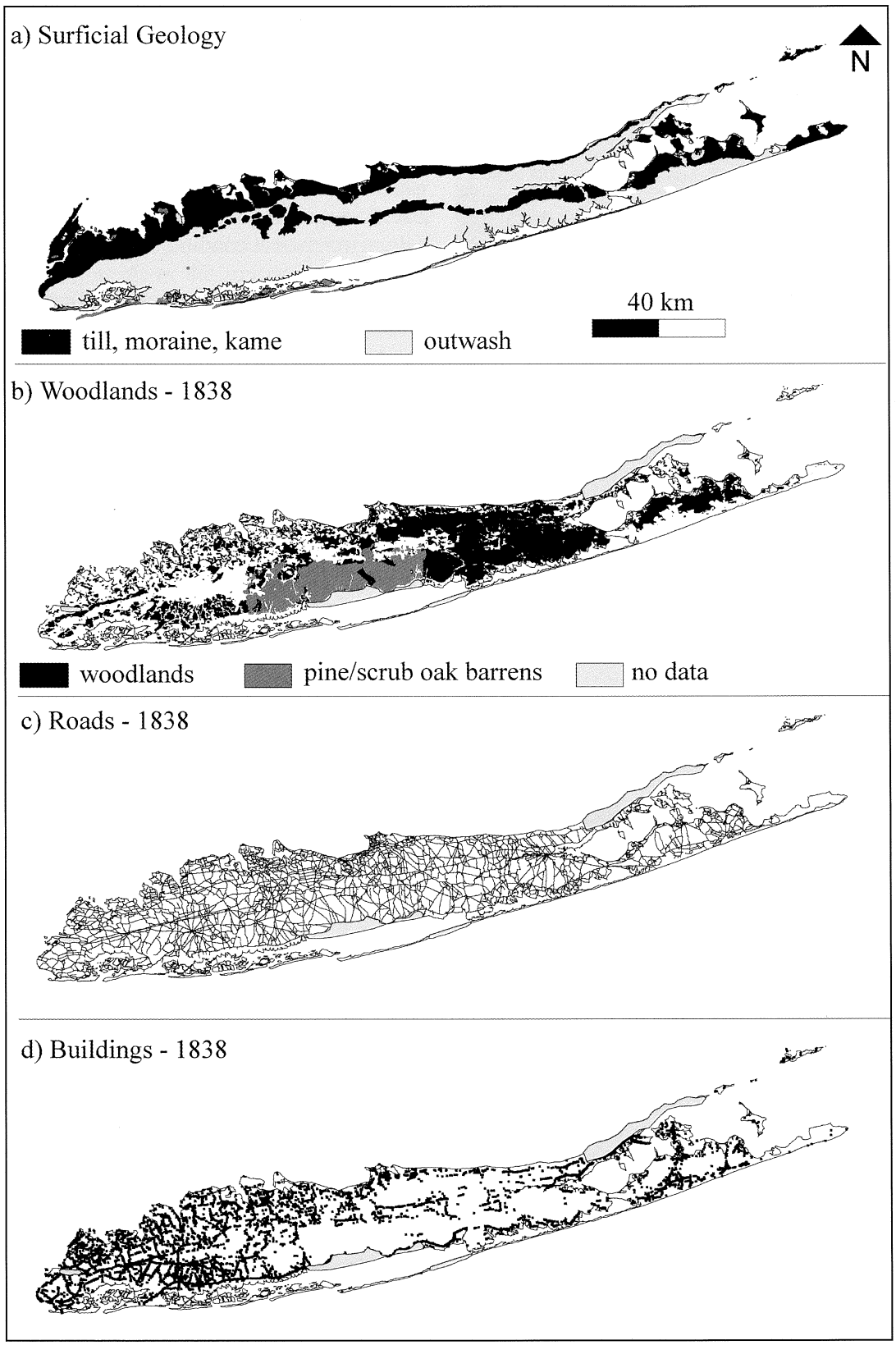
Brian Hall — The mind behind the maps

tionship between modern vegetation variation, site factors, and disturbance history. Field sampling this year, coordinated by Jon with assistance from Erin Largay, Dana McDonald, and summer students Laurie Miskimins, Sara Sabin and Sarah Sekinger, is focussed on grasslands, heathlands and shrublands of Cape Cod, Martha's Vineyard, Nantucket, and Long Island where land-use history and proximity to the coast appear to affect vegetation dynamics significantly.

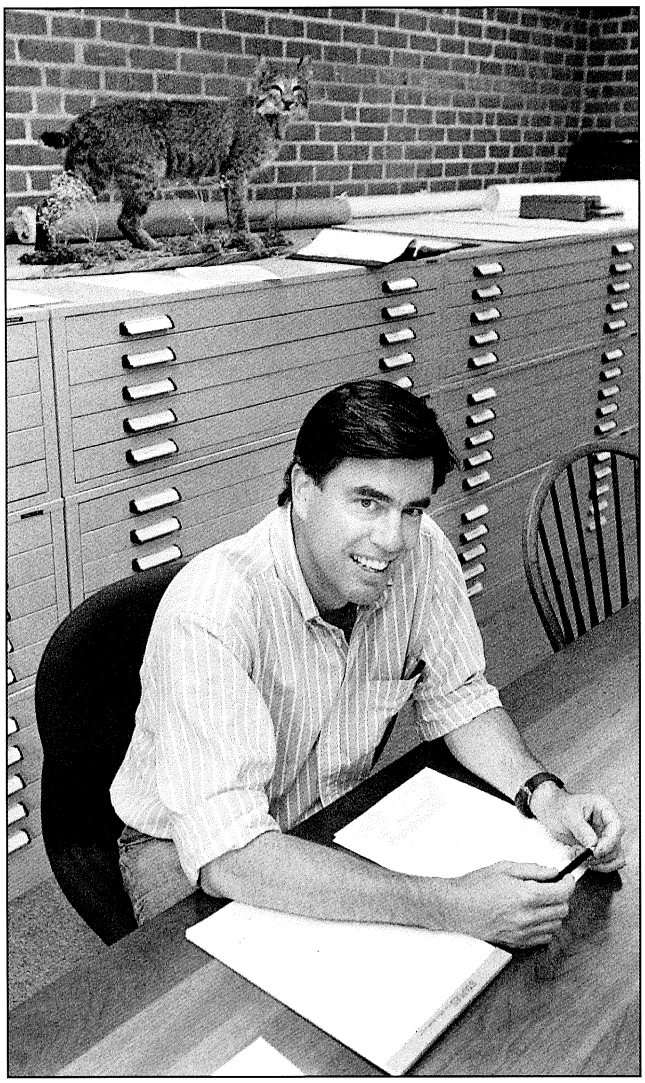
Tim Parshall, with assistance from Ed Faison, Dana MacDonald, Sylvia Barry, Elaine Doughty, Barbara Hansen, and David Foster, is coordinating the investigation of coastal fire and vegetation history based on charcoal and pollen preserved in lake sediments. Long-term records of ecological change are especially important for the coast where: 1) human impact on the vegetation (especially sandplain communities) has been great for millennia; 2) fire is important and can be understood only on the scale of hundreds to thousands of years; and 3) there are high concentrations of rare and uncommon species whose distributions are closely linked to the history of land use and fire. Sediment cores have been collected from six lakes on Cape Cod and are being analyzed for charcoal and pollen to develop 2000 year fire and vegetation histories for each site. Central to the analysis of charcoal is a new imaging system that captures pictures from a microscope and digitally stores them in a computer to measure the sizes of charcoal fragments. Results indicate that before European settlement, substrate and landscape position were strong factors influencing vegetation composition and disturbance. On moraines, oak and hardwood trees were more abundant and fires less common, whereas on outwash pine and fire increase. Over the past 300 years there has been a dramatic conversion of forested land to pastures and agricultural fields. Along with this conversion oak and hardwood trees declined and sediment organic content decreased. Human land use has clearly been the dominant force driving fire and vegetation change over the past 300 years, but the direction of change varies regionally.

Brian Hall's work on coastal maps has emphasized Long Island but has included digitizing (putting into a digital format in a Geographic Information System (GIS)) the U.S. Coast and Geodetic Survey maps of Long Island, Block Island, and Fisher's Island. This series of maps was made in the 1830s and 1840s, and contains much detailed information on the land cover at that time including forests, buildings, and roads. The maps covering the central part of Long Island show the extent of plains, pine/scrub-oak barrens, and shrub lands; these vegetation types are of major interest to conservationists. These GIS datalayers have proven to be critical in determining the history of sites sampled in the modern vegetation component of the coastal sandplain research project.

Last Fall Rob Eberhardt completed the field work for his MFS project investigating relationships among woodland vegetation patterns, land-use history, and site factors on Cape Cod National Seashore. Together with this summer's investigations of coastal heathlands, grasslands, and shrublands by Jon Harrod and



Long Island in 1838. In the mid-nineteenth century extensive areas of woodlands and scrub barrens occupied the central and eastern portions of the region on sandy outwash soils, whereas the human population settled the moister, arable morainal soils.



David Foster

others, Rob's work will help the National Park Service interpret and manage the Seashore's upland vegetation, which has changed dramatically over the last 150 years following agricultural abandonment. In particular, the present distributions of many plant species relate strongly to historic land-use, with hairgrass *(Deschampsia flexuosa),* bearberry *(Arctostaphylos uva-ursi),* and black cherry *(Prunus serotina)* more abundant on former agricultural sites, and clonal ericaceous shrubs (including *Gaultheria procumbens, Epigaea repens, Vaccinium angustifolium, V. pallidum,* and *Gaylussacia baccata)* more characteristic of woodlots that never were cleared for agriculture. Rob is refining explanations for these relationships by examining how site factors such as soil texture, nutrient levels, and topography vary with land-use and vegetation. Explanations that Rob is exploring include: (1) past land-use eliminated species from areas where they potentially occur, with legacies of land-use apparent today due to biotic limitations on reproduction, dispersal or establishment; (2) past land-use altered environmental conditions, which created habitats favorable to certain species; and (3) vegetation and past land-use both reflect initial environmental conditions.

Forest Ecosystem Dynamics and Hemlock Woolly Adelgid Infestation

The hemlock woolly adelgid (HWA), an introduced aphid-like insect that weakens and kills hemlock trees continues to expand across New England. Dave Orwig leads a major effort to document the movement and ecological impacts of this pest. In addition to addressing fundamental questions concerning the effects of biological invasions, this project is helping to identify management and policy options for landowners and agencies. During the summer of 2000, Dave, Richard Cobb, and summer students Aaron Weiskittel and Anthony D'Amato resampled permanent plots established in 1997 to examine the effect of hemlock decline and mortality from HWA on the timing and extent of nitrogen cycling changes. Soil analyses including pH, temperature, carbon to nitrogen ratios, texture, and total soil organic matter have been completed on these eight sites and the researchers are now measuring the rates of nitrogen mineralization in a larger subset of Connecticut sites that are infested with HWA. After the first two years of infestation, thinning canopies from heavy HWA damage resulted in increased light and decreased forest floor moisture content. In comparison with healthy forests, heavily infested sites tend to have higher net N mineralization rates, larger extractable ammonia pools, and a 25-fold increase in net nitrification rates. Lightly infested and undamaged stands typically showed no net mobilization of nitrate. These results indicate that introduced pests and selective tree decline can rapidly and dramatically alter ecosystem processes even prior to the onset of extensive tree mortality. Overstory and understory vegetation was also sampled in these forests and tree ring cores were obtained to examine average tree age and recent dynamics associated with the pest. Although hemlock crowns have started to thin, we have not yet observed understory vegetation changes associated with the adelgid on these sites.

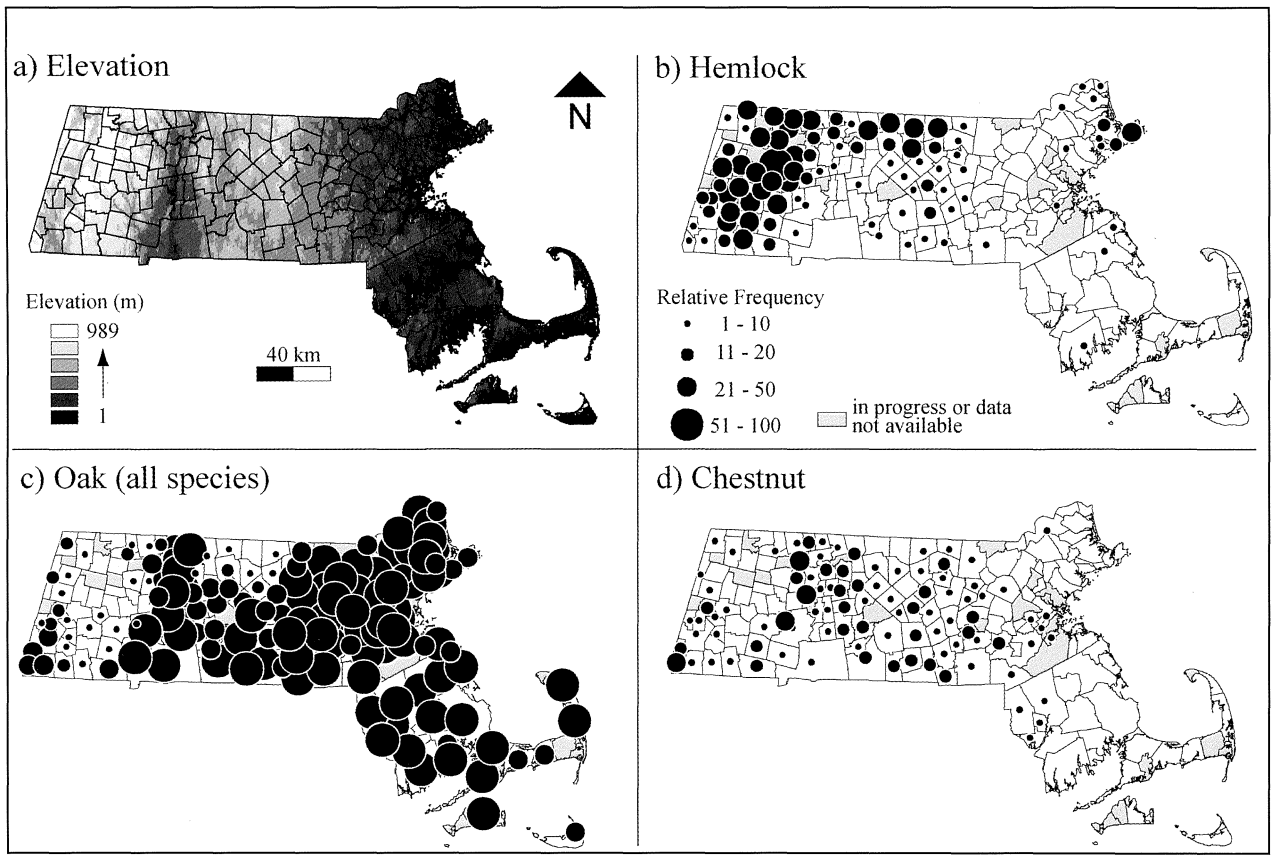
Richard Cobb, Steve Currie, and David Orwig initiated a study examining foliar litter decomposition in HWA-infested stands as litter plays a critical role in the assimilation and release of elements through forest ecosystems. Decomposition rates are closely associated with foliar quality and a growing body of knowledge suggests that insect attack can alter foliar chemistry. Understanding decomposition in HWA attacked ecosystems will be critical for determining how this infestation alters the function of hemlock ecosystems. The objectives of this study are: (i) to determine if HWA attack influences decomposition by directly altering foliar quality; and (ii) to determine if HWA attack influences decomposition by altering the forest microclimate. To accomplish this we designed an 18-month in-field decomposition study placing foliage from an uninfested stand and foliage from infested stands on the soil surface at each of eight study sites. Six-month results indicate that severe and moderate infestation levels of HWA are slowing decomposition. Although the trend was more pronounced in the severely infested sites compared to the moderately infested sites, decomposition was indistinguishable between the two types of litter. Soil temperatures are similar among all sites, however, the severely and moderately attacked stands have lower soil moisture. These results suggest that dry soil conditions associated with thinning hemlock canopies are slowing foliar decomposition.

Forest Composition and Distribution Through Time: the Context for Ecological and Biodiversity Assessment

Because the Massachusetts landscape has a long land-use history, efforts at conservation and long-term planning must incorporate an understanding of this past human activity and landscape modification. However, to date, information on regional patterns of vegetation and historical land-use have been unavailable for most studies. To address this gap David Foster and Glenn Motzkin have initiated two efforts: (1) development of a map of forest composition in southern New England at the time of European settlement; and (2) production of a map of forest distribution (versus cleared agricultural land) across Massachusetts at the peak of deforestion in the mid-nineteenth century.

John Burk, with assistance from Erin Largay and Brian Hall, has gathered colonial tree data for New England towns from sources such as state archives and libraries, town halls, registries of deeds, and historical societies to map forest composition before extensive European impact. The most comprehensive and desirable sources of data are original proprietor's lot division records; other sources include road and boundary surveys. In Massachusetts, every town was checked for records. Comprehensive coverage was found for most or all of the southern Connecticut River Valley and Plymouth, Bristol, Essex, Worcester, Hampden, and northern Middlesex Counties. The years for data ranged from the 1620s and 1630s for coastal and Connecticut Valley towns to the mid-1800s for the northern Berkshires, which was the last

Matt Kizlinski with soil samples from the hemlock project



Distribution of selected tree species in Massachusetts at the time of European settlement as determined from seventeeth and eighteenth century survey data. There is a clear climatic and elevational pattern, with hemlock abundant in the cool uplands and oaks more abundant in the warmer Connecticut Valley, lower elevations, and the coastal region. Interestingly, chestnut has a much more restricted distribution than oak.

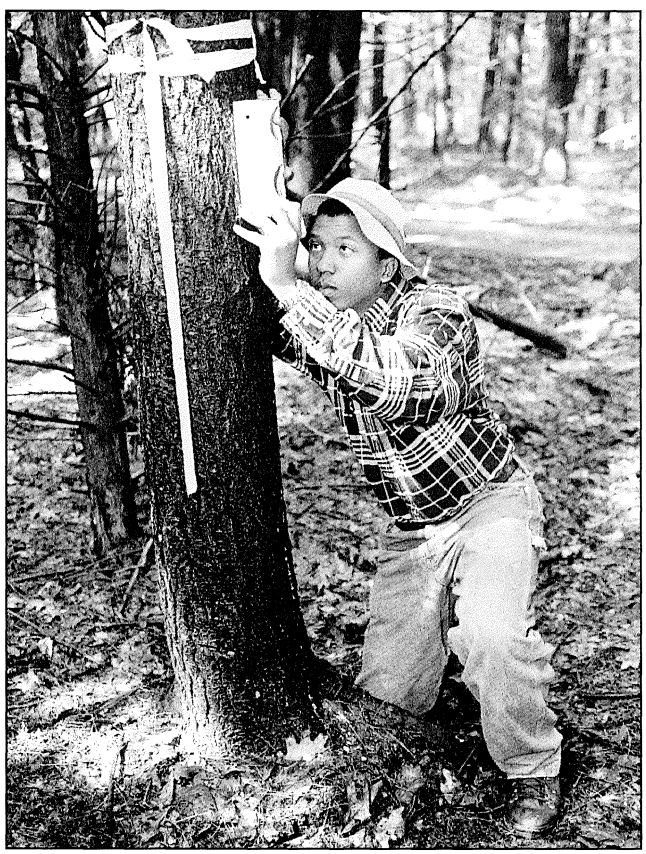
area of the state to be settled. The focus of Connecticut research to date has been the transect from the Connecticut River east to Rhode Island, which has yielded comprehensive data for much of this area except the central Connecticut Valley area. In the Killingsworth land books alone, nearly 4,500 trees were cited. In New Hampshire, proprietor data was gathered for 20 south-central towns. All data are being archived as a resource for use in present and future projects, including analyses and mapping of species distribution throughout the region. The findings were used by project collaborator Charlie Cogbill in a manuscript that addressed the presettlement vegetation of northern New York and New England and are proving valuable to other Harvard projects.

With support from the Massachusetts Natural Heritage and Endangered Species Program, David, Glenn, Mindy Syfert, Erin McCarty, and Brian Hall are developing GIS data layers that will allow for rapid assessment of the history of human land-use throughout the Commonwealth. Using maps that were generated for each town in the Commonwealth in response to a legislative mandate in 1830, we are developing GIS coverages that indicate the historical extent of forest land, open land, meadows, and cultural features, including roads, mills, meeting houses, etc. Because 1830 was at or near the period of maximum agricultural land clearance for much of New England, the resulting data layers will provide a reasonable approximation of the maximum extent of forest clearance. Such information will be valuable for a wide range of research, planning, and management efforts, including evaluation and prioritization for conservation, restoration, and long-term ecological management, comparison of primary versus secondary woodlands, and archaeological and cultural resource assessment.

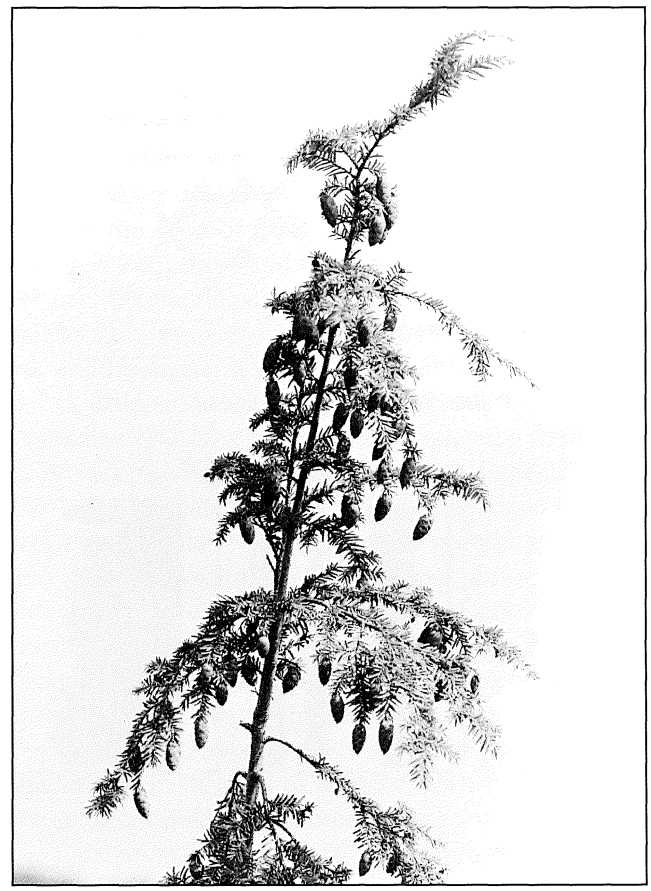
Influence of the Little Ice Age on New England Vegetation

As Harvard Forest studies of long-term changes in New England vegetation proceed it is becoming increasingly apparent that the factors driving these changes are especially difficult to identify and isolate from one another. One particular example that has strong relevance for our understanding and conservation of the modern landscape involves the substantial changes in forest composition that occurred in the period immediately before and then subsequent to the European settlement of the region.

To understand these changes and to relate them to modern ecological patterns, David Foster, Janice Fuller and Donna Francis initiated a study of the long-term dynamics of vegetation surrounding a suite of New England lakes, spanning climatic and vegetational gradients from southern Connecticut to northern Vermont. Lake sediments aging 1,500 years before present to today are being analyzed by Natalie Drake and Susan Clayden for vegetation changes represented in the pollen record. Diatoms are being analyzed by Doerte Koester and Reinhard Pienitz of the University of Laval and sediment isotopes by Brent Wolf at the University of Waterloo. Sylvia Barry is coordinating the field and laboratory activity. We have completed pollen records for this interval at North Round Pond in central New Hampshire, and Levi Pond in northern Vermont. Currently, Susan Clayden is analyzing the pollen in lake sediments from Walden Pond, in Concord, Massachusetts, a site of large historical interest fostered by the mid-nineteenth century writings of Henry David Thoreau, who lived in a cabin by the pond for two years and described the vegetation and pond in detail.



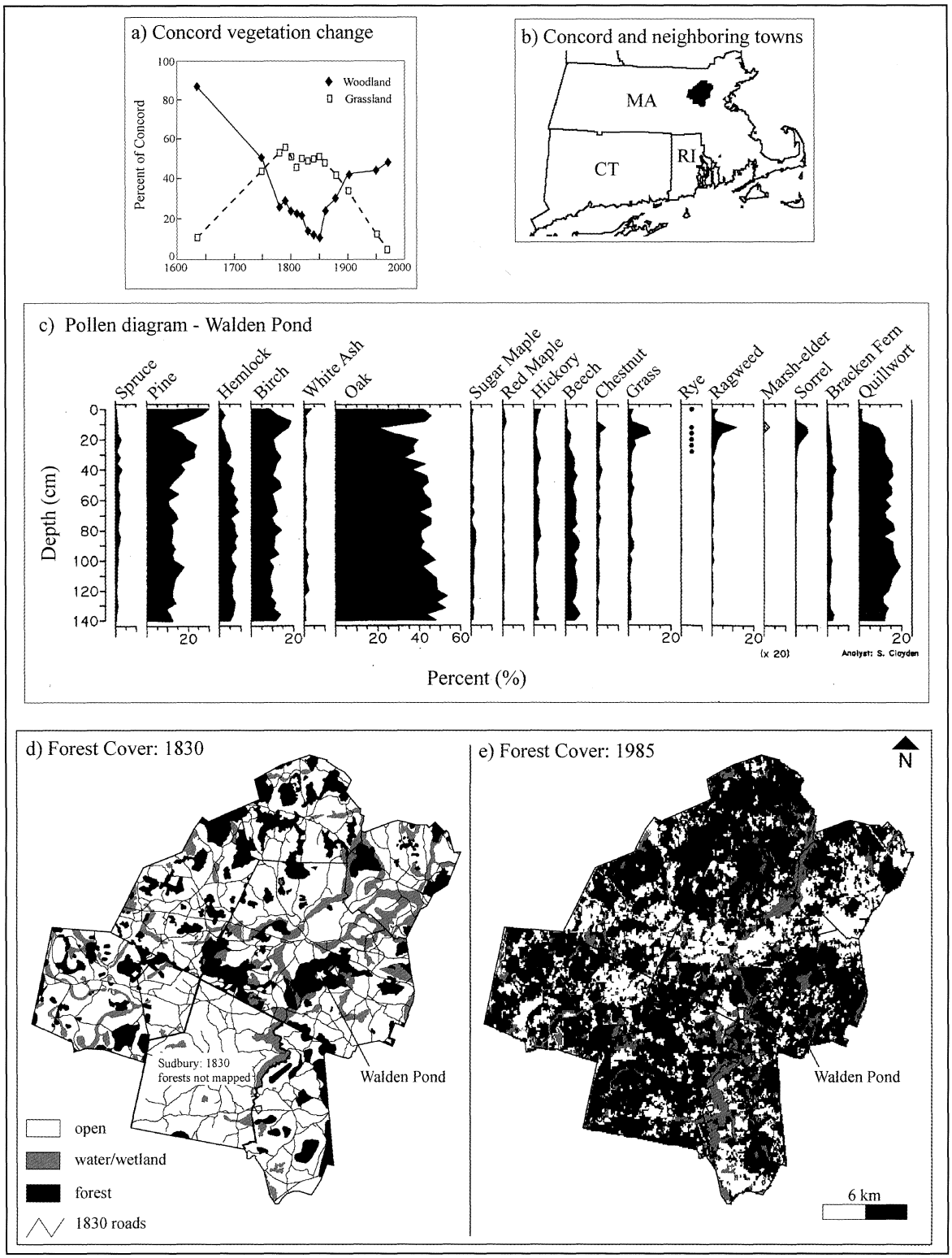
Sean Brown preparing to sample wood respiration from a hemlock tree



Eastern hemlock — 70 feet above the ground

Carbon Exchange of Old-growth Hemlock Forests

The first direct measurements of carbon exchange (uptake and release of carbon) by an old-growth eastern hemlock forest were made by Julian Hadley assisted by Eric Huber over a 12-day period in late July to early August using eddy covariance equipment loaned by David Hollinger of the U.S. Forest Service



Vegetation and cultural changes in the region around Walden Pond and Concord, Massachusetts over the past 1,000 years. Only minor changes occurred in the predominantly oak forest before European settlement as depicted in the pollen diagram from Walden Pond. However major shifts in species abundances accompany the tremendous change in forest cover due to agricultural clearing. Today the area supports more than twice as much forest as in the time of Henry Thoreau (1817–1862).

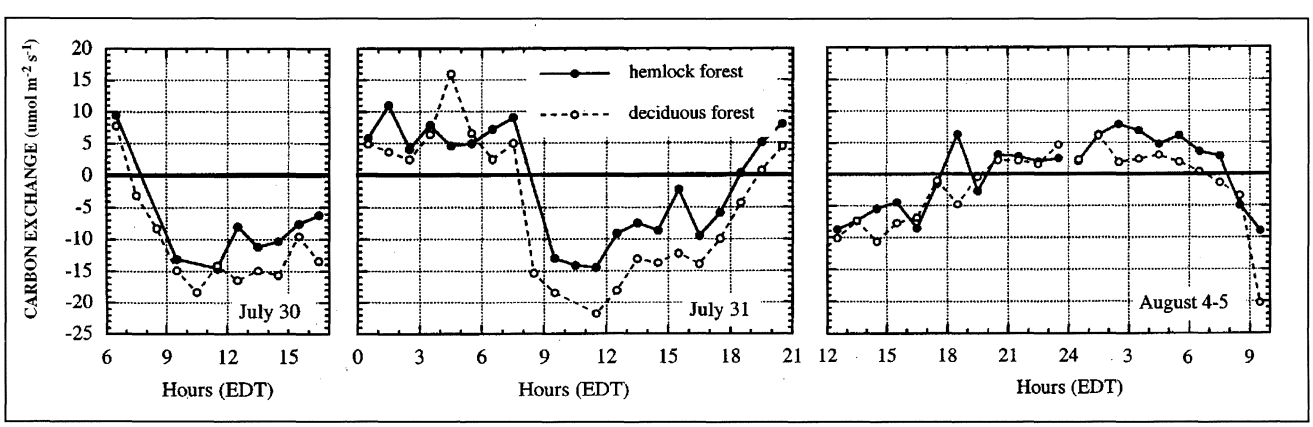
and the Ameriflux network. The resulting data set is being used to test predictions of a hemlock forest carbon exchange model and to compare the carbon exchange of old-growth hemlock versus a younger deciduous forest that continues to be studied by Steve Wofsy and colleagues in the Department of Earth and Planetary Sciences. Three conclusions were reached from the measurements and predictions of a hemlock forest carbon exchange model: (1) At night, the hemlock forest carbon exchange model predicted net carbon loss which was close to the average measured value. During the day, the model predicted less carbon uptake than was measured, on average. This was true even when red oak and white pine, which typically grow much faster than hemlock, were assumed to have twice as high a photosynthesis rate; (2) a graph of nighttime carbon release versus wind direction showed that the hemlock forest released much more carbon than forests dominated by other species; and (3) simultaneous measurements of carbon exchange by eddy covariance in the hemlock forest and in deciduous forest showed that the hemlock forest usually had higher nighttime carbon release and lower daytime carbon uptake.

Mice and Songbirds: Vertical Distributions and Predator-Prey Interactions in Oak Forests

Cathy Langtimm and Becky Field continue examining songbirds and white-footed mice, focussing on the possibility that mice are important predators on bird eggs. White-footed mice *(Peromyscus leucopus)* are ubiquitous in New England forests and have both positive and negative effects on plants and animals. On the positive side they eat many insects including the pupae of gypsy moths. They also eat seeds and can either reduce regeneration of plant species by consuming the seed or assist with regeneration through lost stores of acorns and seeds that they cache for winter use. On the negative side deer ticks, which transmit Lyme disease to humans, initially become infected with the bacteria by feeding on infected mice.

A little studied aspect of the mice is their climbing behavior. Cathy Langtimm completed a third year of work on the climbing activity of this species with the help of Ana Laborde, a summer student. They live-trapped small mammals on the ground, in shrubs, and in the crowns of canopy oak trees at two sites. All three years have shown marked differences in population densities and weather conditions. This year's drought stressed vegetation and severely reduced insect populations, especially mosquitoes. Mouse populations were the lowest in three years and climbing activity in shrubs was reduced, perhaps because of the smaller number of caterpillars feeding on leaves in the understory. Nonetheless, mice were still captured at low frequencies in canopy oak trees. As in previous years climbing activity in the understory increased from summer into fall as the number of insects, fruit, and seeds on plants increased.

Acorns are important for winter survival of mice and estimates of acorn abundance at both trapping

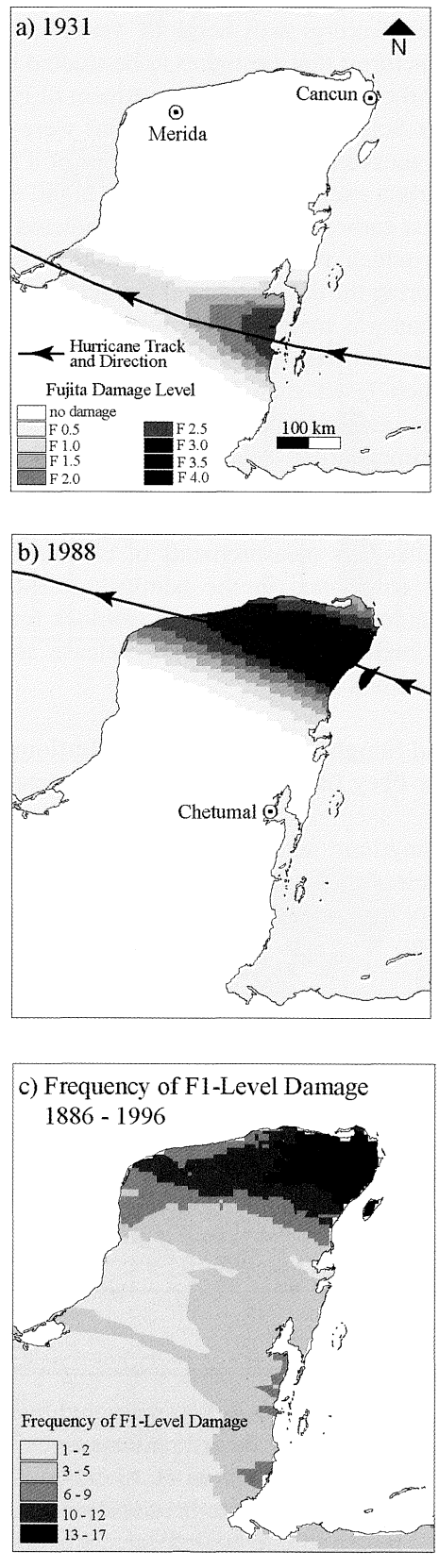


Hourly carbon exchange (CO_2) measured by eddy covariance at two locations at Harvard Forest in late July and early August 1999. Measurements at the hemlock site were over a 12-day period, but data presented here are only for periods of SW wind, when the wind blew over hemlock-dominated forest for an adequate distance (≈ 200 m) from the hemlock measurement site. Negative numbers indicate carbon uptake by the forest and positive numbers indicate carbon release to the atmosphere. Data from the deciduous forest site courtesy J.W. Munger, Department of Earth and Planetary Sciences, Harvard University.

sites continued in a collaborative study with John O'Keefe and Becky Field. Fall 1998's estimates successfully predicted the lower mouse population numbers in 1999. Fall 1999's acorn estimates were higher leading to an expectation of higher mouse population levels in the summer of 2000.

Mice and Stone Walls

Stonewalls, characteristic of the regenerated hardwood forests of post-agricultural New England, can provide nest sites and refuges to a wide variety of mammals, both predator and prey. Because there is variation in species preferences for different microhabitats, stonewalls could influence the distribution of small mammals within the forest as well as animal community composition. Differences in microhabitat use also have implications for plant-animal interactions. Because small mammals browse on plants and often cache and store seeds, animal activity can have a significant effect on regeneration and vegetation composition near and away from stonewalls. Ana Laborde investigated these issues for a senior thesis at Harvard by extending work begun by REU students Delia Santiago and Kevin Puhls. In collaboration with Cathy Langtimm, John O'Keefe, and David Foster, she examined the distribution of small mammals near stonewalls by trapping animals on three plots that varied in understory vegetation composition, moisture, small mammal composition, and stand age. Overall she found that in summer the Red-backed vole, *Clethrionomys gapperi,* was captured more frequently at stone walls, while the similarly sized White-footed mouse, *Peromyscus leucopus,* was more frequently captured away from walls. Although mice crossed the walls they appeared to have an aversion to foraging near stone walls. Competition between the two species did not appear to be the cause of the pattern as White-footed mice were only rarely caught at the wall on the plot where Red-backed voles were absent. There appeared to be no correlation of the pattern with the majority of the various habitat characteristics that Ana measured. However, at moist stations where



Reconstructions of select hurricanes and the long-term gradient of hurricane frequency to the Yucatan peninsula, Mexico. Damage ranges from F0 (branch break) and F1 (localized blowdown) to F4 (entire stands windthrown).

a seasonal stream flowed through one of the sites, the Red-backed vole was routinely captured near and away from the wall. Preferences for different humidity and temperatures may have an influence on the specific patterns for each species. It is also possible that differences in foraging behavior may play a part as well. In late fall after leaf fall, the pattern began to break down. The cover provided by stone walls may become more important at this time of the year for mice as they settle into winter nest sites and rely on their stored caches of acorns to see them through the winter. The implications these animal distribution patterns have for forest regeneration patterns remain to be explored. These results, however, add to a growing list of long-lasting impacts of land-use history on the New England landscape.

Forest Response to Land Use and Land Cover Change in the Yucatan

The Southern Yucatan Peninsula Region (SYPR) contains the largest and most threatened expanse of tropical forest in Mexico. The SYPR has experienced two historical waves of human activity. The first involved the Ancient Maya, who developed an elaborate culture largely dependent on corn *(Zea mays)* agriculture. Mayans inhabited the SYPR for more than 2,000 years, and largely abandoned the region at circa 800 A.D. resulting in broad-scale reforestation. The second wave occurred in the twentieth century and has included the exploitation of the timber tree species Spanish Mahogany *(Swietenia macrophylla)* and Spanish Cedar *(Cedrella odorata)*; the extraction of sap from the chicle tree *(Manilkara zapota)* for the production of chewing gum; and the establishment of immigrant farmers from other parts of Mexico who have engaged in shifting agriculture. Deforestation intensified under major governmental initiatives and following highway construction in 1967.

Drawing from extensive experience in New England and Puerto Rico, Harvard Forest researchers are investigating the role of historical land use and natural disturbances in shaping the structure and composition of forests in the SYPR. The work is part of a multidisciplinary collaboration with the College of the Southern Frontier (ECOSUR) in Mexico, and Clark University aimed at producing spatially explicit projection models of change in vegetation cover and land use. These models will be based on the interpretation of satellite imagery and a clear understanding of the social and ecological processes driving changes in vegetation and land use in SYPR. The research covers an area of c. 18,000 km^2, embracing gradients of precipitation, soil depth, elevation, hurricane exposure, and twentieth century land use. In addition to addressing key theoretical questions, research efforts seek to provide input to conservation efforts and land management.

Currently, the research of Harvard Forest in SYPR is concentrated on four efforts. First, using models developed at Harvard Forest, David Foster, Emery Boose and Brian Hall have produced maps of hurricane frequency since 1880. These models incorporate data from the U.S. National Oceanic and Atmospheric Administration (NOAA) and Mexican meteorological stations. Along with fire and human activity, hurricanes are a major natural disturbance that controls vegetation structure and dynamics in the SYPR. The second line of research undertaken by Audrey Barker Plotkin and David Foster seeks to extend regional land-use and land-cover data available from remote sensing through the interpretation of aerial photographs taken in 1969. The resulting maps document the establishment of settlements in SYPR promoted by Mexican government policies in the early 1970s and widespread forest disturbance by logging across large areas of SYPR.

In the third line of research, Diego Pérez-Salicrup has established a network of over 150 500 m^2 permanent plots in six sub-regions that capture gradients of rainfall, soil depth, elevation, hurricane frequency, and twentieth century land use. This plot network provides information necessary to classify the major forest types and to determine the major factors controlling their structure and composition. There are two broad types of forest: Low Statured Forests (LSF) and Mid Statured Forests (MSF). While these forest types can be readily identified based on tree composition they share more than 80% of their tree species. Because LSF grow on areas unsuitable for shifting agriculture and largely lacking ancient ruins, it appears that LSF were not used agriculturally by the Maya. Hence this forest type might have served as a repository for tree species diversity during the demographic peak of Maya activity when most of the landscape was cleared for forest. Consequently, MSF, which grow on agriculturally suitable soils and with a high presence of Maya ruins, might have been reforested from the tree species pool of LSF.

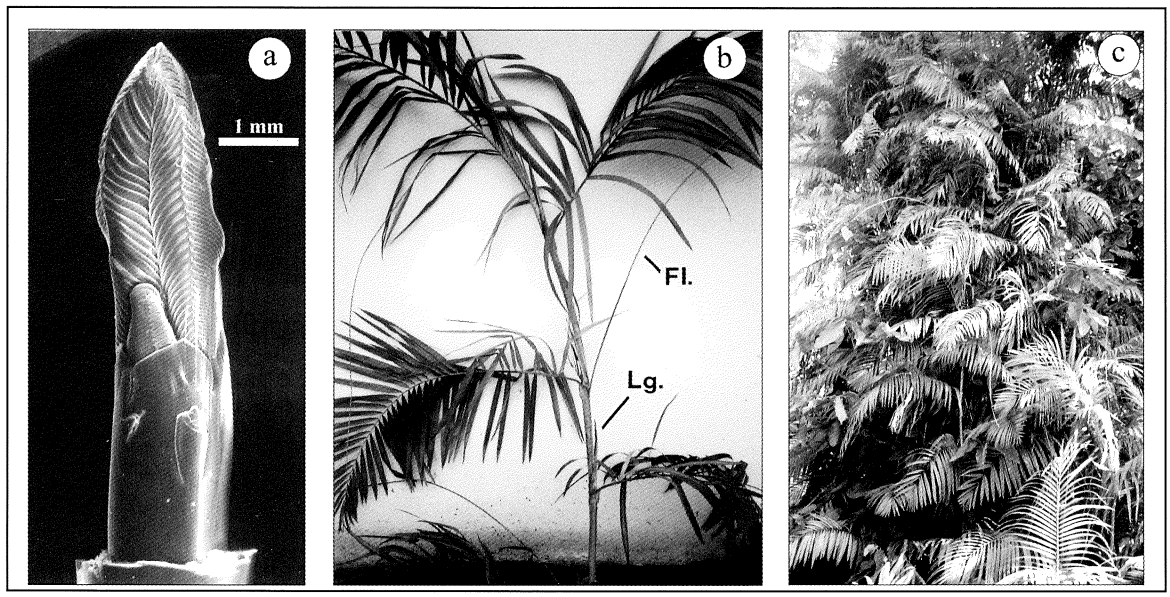
A second finding of Diego's research is that the recovery of tree species following the abandonment of agricultural fields is very fast. After 25–30 years, the

tree composition of fallow sites is not distinguishable from MSF. Two factors explain this rapid succession. First, this is the first agricultural cycle in over 1,000 years and conditions for tree species reestablishment are ideal due to limited soil nutrient depletion and the large expanse of remaining forest. Second, the shifting agriculture of the Maya may have selected for species that are resilient to such conditions.

The fourth line of research includes a characterization of plants that inhibit forest regeneration after shifting agriculture. Although forest regeneration is generally rapid, under some conditions related to fire and shifting agricultural practices, abandoned agricultural fields are invaded by bracken fern *(Pteridium aquilinum),* or by the annual herb *Viguiera dentata* and forest regeneration is retarded or brought to a halt. These two species of plants already cover extensive areas of abandoned agricultural lands next to roads and human settlements. Diego is conducting experiments in order to identify the biological characteristics that make these two plant species so successful once they have established, and possible mechanisms to eradicate them to promote forest regeneration.

Three students working with Diego developed independent field projects. Karen Vitkay and Ricardo Esquivel, presented their results at the Annual Meeting of the Association for Tropical Biology. Autumn Bryant wrote an undergraduate honors thesis, "Sustainable Forest Management and Forest Certification on the Southern Yucatan Peninsula, Mexico" at Oregon Sate University.

Sarah Martell and Audrey Barker Plotkin sampling understory response in the experimental hurricane.



The palm genus *Calamus* is the source of rattan canes, used in furniture. The palms are high-climbing lianas and a characteristic component of Asian rain forests. Research at Harvard Forest has deciphered the unusual vascular system of these canes. Shown are (a) scanning electron microscope photograph (SEM) of a developing shoot, (b) the extended shoot which is supported by a whip-like "flagella" (Fl.), the leaf shoot extended as a tubular "ligule" (Lg.), (c) the canopy of a dead tree festooned by climbing shoots.

Forest Response to Experimental Hurricane

In October 1990, the experimental hurricane study was initiated to simulate the impacts of the 1938 hurricane to mature hardwood forest. By pulling canopy trees over using a winch direct and indirect damage was generated in nearly 70% of the stand. One goal of the experiment is to study plant regeneration to document long-term changes in species composition. Seedling establishment and sprouting have been tracked over eleven years in 10m^2 plots in the experimental (0.8 ha) and control (0.6 ha) sites. Red maple, birch species, white ash and black cherry now dominate this regeneration, whereas red oak, which was dominant in the original forest is less abundant and below average in height. Sprouting was important in maintaining canopy cover initially; however, sprouts will likely have limited long-term importance in shaping the future forest structure and composition as they are dying and being replaced by saplings. We are doing a full ingrowth survey this summer to monitor the dynamics of this new cohort as it undergoes self-thinning and interacts with the remaining overstory trees. In addition, we are revisiting the original overstory trees to monitor survival and sprouting, and resurveying the understory flora of the experimental and control sites.

Botanical Studies

A study of the self-erecting habit of the viviparous seedlings of mangrove Rhizophoraceae was presented by Barry Tomlinson at a meeting in September 1999 of the Linnaean Society of London ("Under the Microscope"), the results to be published in their botanical journal. Further work has confirmed the original observation that the development of reaction fibers (tension wood) is the mechanism involved. A quantitative study of the distinctive vascular anatomy of the rattan palm *(Calamus)* was accepted for publication in the American Journal of Botany. Continuing research has elucidated developmental details. The vascular system of these long canes, which may reach close to 200 m in length must be efficient, and yet has been shown to be structurally discontinued. A study of the phyllotaxis of shoots in the conifers *Cephalotaxus* and *Torreya,* based on material grown at the Arnold Arboretum, was submitted for publication. Phyllotaxis is unusual in both genera in being bijugate (i.e., leaves in pairs, but the pairs spirally

MFS students: Rebecca Anderson, Matt Kizlinski and Jesse Bellemere

arranged), but in *Torreya* changes to distichy in the formation of bud-scales. In collaboration with Dottie Recos-Smith text for the second edition of *The Biology of Trees Native to Tropical Florida* was completed and work begun on the modification of the original drawings.

Graduate Student Research

During the past year Rebecca Anderson developed a research proposal focussing on the development and lateral expansion of forested peatlands in central New England. Peat, formed of partially decomposed plant remains, accumulates over time and preserves a record of the plant communities growing in the peatland. The objective of Rebecca's work is to evaluate the extent to which wetlands developed through expansion across upland sites and to document the timing of this development in relationship to past climate change. Based on extensive evaluation of sites across central and southern New England she selected three 10–12 hectare forested peatlands for intensive study. Fieldwork involves detailed mapping of the morphometry (sub-surface topography) of each wetland basin, characterization of the underlying sediments, and radiocarbon dating of peatland development. Results from this study will contribute greatly to our understanding of long-term landscape development in New England and to ongoing assessments of carbon dynamics in upland and lowland sites.

Jesse Bellemere is investigating the environmental and historical factors influencing the distribution of the rich mesic forest community in western Massachusetts. Rich mesic forests are uncommon woodland communities that support numerous rare plant species and have been identified by the Massachusetts Natural Heritage Program (MNHESP) as high priorities for conservation in Massachusetts. An initial inventory of sites was developed through consultation with other botanists, MNHESP data, field reconnaissance, and an aerial reconnaissance conducted in the spring when these sites are the earli-

Christine Muth and summer student Kate Capecelatro

est to green-up. During the fall and early winter of 1999 Jesse established research plots at ten of these sites in the eastern foothills of the Berkshire Mountains and began collecting tree and sapling layer data. In the spring he sampled the abundant spring flora, rich in wildflowers such as bloodroot, wild ginger and squirrel corn, typical of rich mesic forests.

Matt Kizlinski continued work on his Master's project studying the ecosystem and vegetation responses to hemlock logging. Ten sites in Massachusetts and Connecticut covering 13 years of post-logging succession have been selected. Overstory reconstruction and vegetation sampling are ongoing, as are measurements of nitrogen cycling, decomposition, and nutrient availability. These data will be used to compare and/or contrast the effects of hemlock woolly adelgid infestations to logging operations.

Increasing levels of nitrogen deposition in New England as a consequence of fossil fuel combustion pose a serious threat to the integrity of forests in the region. To examine how nitrogen deposition may alter the composition of these forests, Sebastian Catovsky (Ph.D. student in OEB) investigated how dominant evergreen coniferous and deciduous broad-leaved tree species at Harvard Forest differed in their responses to increasing nitrogen supply. He addressed nitrogen effects on two critical components of forest regeneration dynamics: (1) development of the understory seedling bank; and (2) seedling responses to canopy gap formation. Nitrogen differentially influenced species' regeneration patterns, although the nature of these effects depended on growth environment. Overall, successional position was a better predictor of nitrogen responsiveness than was leaf habit

(i.e., broad-leaved vs. coniferous). Thus, increased nitrogen deposition in New England forests may exaggerate successional trajectories in the future, giving early-successional species increased dominance following a canopy disturbance, but also extending dominance of late-successional species in undisturbed forest stands.

Because plants are sessile organisms, an individual's location in the forest and position in the canopy plays a critical role in determining resource availability and determining competitive interactions. Plants are, however, able to control the location of particular modules or organs by altering their patterns of growth. Due to this flexibility, tree canopies are rarely positioned directly above their stem bases and are often displaced towards the side with more light. Canopy displacement represents an important form of habitat choice among trees, which may affect both individual plant success and forest community structure. Christine Muth has been investigating the phenomenon of tree canopy displacement for her Ph.D. research in OEB with assistance from summer students Tana Collazo and Kate Capecelatro. Christine found trees along gap edges forage for light by occupying both horizontal and vertical gap space. The magnitude and precision of foraging differed among species, size classes, and gap microenvironments. This morphological flexibility in tree canopy shape, therefore, affects species life history strategies, rates of gap closure and patterns of forest succession.

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. 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 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 (Central Massachusetts), and regional (New England) scale.

Heidi Lux and Paul Steudler — LTER colaborators from the MBL-Ecosystem Center

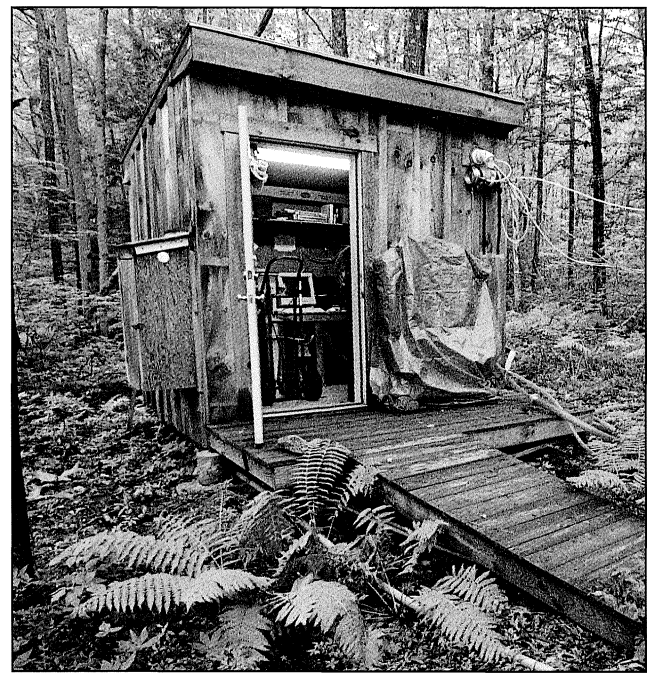
The research project involves soil scientists, atmospheric chemists, and ecologists studying physiological, population, community and ecosystem processes. Investigators represent the Department of Biology (F. Bazzaz), Earth and Planetary Sciences (S. Wofsy, B. Munger, C. Barford), and Harvard Forest (D. Foster, G. Motzkin, D. Orwig) 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 (D. Kittredge, R. Field, 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 2000 symposium is shown on page 23.

Soil warming experiment

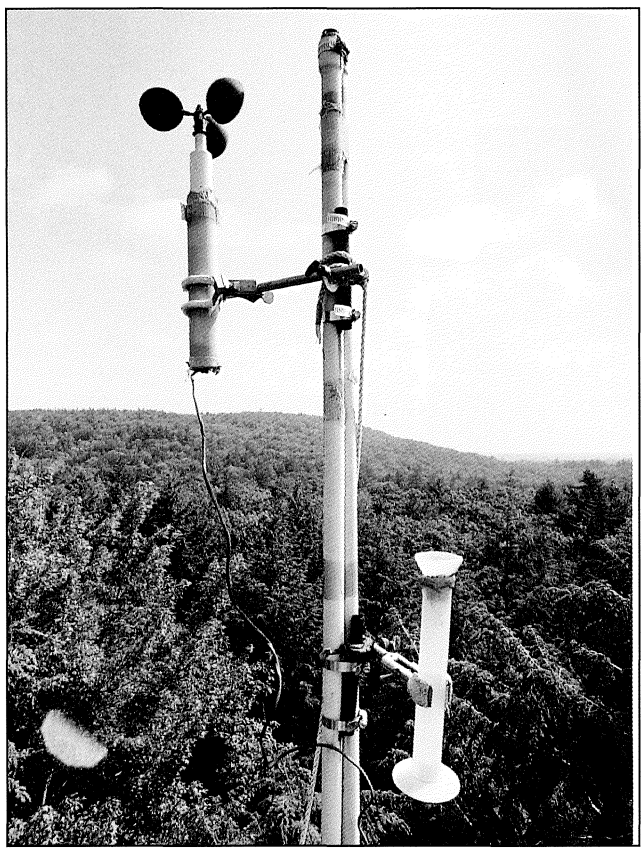
One of the zero litter plots in the Detritus Input and Removal Treatment (DIRT) experiment where LTER scientists are evaluating rates of organic matter dynamics in forest soils.

National Institute for Global Environmental Change (NIGEC)

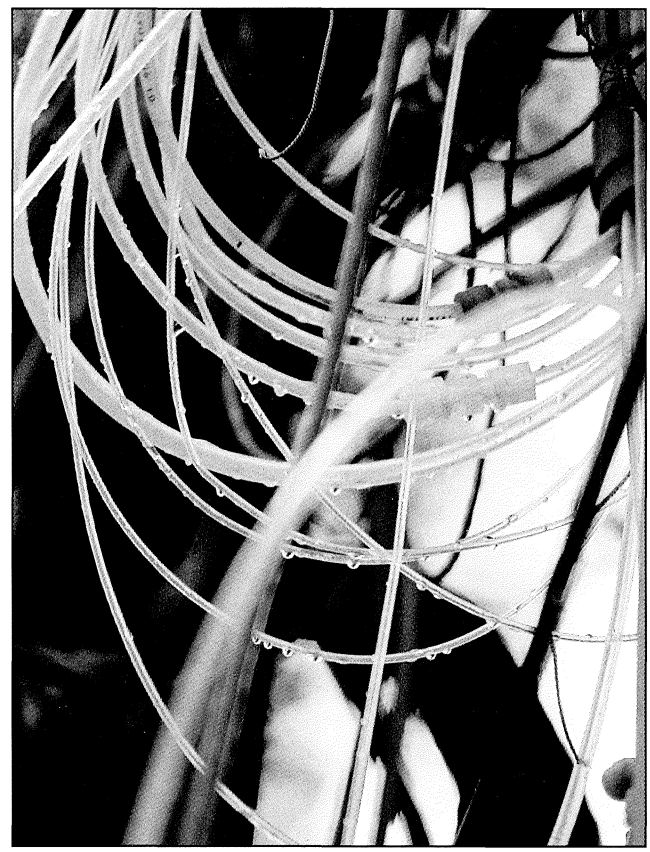
Harvard University is the Northeastern Regional Center for the NIGEC program sponsored by the Department of Energy. NIGEC research seeks to improve the understanding of mechanisms of global environmental change, to develop experimental and observational programs that enhance the understanding of ecosystem 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 and a large proportion 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 University of New Hampshire (P. Crill, R. Harris, R. Talbot), State University of New York (D. Fitzjarrald, K. Moore) and Woods Hole Research Center (E. Davidson), University of Virginia (J. Moody), University of California (S. Trumbore), U.S. Geological Survey (E. Sundquist) and Harvard Forest (J. Hadley).



Instrumented shack for measuring fluxes between the forest and the atmosphere



Above the forest canopy



Moving gases

Harvard Forest Ecology Symposium 2000 — Abstracts and Presentations

Ahrens, T., H. Lux, J. Melillo, P. Steudler, F. Bowles. Interannual Variability in Soil Respiration in Mixed Hardwoods.
Aitkenhead, J., G. Berntson, W. McDowell. The Effect of Carbon and Nitrogen Manipulation on Soils.
Anderson, R., D. Foster, G. Motzkin. The Development and Lateral Expansion of Peatlands in Central New England.
Barford, C., E. Pyle, L. Hutyra, D. Patterson, J. Munger, S. Wofsy. Carbon Cycling by the Harvard Forest.
Barker Plotkin, A., D. Foster. Regeneration Trends in the Experimental Hurricane, 1990–1999.
Barker Plotkin, A., D. Foster. Extending Spatially Explicit Land-Use of the Southern Yucatan.
Barnes, D., S. Wofsy. Evaluation of Greenhouse and Ozone-Depleting Gases in Rural New England.
Bauer, G., F. Bazzaz. How N Partitioning Influences Leaf Photosynthesis and Tree Carbon Gain.
Bellemare, J., G. Motzkin, D. Foster. The Rich Mesic Forest Community in Western Massachusetts.
Berntson, G., G. Bauer, R. Minocha. Deposition and NPP in Temperate Forests.
Boose, E., J. Pallant. Data Management 1999–2000.
Burk, J. Archive Projects, 1999–2000.
Burk, J., E. Largay, G. Motzkin, D. Foster. Witness Tree Research from Early New England Town Records.
Catovsky, S., F. Bazzaz. Nitrogen Deposition Influences Tree Regeneration.
Cavender-Bares, J., F. Bazzaz. Changes in Drought Response Strategies with Ontogeny in Red Oak.
Cavender-Bares, J., M. Potts, E. Zacharias, F. Bazzaz. Consequences of CO_2 and Light Interactions for Leaf Phenology, Growth, and Senescence in Red oak.
*Chorover, J., M. Amistadim, E. Davidson. I*nteraction of Forest Floor Leachate, Organic Matter and Mineral Surfaces.
Clayden, S., D. Foster, J. McLaughlin, D. Koester, S. Barry, D. Francis, B. Wolfe, E. Doughty. Vegetation and Climate History from Northern New England in Relation to the Little Ice Age.
Cobb, R., S. Currie, D. Orwig. Foliar Decomposition After Hemlock Woolly Adelgid Infestation.
Crill, P., K. Bartlett. Diurnal to Interannual Scales of Variability in Ambient Methane.
Dail, B., E. Davidson, J. Chorover, K. Dria, P. Hatcher. Immobilization of Nitrate and Nitrite in Soils.
Dria, K., B. Dail, J. Chorover, E. Davidson, P. Hatcher. Soil Changes Observed by NMR and Pyrolysis Gc/Ms.
Eberhardt, R., et al. Woodland Vegetation and Land-Use History: Cape Cod National Seashore.
Field, R. Songbird Nest Predation in Eastern Oak Forest: Variations with Nest Height.
Fitzjarrald, D., K. Moore, R. Sakai, J. Freedman, O. Acevedo, R. Staebler, G. Wocjik, M. Czikowsky. Forest-Atmosphere Exchange Processes.
Frolking, S. A New Approach to Modeling Soil Carbon Dynamics.
Hadley, J., E. Huber. Carbon Exchange by an Old-Growth Hemlock Forest.
Harrod, J., D. Foster, G. Motzkin, B. Hall, R. Eberhardt. The Forest Vegetation of Cape Cod.
He, J. S., F. Bazzaz. Differential Responses of Trees to Drought During Ontogeny in New England.
Horii, C., M. Zahniser, J. Munger, S. Wofsy. Atmospheric Reactive Nitrogen at Harvard Forest.
Kittredge, D., D. Foster. Timber Harvest as a Form of Disturbance in the North Quabbin Region.
Kizlinski, M., D. Foster, D. Orwig. Ecosystem and Vegetation Response to Hemlock Logging.
Langtimm, C. Variation in Vertical Activity of White-footed Mice in Oak Forest.
Lux, H., T. Ahrens, J. Melillo, P. Steudler, A. Ricca, F. Bowles. Does Carbon Quality Limit Soil Carbon Loss Due to Warming?
Magill, A., J. Aber. Chronic Nitrogen Additions to Two Forest Stands.
Melcher, P., M. Zwieniecki, N. Holbrook. Embolism Intolerance of Black Willow (*Salix nigra* Marshall).
Micks, P., K. Nadelhoffer. Retrenching at the Harvard Forest DIRT Plots.
Min, Q., K. Moore. A Regional Climatology of Cloud and Aerosol for Forest-Atmosphere Exchange.
Moore, K., D. Fitzjarrald. Effect of Diffuse Light on Canopy CO_2 Uptake.
Munger, J., C. Horii, S. Wofsy. Hydrocarbons and Nitrogen Oxides: Forest Atmosphere Interaction.
Muth, C., F. Bazzaz. Tree Canopy Asymmetry at Forest Gap Edges.
O'Keefe, J. Regeneration Following Clearcutting of Red Pine Overstory — Year 10.
O'Keefe, J., S. Johnson. Woody Species Phenology, Prospect Hill Tract, Harvard Forest — 1999.
Ollinger, S., J. Aber, P. Reich, R. Freuder. Ozone and History Affect C Uptake in Response to CO_2 and N.
Orwig, D., D. Mausel, D. Foster. Landscape-Level Analyses of HWA Outbreaks in New England.
Orwig, D., R. Cobb, M. Kizlinski, S. Currie, D. Foster. Ecosystem Impacts of the Hemlock Woolly Adelgid.
Orwig, D., S. Van de Gevel, D. Foster. Stand Dynamics and Community Reorganization due to HWA.
Parshall, T., D. Foster, E. Faison, D. MacDonald, B. Hansen, E. Doughty, J. Murnock. Reconstructing Changes in Vegetation Composition and Fire Occurrence on Cape Cod, Massachusetts.
Pérez-Salicrup, D., D. Foster. Forest Types and Forest Regeneration in Southern Yucatan, Mexico.
Savage, K., E. Davidson. The Effects of Spring Climate on Interannual Variation in Soil Respiration.
Steudler ,P., G. Nowicki, Y. Hrywna, J. Gulledge, C. Cavanaugh. Microbial Regulation of Soil CH_4 Consumption.
Sundquist, E., G. Winston, L. Bergen, N. Finnegan. Rapid and Spatially-coherent Soil CO_2 Fluxes.
Trumbore, S., J. Gaudinski, E. Davidson, K. Savage. C-14 Measurements of Soil Organic Matter and Respiration.
Woodcock, D., A. Shier. Does Canopy Status Affect Wood Specific Gravity (and Sequestration) in Trees?

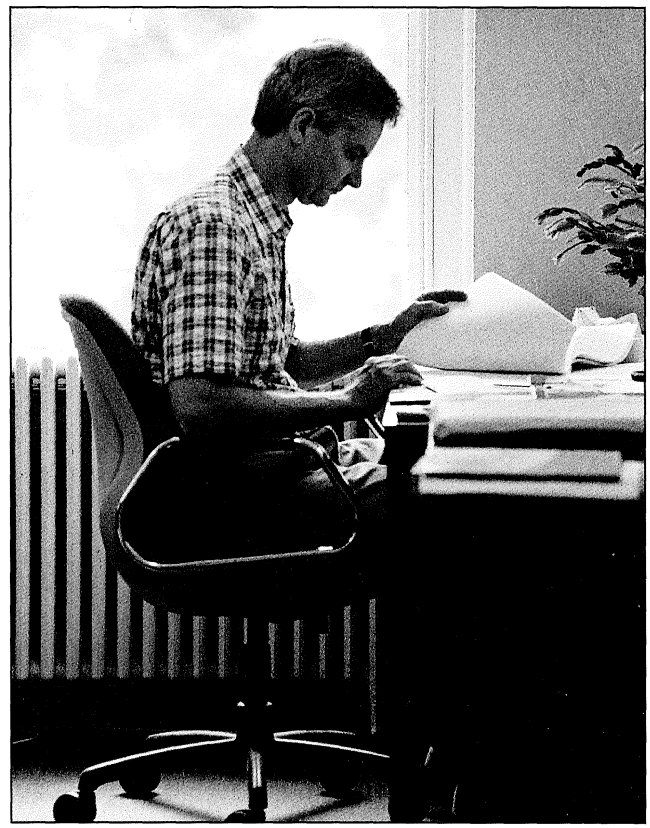
BULLARD FELLOWS

Nick Brokaw (Manomet Center for Conservation Science) completed a first draft of 148 species accounts for *A Field Guide to Trees of the Maya Forest,* a book in collaboration with Central American researchers and the Natural History Museum (London), and a chapter on the response to natural and human disturbances of the Luquillo Experimental Forest, in Puerto Rico, as part of a book on the Luquillo LTER program. He completed manuscripts on forest gap dynamics, the effects of land-use history on tree composition in a tropical forest, and the effects of disturbance on tropical forest canopy structure. He also wrote short essays on tropical forests for the Macmillan encyclopedia and on the effects of forest fragmentation on tropical forest plants for a Spanish language book. He analyzed data on seedling-sapling dynamics after a hurricane in a tropical forest.

Jiquan Chen (Michigan Technological University) has focussed on spatial and temporal scales of various ecological characteristics (e.g., energy flow, species distribution, and carbon flux). He completed four manuscripts, one book chapter, and three research proposals seeking to examine how structure and function are coherently related within and among ecosystems. A synthesis workshop on edge effects and fragmentation was organized for late June 2000. He also presented several seminars at the Harvard Forest, the Marine Biological Lab (MBL) in Woods Hole, and the Natural Resource and Ecology Lab (NREL) at Colorado State University.

Peter DelTredici (Arnold Arboretum of Harvard University) was involved in several projects related to the vegetative regeneration in trees following catastrophic disturbance, and the response of hemlock forests to infestation by the Hemlock Woolly Adelgid. He completed one review article and began work on a book, *The Growth and Cultivation of Trees in the Human Landscape.*

Paul Harcombe (Rice University) completed a manuscript on forest change over 20 years, based on his long-term permanent plot study in southeast Texas. He presented a Harvard Forest lab group discussion and a seminar at the Institute of Ecosystem Studies on aspects of that study. With the assistance of Emery Boose, he completed a preliminary analysis of hurricane impacts on the upper Texas coast using HURRECON. The weekly Harvard Forest seminar series on land protection in New England provided an



Nick Brokaw

opportunity to learn more about the political and social context of conservation, as well as to discuss conservation issues with speakers and staff. The contacts made and the lessons learned will be put to use in teaching, research, and his work with conservation organizations in Texas. Through field trips and discussions with staff, he also gained a clearer understanding of the magnitude and variability of human effects on landscape and community pattern. He began compiling information for a paper on disturbance regimes in forested landscapes.

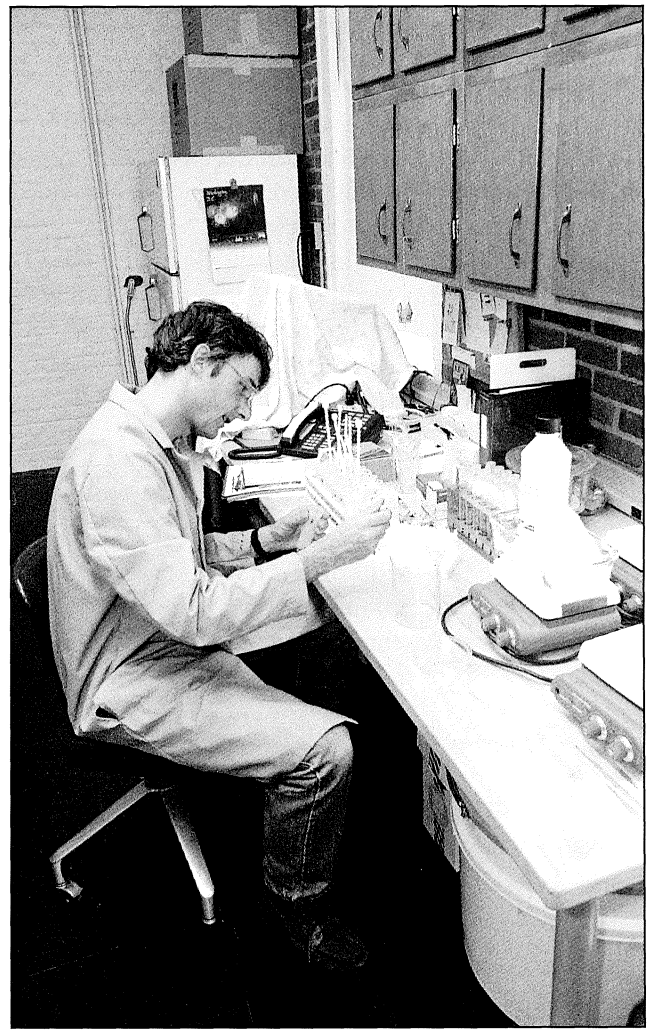
Malcolm Hughes (University of Arizona) worked on problems of the climatic control of growth in the forest-tundra of Northern Eurasia, a collaboration involving E.A.Vaganov of the Russian Academy of Sciences. He presented seminars at Harvard Forest, the University of Massachusetts, Pune, India, Mendoza, Argentina, and at the Pacific Climate Workshop on Santa Catalina Island, California. He took part in the Synthesis Workshop of the PAGES (PAst Global changES) project of the International Geosphere-Biosphere Program. Jointly with David Orwig, he has commenced exploratory work on the dendroclimatology of black gum in central New England.

Richard Primack (Boston University) spent his fellowship investigating the unique features of rain forests in the major tropical areas of the world: South America, Southeast Asia, Africa, Madagascar, New Guinea, and Australia. In addition to writing eight articles on conservation biology and environmental ethics, he worked on two books, *Many Tropical Rain Forests: an Ecological, Biogeographical and Conservation Comparsion,* and a second edition of *A Primer of Conservation Biology.* He gave lectures at Miami University, Missouri Natural Resources Conference, European Ecological Congress in Greece, Hungarian Academy of Science, and evaluated the School for Field Studies program in Kenya.

Stephen Scheckler (Virginia Polytechnic Institute & State University) studied forest reconstruction techniques as an aid to his studies of the first forests of the Paleozoic. He completed four papers and worked on several others on the growth, paleoecology, and biomechanics of Late Devonian and Early Carboniferous woody plants. His NSF proposal on the "Evolution of Tree Design" was funded for three years. Steve delivered seminars at the Harvard Forest, OEB, and the University of Pennsylvania. The results of his study of paleosol-rooted trees and shrubs exposed in Devonian rocks of New York's Catskills were presented at meetings in China, U.S.A., and Canada. Many will remember Steve as "Smoky" for his helpful contributions to the atmoshere of the Christmas party.

Dr. Claire Williams (Texas A & M University) worked in OEB studying the genetic mechanism controlling outcrossing in pines and identified a candidate region for further characterization. She and her colleagues are also determining the phylogeny of the leviathan genome size of conifers. She completed data analysis and writing five manuscripts. She gave seminars at the Harvard Forest, Harvard University Herbaria, University of Maine, and at the Hybrid Pine Conference in Brisbane, Queensland.

Bullard Fellows for 2000–2001 include Kathleen Donohue (University of Kentucky), Mary Ann Fajvan (West Virginia University), Manuel Lerdeau (State University of New York, Albany), Lucinda McWeeney (Yale University), Fraser Mitchell (Univeristy of Dublin, Ireland), Karn Singh, and Fred Swanson (Forestry Sciences Laboratory, Corvallis, Oregon).



Fraser Mitchell

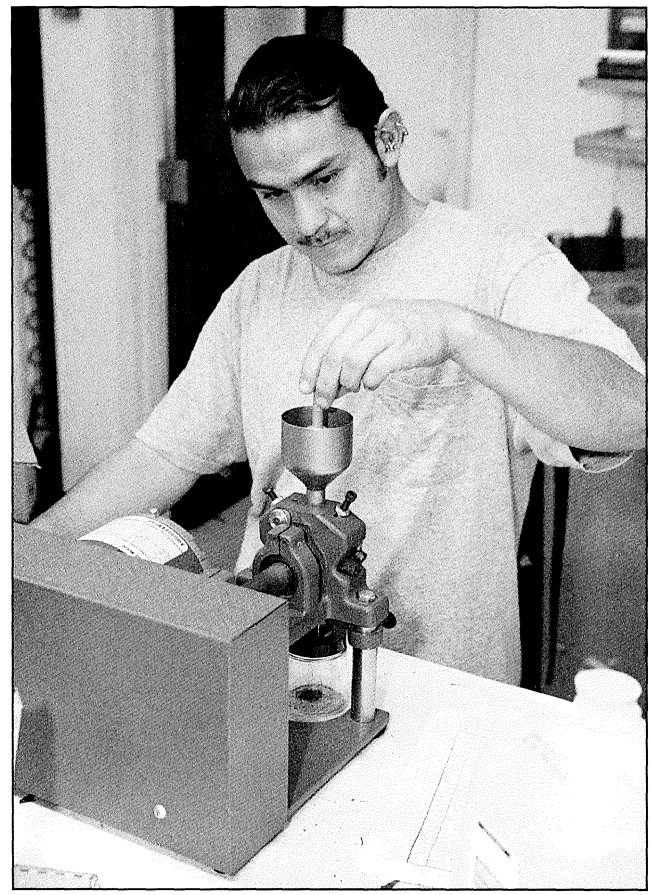
EDUCATIONAL ACTIVITIES

Summer Research Program

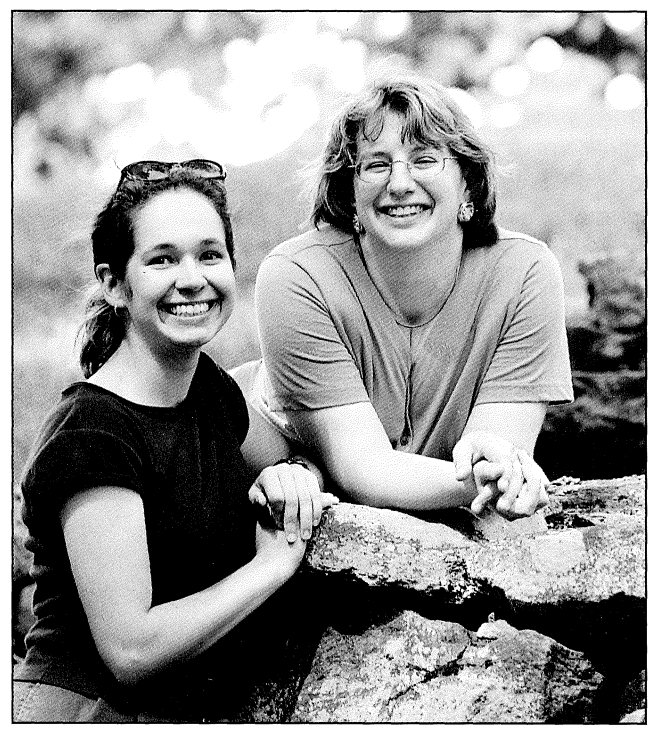
The Harvard Forest Summer Student Research program, coordinated by Edythe Ellin and assisted by Robin Sievers, attracted a diverse group of students to receive training in scientific investigations, and experience in long-term ecological research. Students work closely with faculty and scientists, and many conduct their own independent studies. The program includes weekly seminars from resident and visiting scientists, discussions on career issues in science (e.g. career decisions, ethics 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. At the Annual Summer Student Research Symposium students present major results of their work.

Summer Students 2000

Catherine Angeloni	Wheaton College
German Arellano	Univ. Southern California
Sean Brown	Howard University
Kate Capecelatro	Cornell University
Anthony D'Amato	University of Maine
Shelly Du Plessis	University of California, Davis
Andrew Finley	Pennsylvania State University
Felicia Frizzell	Leland Stanford Junior University
Shane Heath	Dartmouth College
Matthew Kirwan	College of William and Mary
Erin Largay	Connecticut College
Sarah Martell	Greenfield Community College
Erin McCarty	Mary Washington College
Laura Miskimins	Northland College
Sara Sabin	Jamestown College
Sarah Sekinger	University of Virginia
Nicole Smith	Beloit College
Samuel Stratton	Clark University
Morgan Tingley	Harvard University
Aaron Weiskittel	Ohio State University

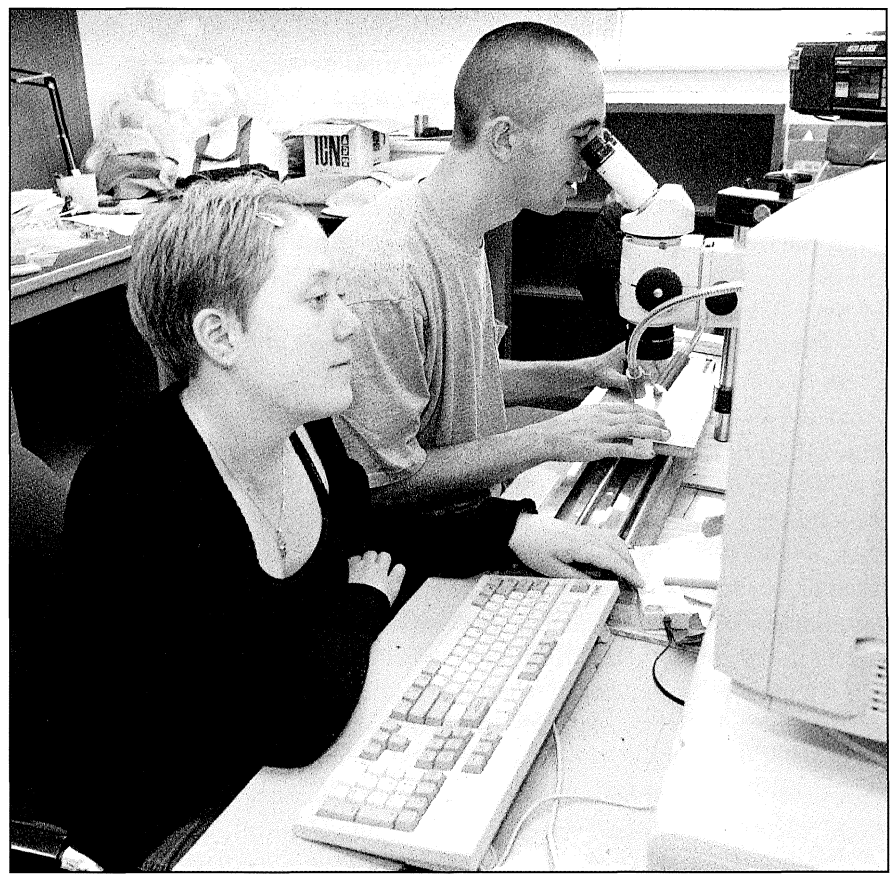


German Arellano

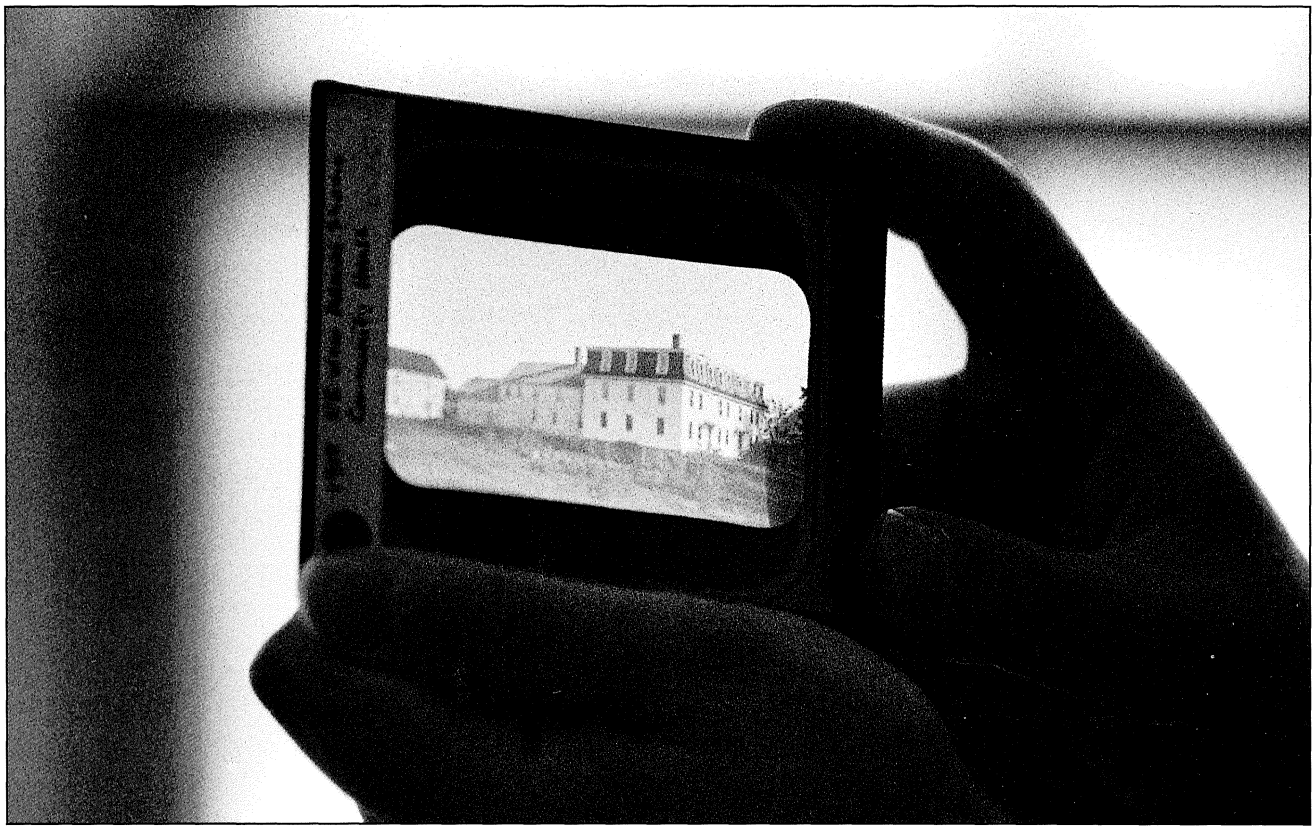


Robin Sievers and Edythe Ellin

Morgan Tingley and
Felicia Frizzell



Nicole Smith and
Aaron Weiskittel



ACTIVITIES OF THE FISHER MUSEUM

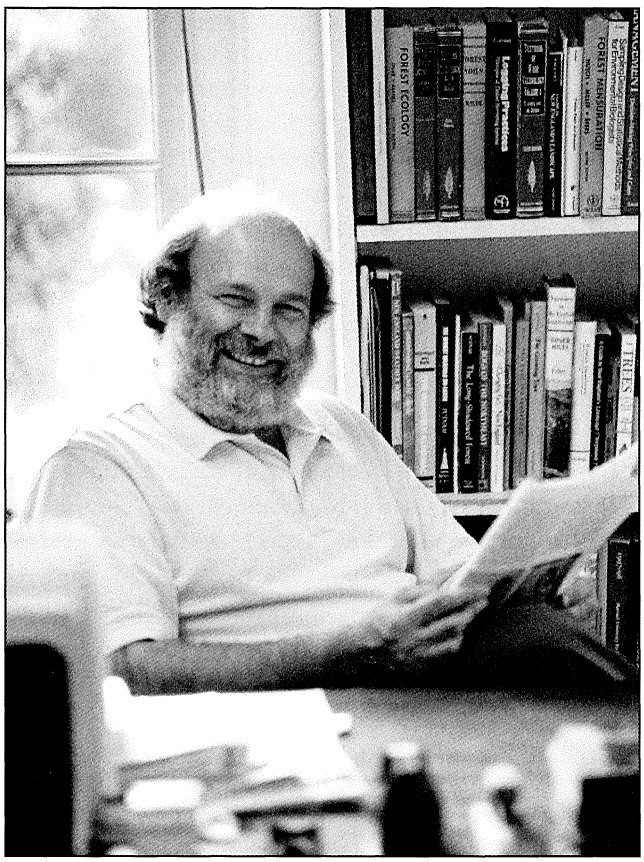
The Fisher Museum plays an important role in the educational mission of the Harvard Forest by providing a public outlet for research in forest biology, conservation and management. The Museum also provides a unique setting for conferences and workshops sponsored by the Forest and outside organizations.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

The recent publication by Harvard University Press of *New England Forests Through Time: Insights from the Harvard Forest Dioramas* by David Foster and John O'Keefe extends the message of using forest history to inform ecology and management far beyond the Museum. Using scenes from all the dioramas, it interprets the story of New England land-use change, several conservation themes, and silvicultural approaches that are useful for local woodland management within both historical and modern contexts.

Thanks to the ongoing commitment of our enthusiastic volunteers the Museum enjoyed another very successful weekend schedule, welcoming well over a thousand visitors on Saturday and Sunday afternoons, May through October. In November, the Ninth Annual Volunteer Recognition Dinner provided an opportunity to thank the volunteers and review the season's activities while sharing good food and companionship. Mary Ann Walker received special thanks for her continuing, enthusiastic work as volunteer coordinator. Bill and Marianna Berry, Roger and Barbara Corey, and Walt Davidson received special recognition for being the most active volunteers during the season.

By the fall the woods crew had completed construction of the seven hundred-foot long boardwalk through the Black Gum Swamp, now part of the Black Gum Trail. The boardwalk is constructed from larch grown on the Forest and was partially funded through a Trail Development Grant from the Massachusetts Department of Environmental Management. The boardwalk provides visitors with an outstanding opportunity for close-up examination and interpretation of this fascinating habitat, while minimizing environmental impacts.

During the year the Museum provided programs for 27 elementary and secondary schools, 24 college and university classes, and 23 community and professional groups. In addition Harvard Forest hosted ten "Learn About the Forest" workshops organized and led by the Eagle Eye Institute, a group headquartered



John O'Keefe

in Somerville that facilitates programs for inner city youth groups to familiarize them with the natural environment. In September the Museum presented a workshop on the history and ecology of Massachusetts forests for the science teachers in the Hingham Middle School, and in October, 35 Danish forestry and planning students visited the Forest as part of their tour to learn about North American forest history and management.

Meetings, Conferences, Seminars

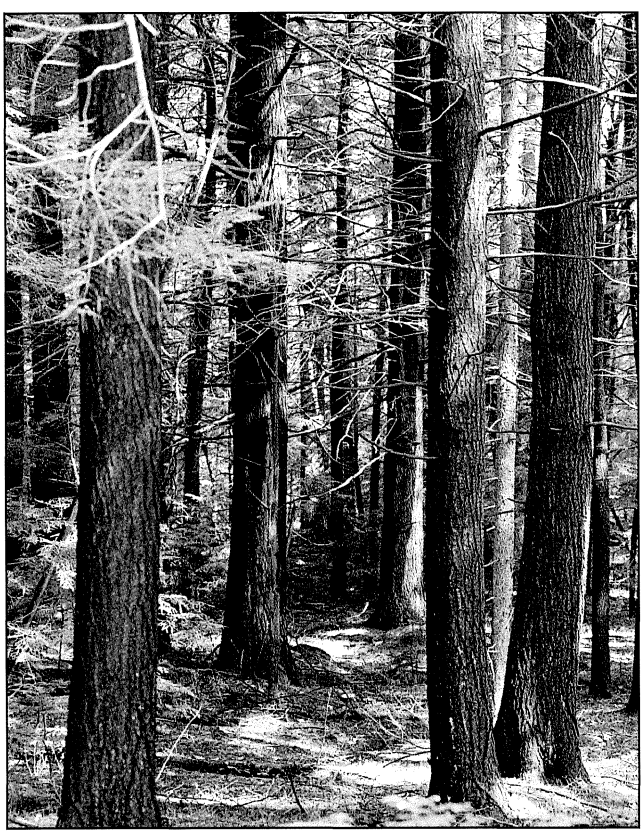
The 11th Annual Harvard Forest Long Term Ecological Research Symposium and meeting of the National Institute for Global Environmental Change were held in the Museum on April 3–4. Other meetings included the Massachusetts Executive Office of Environmental Affairs, Millers River Watershed Council, Natural Resources Conservation Service, Mount Grace Land Conservation Trust, New England Chapter of the Wildlife Society, Athol Bird and Nature Club, North Quabbin Regional Landscape Partnership, Massachusetts Common Wealth/ Common Ground, Massachusetts Extension Service Coverts Project, Massachusetts Department of EnvironmentalManagement Logging Safety Workshop, Massachusetts Forest Stewardship Committee, Northeast Forest Mensurationists, and the Trustees of Reservations. The Forest also hosted faculty retreats for the University of Massachusetts Department of Natural Resources Conservation and Harvard University Department of Organismic and Evolutionary Biology.

Speakers in the Harvard Forest Seminar series included:

Nick Brokaw	Manomet Center for Conservation
Jiquan Chen	Michigan Tech University
Richard Cobb	Harvard Forest
Heather Erickson	University of Puerto Rico
Sylvan Kaufman	Harvard University
Cathy Langtimm	U.S. Geological Survey
Malcolm North	USDA Forest Service
Neil Pederson	Columbia University
Richard Primack	Boston University
Stephen Scheckler	Virginia Polytechnic Institute
Denguyin Tang	Chinese Academy of Sciences
Xianqun Xie	Chinese Academy of Sciences

Conservation and Management of New England's Landscape – Seminar Series

David Foster and Audrey Barker Plotkin organized a 19-lecture seminar series this year on land conservation and management in New England. Over the past 300 years the landscape of New England has undergone dramatic changes, primarily as a consequence of changing land-use activity. Today, the landscape continues to change as it recovers from past use, as it responds to ongoing changes in the natural and human-imposed environment, and as it is managed by individuals and a wide array of public, private, and non-profit organizations and agencies. The seminar series provided a forum in which individuals involved in establishing policies and undertaking applied management activities could share their visions for the New England landscape and their conservation and management approaches. Speakers representing state and federal land management agencies, conservation groups, foresters, and land trusts provided a glimpse into the diversity of actions that are shaping today's landscape. A broad audience of conservation professionals, local residents, and Harvard staff engaged each speaker in lively discussion after each seminar. Speakers included:



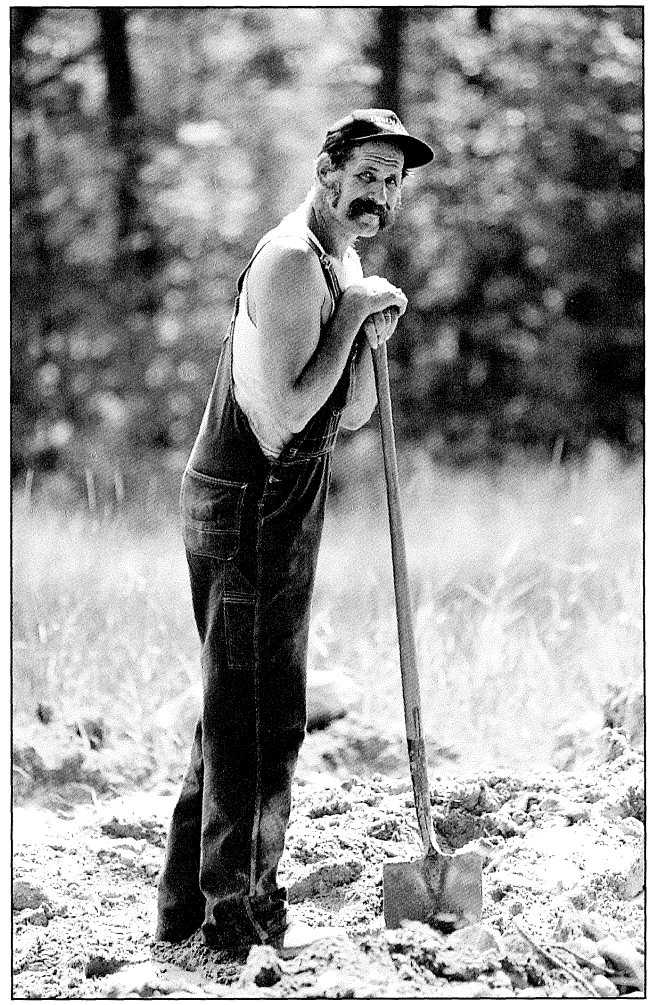
Hemlock woods

Bruce Spencer	Metropolitan District Commission
Thom Kyker-Snowman	Metropolitan District Commission
David Kittredge	University of Massachusetts
Shaun Bennett	North Quabbin Regional Landscape Partnership
Geoff Jones	Society for Protection of N.H. Forests
John Scanlon	Massachusetts Division of Fisheries & Wildlife
Keith Ross	New England Forestry Foundation
Chris Leahy	Massachusetts Audubon Society
Rich Hubbard	Massachusesetts Agricultural Preservation Restriction Program
Ross Morgan	Forest Stewards Guild
Jamie Sayen	Northern Appalachian Restoration Project
Wesley Ward	Trustees of Reservations
Paul Brewster	Green Mountain National Forest
Michael Kellet	Restore the North Woods
Henry Barbour	The Nature Conservancy
Mark Anderson	The Nature Conservancy
Kathy Ruhf	New England Small Farm Institute
Andy Backman	Massachusetts Department of Environmental Mangement (DEM) and Metacomet Land Trust
Christie Anderberg	SWM and Metacomet Land Trust
David Publicover	Appalachian Mountain Club
Bill Rivers	Massachusetts DEM, Forestry
Bill Hull	Hull Forest Products
Henry Woolsey	Massachusetts Natural Heritage and Endangered Species Program

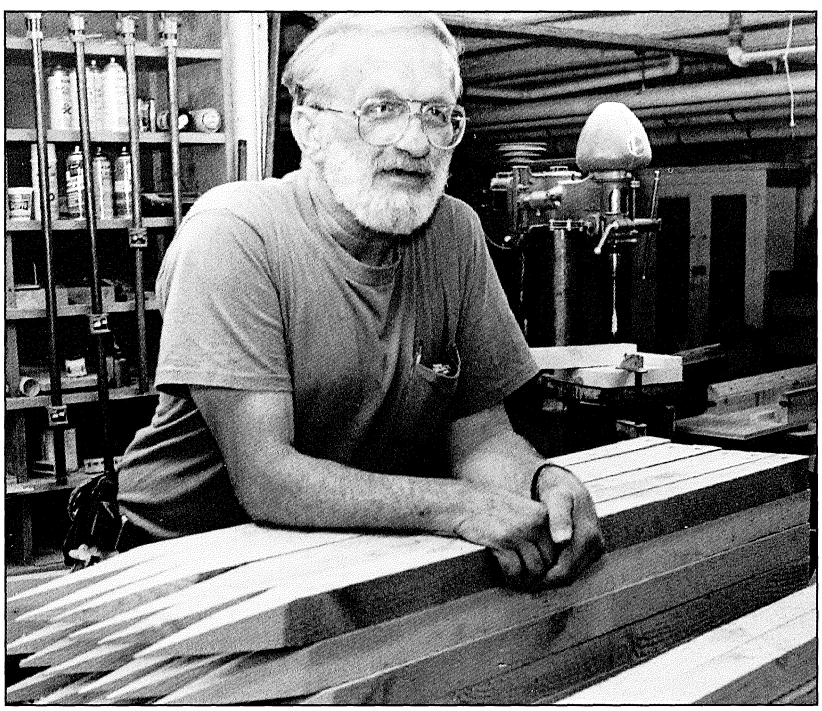
FOREST MANAGEMENT AND MAINTENANCE

Donald Hesselton retired this year after 13 years of service on the Woods Crew. During his tenure he applied his superb carpentry skills to improve every Harvard Forest building and residence. His diverse skills also helped many researchers at the Forest design and manufacture specialized equipment tailored to their project's needs. As he settles into retirement, Donald will be missed but not forgotten. His contributions are apparent in many ways, from the lovely Fisher House he helped renovate to the new Black Gum Swamp Boardwalk and the entrance of the Fisher Museum.

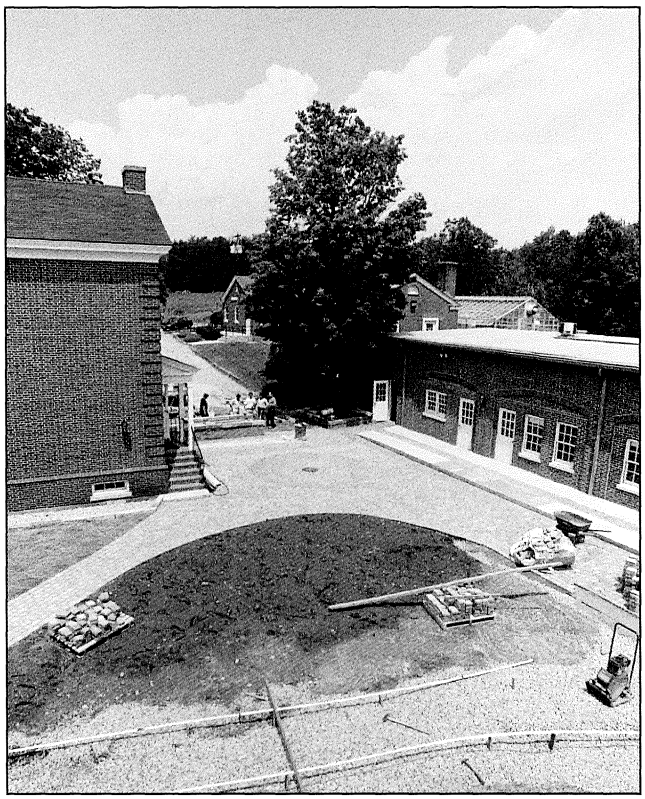
In early Spring work began to re-landscape the east façade of Shaler Hall. New walkways, sidewalls, lighting and drainage will create a patio and courtyard and will help to connect the Archive and Torrey Lab buildings to Shaler Hall. These landscaping projects also include burying fiber optic cable to connect Shaler's upgraded computer system with the Raup House, Community House, Fisher House and School House. When completed, the majority of the facility will be networked allowing computers to be interconnected. Other activities of the woods crew include the ongoing timber stand improvement in the softwood plantations at Harvard Pond, the reconstruction of the Pool Pump House and relocation of the weather station.

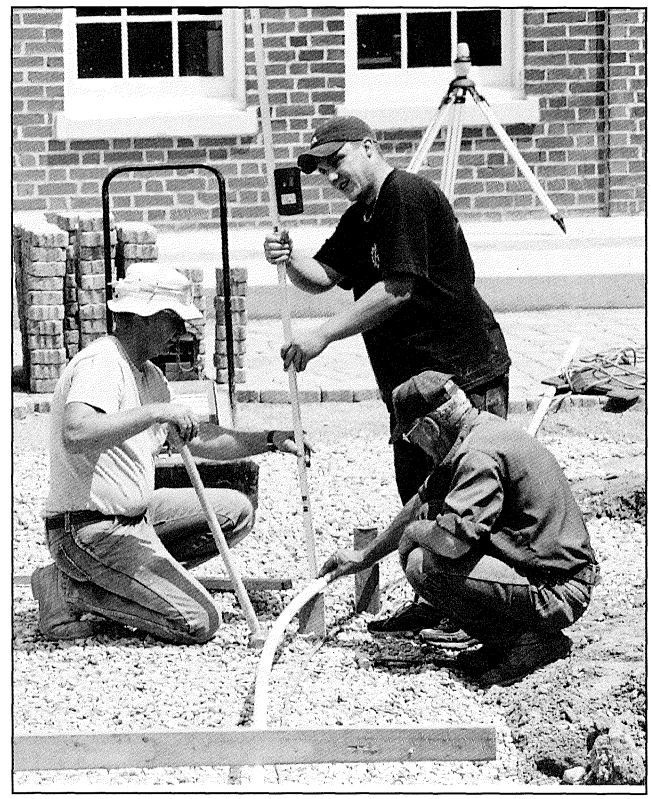


John Wisnewski

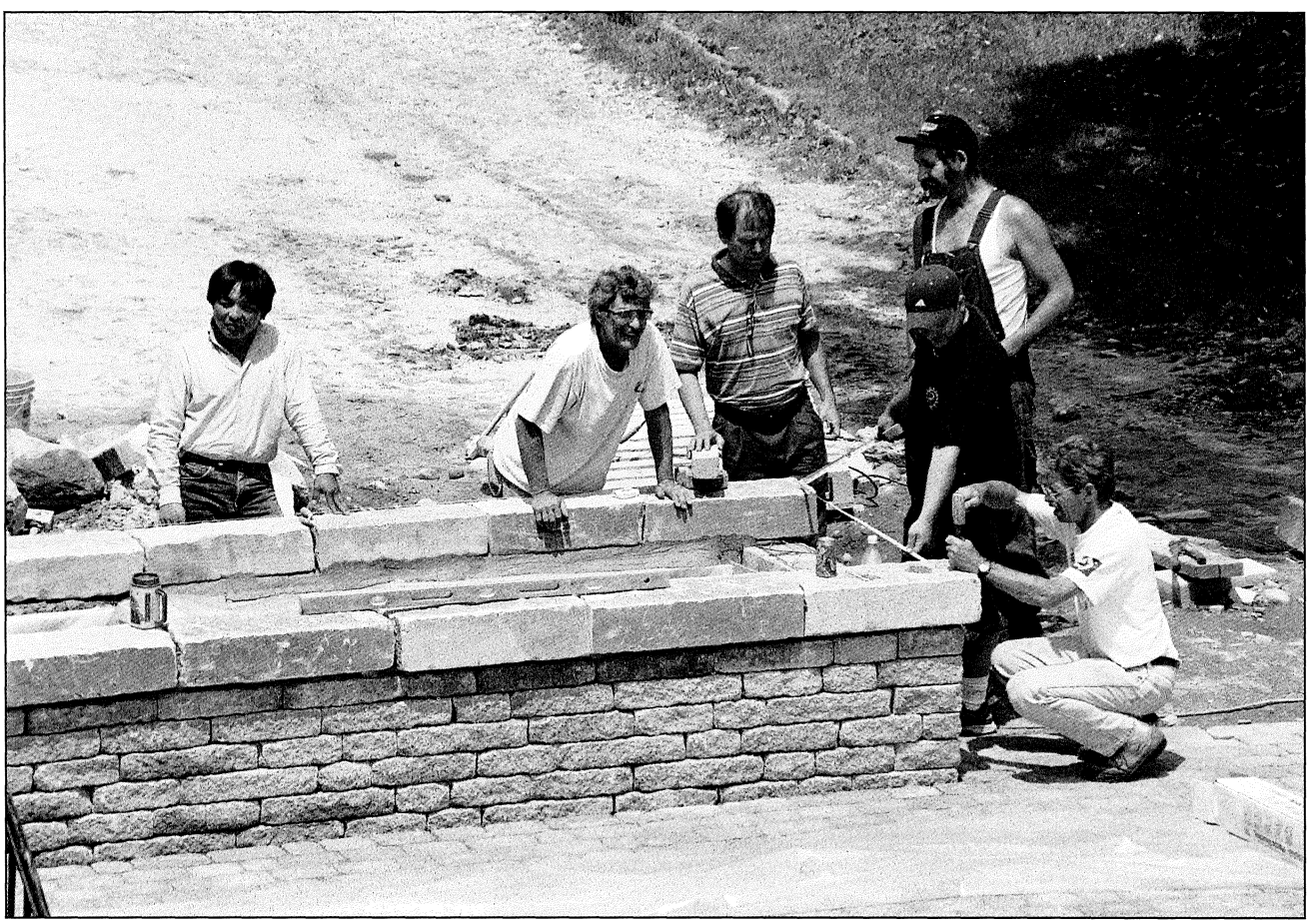


Don Hesselton





Constructing a courtyard to the Archives

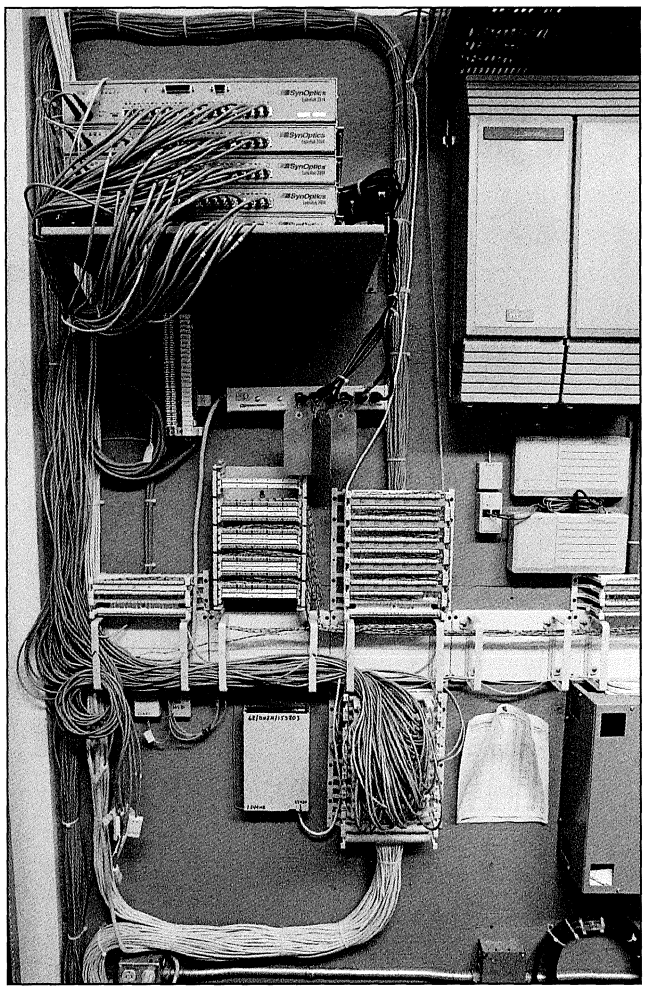


Harvard Forest Archives

The Archives are used daily by staff researchers, collaborators, area residents, and organizations such as the Metropolitan District Commission, Department of Environmental Management, Worcester EcoTarium, an Australian textbook publisher, and the Forest History Society which included two 1938 Hurricane photos in their centennial publication. Microfilm copies were made of all forest inventory records from 1907 to the present, 1938 Hurricane records, outlot records for the Pisgah, Schwartz, Matthews Plantation, and Tall Timbers tracts, cutting summaries, and plantation, nursery, Cabot Foundation, and case history data sheets. Microfilms are stored in the Shaler Hall vault with a duplicate copy at the Harvard University archives in Cambridge.

In conjunction with the renovation of the Shaler Hall basement, all of the historical reprint collections were inventoried and sorted. A large library of Harvard Forest reprints from the 1900s to present was established for use by researchers. Several hundred historical maps of Massachusetts and New England were cataloged and added to the map collection, mostly from the nineteenth century Coast/Geodetic Survey, WPA Franklin County, and 1830 Massachusetts series, and a detailed database of the 1830 map series was created. The extensive physiology research collection of Dr. Martin Zimmermann, including foreign article translations, photographs, and film logs was incorporated into the research file collection. Additions were made to the research file, map, publication, photograph, sample, and slide collections on a regular basis, and each database updated and printed for reference.

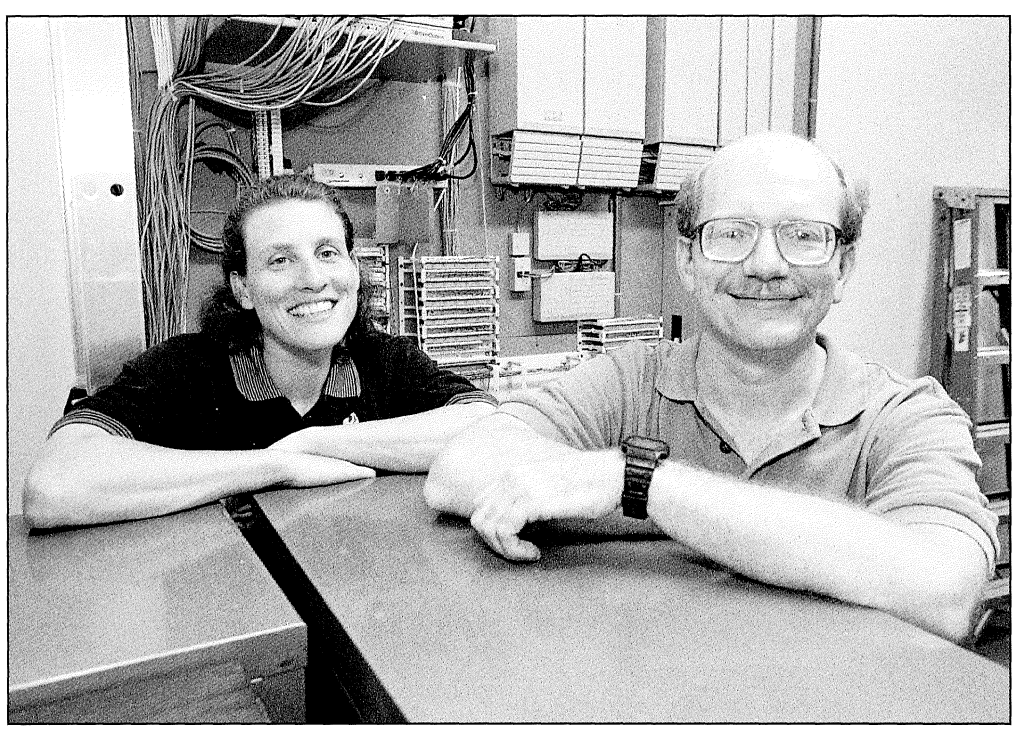
Brian Hall, David Foster, Mindy Syfert, John Burk and Edythe Ellin in the Archives



Computers

Major renovations to our computer facilities continued this year with funding from NSF and Harvard Forest. The network connection from the Forest to Harvard University was upgraded from 56 kbps to 1.5 mbps (T1) and buildings were wired for voice and data, with optical fiber. Twenty-one new computers were purchased and installed, including a dedicated graphics computer attached to an optical scanner, slide scanner, and slide maker. All of our computers run Windows NT, which provides enhanced support for networking and security. The Harvard Forest web page *(http://lternet.edu/hfr)* was redesigned and updated, including the Data Catalog, an on-line repository of data and documentation for a wide range of scientific projects at the Forest.

Planned improvements for the coming year include installation of: (1) Windows NT servers to enhance network connectivity and to host the Harvard Forest web page; (2) an automated weather station in the field to the west of the Fisher House; (3) a high-speed network connection from Shaler to the EMS tower; and (4) general-use computers in the Fisher and Raup houses.



Julie Pallant and Emery Boose

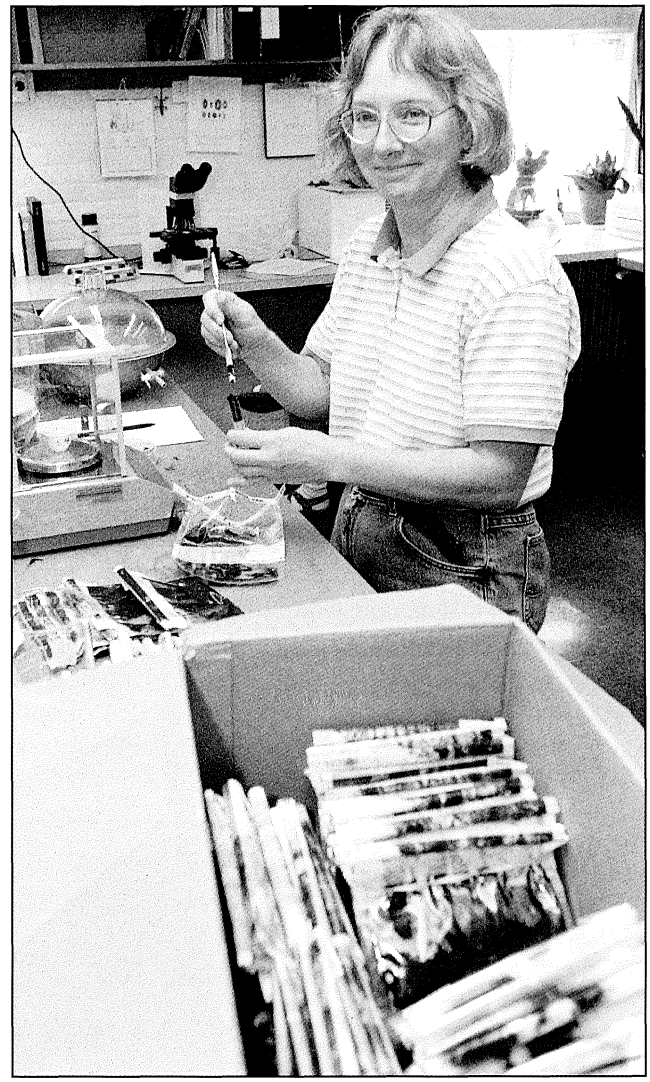
ACTIVITIES OF THE HARVARD FOREST STAFF

Rebecca Anderson wrote grant proposals to the National Science Foundation, the Environmental Protection Agency, and the Geological Society of America. She led a biology class from Mount Holyoke College to several local peatlands to describe wetland ecology and development and she spoke to a middle school science class in Winchendon about careers in science. Audrey Barker Plotkin attended the Ecological Society of America (ESA) and Society of American Foresters (SAF) Northeastern Chapter meetings. She coordinated tours of Harvard Forest for researchers from LTER sites in Japan and China, and for the president of the United Nations global climate change negotiations. Sylvia Barry gave a talk at a GEF/IDEAL (Global Environmental Facility/ International Decade for East African Lakes) symposium in Malawi, East Africa.

Jesse Bellemere participated in a soil morphology and mapping course studying soils at various locations across Massachusetts. Emery Boose attended the LTER Data Managers meeting in Spokane, Washington. He continued to serve on the LTER Climate and Technology Committees and as the Forest's Information Technology contact for FAS. John Burke contributed to the Harvard Forest web page photo gallery by selecting and scanning current and historical photographs and slides, and assisted on several administrative projects. He remained active with the Water Supply Citizen's Advisory committee and as a weather spotter for NOAA, led regional tours for visitors and staff, and participated in the Millers River Watershed Council Biodiversity weekend. He also assisted Cathy Langtimm and Becky Field on their project as a volunteer.

Susan Clayden gave a talk at ESA on the vegetation history of central Massachusetts based on the paleoecogical studies at Chamberlain Swamp and Lily Pond. Richard Cobb presented a paper at the annual meetings of the Soil Science Society of America, and the Society of Soil Scientists of Southern New England.

David Foster presented lectures on *Thoreau's Country: Journey Through a Transformed Landscape* at the Nantucket Conservation Foundation, the Edwin Way Teale Lecture series at the University of Connecticut, Wallingford (Connecticut) Public Library, the Department of Interior Executive Seminar, the Cambridge Forum, Harvard Divinity School Environmental Ethics Seminar, Pforzheimer House Harvard University, New England Wildflower Society, and the Environmental Action Committee of Harvard University and was interviewed on the book by WAMC, WBUR, WUMB, Frontiers magazine of the University of Minnesota, the Hartford Courant and Boston Globe. He gave lectures at a symposium on Re-wilding the Northern Forest of New England sponsored by RESTORE and the Orion Society, a symposium on suburban and urban forests and agriculture sponsored by Tufts and Brandeis Universities, the Ecological Society of America, American Environmental History Society, and the Society of American Foresters annual meeting, He presented keynote addresses at the U.S. Forest Service symposium on Sustainable Management of Hemlock Ecosystems in Eastern North America and the

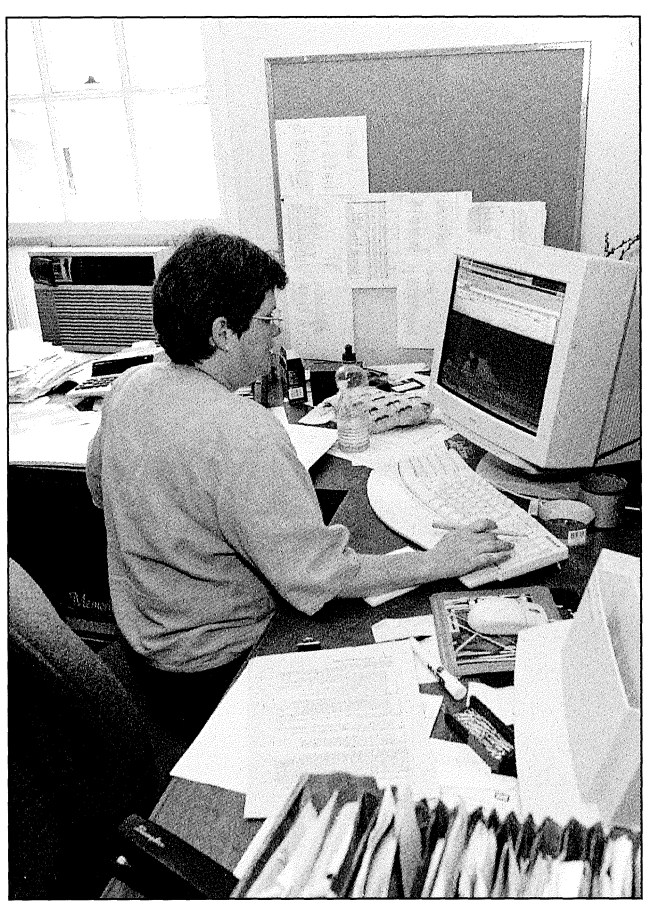


Elaine Doughty

Massachusetts Regional Science Fair at Worcester Polytechnic Institute. He also attended a PAGES International Global Program workshop in Bern, Switzerland

Julian Hadley supervised summer students studying photosynthesis and respiration as functions of leaf age in developing hemlock foliage. He presented a paper at ESA on the effects of low night temperature on photosynthesis in eastern hemlock. Brian Hall attended the GAP analysis workshop at UMASS, and presented a poster at the ESA Annual meeting, "Historical Influences on Modern Landscapes: Background for Conservation Management on Martha's Vineyard, Massachusetts".

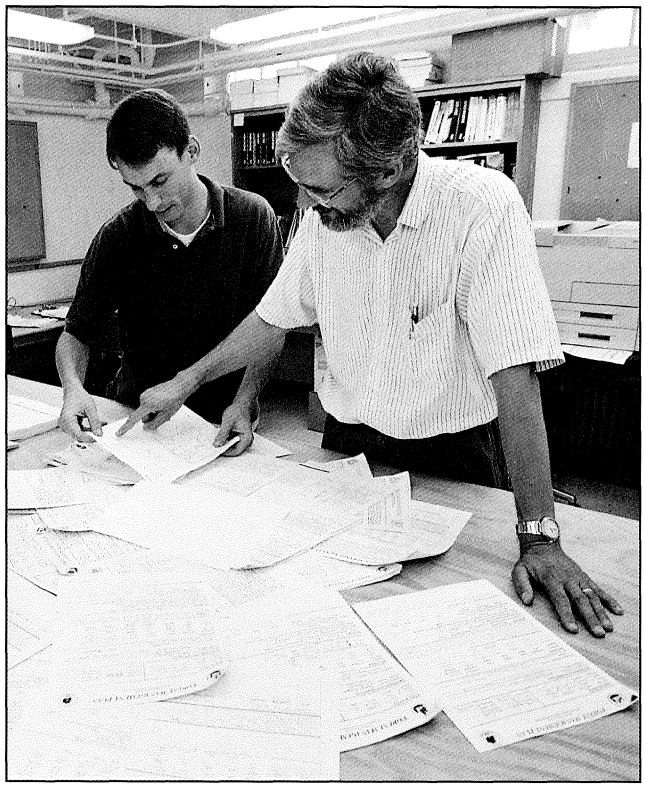
David Kittredge was active in Massachusetts forest policy by organizing a Forest Vision Team to advise Robert Durand, Secretary of the MA Executive Office of Environmental Affairs (EOEA) on a desirable future condition, and recommendations for the Commonwealth's forests. Dave was also invited to serve as a member of the MA EOEA Land Conservation Plan Task Force, to advise the Secretary on conservation and fiscal strategies to protect 200,000 acres. Dave worked with summer student Andrew Finley on the ongoing study of the north Quabbin region in terms of human-caused disturbance in the form of timber harvesting, and forest protection strategies. In 1999–2000, Dave attended the Extension working group meeting of International Union of Forest Research Organizations (IUFRO), in Bled, Slovenia, where he presented a paper on his research on forest landowner attitudes towards their land and management at an ecosystem scale. While in Europe, he visited a successful forest landowner cooperative in Bavaria, seeking to understand characteristics of this model, and how it might be applied in the United States. He also attended the Kennedy School of Government conference on Conservation in the Internet Age, seeking information on how these new information technologies can be applied to forest policy development and analysis.



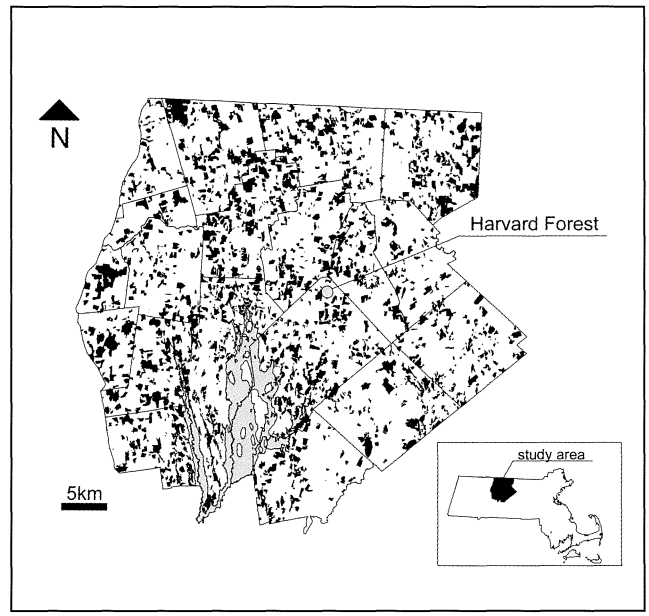
Jeannette Bowlen

Glenn Motzkin gave research seminars at Tufts University, the George Wright Society, the Sheriff's Meadow Foundation (Martha's Vineyard), and at a symposium on coastal research sponsored by The Nature Conservancy and the Marine Biological Laboratory at Woods Hole. He led a field trip on land-use history interpretation for the Eastern Massachusetts Botany Group and participated in the development of guidelines for the conservation and management of forests in Massachusetts as a member of the Executive Office of Environmental Affairs' Forest Vision Team. Glenn continues to serve as an Ecology Advisor for The Trustees of Reservations, and as a member of the Technical Advisory Group of the EOEA and UMASS Housatonic Watershed Biodiversity Conservation Planning Project.

John O'Keefe gave talks on the history of Massachusetts forests at the 500-Year Forest Foundation Conference at Sweet Briar College in Virginia, the Rhode Island Environmental Education Conference, the University of Massachusetts, Emerson College, Fruitlands Museums, and the Pelham Historical Society. He represented Harvard Forest on the ENFOR Distance Learning in Forestry planning group, cosponsored by the Lincoln Institute of Land Policy and the Kennedy School of Government and at the Kennedy School Conference on Conservation in the Internet Age. John attended ESA and the New England Society of American Foresters conference. He was a judge at the Mahar High School Science Fair, and serves on the boards of the Millers River Watershed Council and Mount



Andrew Finley and Dave Kittredge



Forest harvest areas in central Massachusetts 1984–2000. Data compiled by Dave Kittredge and Andrew Finley.

Grace Land Conservation Trust, where he is currently Vice-president, and on the executive committee of the North Quabbin Regional Landscape Partnership. He also serves on the Quabbin Science and Technical Advisory Committee and Secretary Durand's Advisory Group on Environmental Education.

Dave Orwig presented a talk "Hemlock woolly adelgid damage in relation to hemlock distribution across southern New England landscapes" at the ESA with summer student David Mausel, and seminars at the University of Connecticut and Northeast Forest Pest Council meetings. Dave led a field trip to Connecticut for MDC scientists and managers to visit hemlock forests infested with HWA, and hosted a planning meeting for State Senator Steven Brewer's Special Commission on Forest Management Practices hearing to discuss the current HWA crisis in Massachusetts. Dave also gave a seminar on tree ring analysis as part of the adult education program for the Massachusetts Audubon Society.

Tim Parshall presented a paper at the Eastern Old Growth Conference and presented a poster at the AMQUA meeting. Diego Pérez-Salicrup presented posters or gave talks at ESA, American Society of Naturalists, Society of Systematic Biologists, Association for Tropical Biology, Society of Study of Evolution, Institute of Ecosystem Studies, National Autonomous University of Mexico, the college of Southern Frontier, Mexico and University of Laval, Quebec.

Barry Tomlinson received the Gold Medal of the Linnean Society of London at their September meeting. In the fall he taught the introductory biology course, Biological Sciences 2 (Introduction to Organismic Biology) with Andy Biewener and Brian Farrell. Barry's responsibility was the introductory material, plants, fungi and algae. In the spring semester he taught Biology 24 (Biology of Plants), with Missy Holbrook, thus resurrecting an early course. The Freshman Seminar at Harvard Forest with Barry, David Foster and other staff members was again taught on four weekends in the spring semester, beginning with the first severe snowstorm of the winter season. In June an innovative graduate "workshop in Tropical Botany" was taught in Miami, Florida involving facilities at Fairchild Tropical garden and "The Kampong" of the National Tropical Botanical Garden. This replaced the original Harvard Summer School course, which had been taught since 1972.

VISITING RESEARCH SCIENTISTS AT THE HARVARD FOREST 1999–2000

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 program or NIGEC project.

John Aber	University of New Hampshire
Jody Ackerman	University of Maryland
Toby Ahrens	Ecosystems Center – MBL
Carol Barford	Harvard University
Diana Barnes	Harvard University
Gutram Bauer	Harvard University
David Baum	Harvard University
Fakhri Bazzaz	Harvard University
Glenn Berntson	University of New Hampshire
K. Boering	Harvard University
Frank Bowles	Ecosystems Center – MBL
John Budney	Harvard University
Sean Burrows	University of Wisconsin
John Campbell	University of Wisconsin – Madison
Sebastian Catovsky	Harvard University
Jeannine C-Bares	Harvard University
Alex Cobb	Harvard University
Warren Cohen	Oregon State University
Alan Coleman	Harvard University
Benjamin Coleman	Ecosystems Center – MBL
Enir Costa	University of California – Irvine
Patrick Crill	University of New Hampshire
Karen Cristian	Framingham State Teachers College
William Currie	University of Maryland
David B. Dail	Pennsylvania State
Eric Davidson	Woods Hole Research Center
Marty Downs	Ecosystems Center – MBL
Todd Drummey	Ecosystems Center – MBL
Noelle Eckerly	Harvard University
Bob Evans	U.S.D.A. Forest Service
Drew Feldkirchner	University of Wisconsin– Madison
Rebecca Field	University of Massachusetts
Noah Finnegan	U.S.G.S.
David Fitzjarrald	SUNY, Albany
Richard Forman	Harvard University
Steven Frolking	University of New Hampshire
Julia Gaudinski	UCLA, Irvine
Evgeniy Gladyshev	Woods Hole Research Center
Robert Harriss	University of New Hampshire
Jin Sheng He	Harvard University
Michelle Holbrook	Harvard University
David Hollinger	U.S.D.A. Forest Service
Cassandra Horii	Harvard University
Lucy Hutrya	Harvard Unversity
Daniel Jacob	Harvard University
Tracy Jilson	Ecosystems Center – MBL
Chris Kerfoot	Ecosystems Center – MBL
Alan Kirschbaum	University of Wisconsin – Madison
Otto Klemm	University of New Hampshire
Doerte Koester	Laval University
Cathy Langtimm	U.S.G.S.; Holy Cross College
Deborah Lawrence	University of Virginia
Barry Lefer	University of New Hampshire
Manuel Lerdau	SUNY, Stony Brook
Heidi Lux	Ecosystems Center – MBL
Alison Magill	University of New Hampshire
Thomas Maiersper	Oregon State University
Lynn Margulis	University of Massachusetts
Mary Martin	University of New Hampshire
Peter Melcher	Harvard University
Jerry Melillo	Ecosystems Center – MBL
Patricia Micks	Ecosystems Center – MBL
Kathleen Moore	SUNY, Albany
Mitch Mulholland	University of Massachusetts
J. William Munger	Harvard University
Christine Muth	Harvard University
Knute Nadelhoffer	Ecosystems Center – MBL
Jeffrey Parker	Smithsonian Environ. Res.
George Peterken	United Kingdom
Reinhard Pienitz	Laval University
Marc Potosnak	Harvard University
Elizabeth Pyle	Harvard University
Michael Rogers	GA Institute of Technology
Jim Sadle	Harvard University
Ricardo Sakai	SUNY, Albany
Kathleen Savage	Woods Hole Research Center
Daniel Schrag	Harvard University
Ulrike Seibt	Scripps Institute of Oceanography
Timothy Sipe	Franklin & Marshall College
Ralph Staebler	SUNY, Albany
Paul Steudler	Ecosystems Center – MBL
Britt Stephens	Harvard University
Eric Sundquist	U.S. G. S.
Robert Talbot	University of New Hampshire
Matt Thompson	Harvard University
Susan Trumbore	University of California
Billie Turner	Clark University
David Turner	Oregon State University
Hans Vester	ECOSUR, Mexico
Greg Winston	U.S. Geological Survey
Brent Wolfe	University of Waterloo
Deborah Woodcock	Radcliffe Institute
Charlotte Zampini	Framingham State College
Maciej Zwieniecki	Harvard University

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Bell, S. 2000. The impact of long-term nitrogen deposition on nitrogen metabolism of forest soils. Senior thesis, University of Oregon.

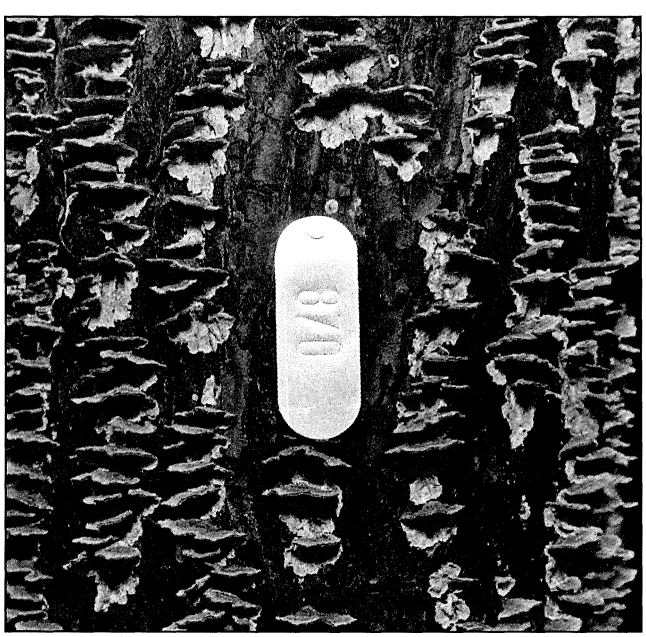
Blackman, R. 2000. The determination of the relationship between wood respiration and sapwood temperature in an old growth eastern hemlock *(Tsuga canadensis)* stand. Senior thesis, University of Edinburgh.

Bürgi, M. and E. W. B. Russell. 2000. Evaluating accuracy for two types of early land survey records in the northeastern United States. *Journal of the Torrey Botanical Society* 127: 94–98.

Bryant, A. 2000. Sustainable forest management and forest certification on the Southern Yucatan Peninsula, Mexico. Undergraduate Thesis, Oregon State University.

Catosvky, S. and F. A. Bazzaz. 1999. Elevated CO_2 influences the responses of two birch species to soil moisture: implications for forest community structure. *Global Change Biology* 5: 507–518.

Catovsky S. and F. A. Bazzaz. 2000. Contributions of coniferous and broad-leaved species to temperate forest carbon uptake: a bottom-up approach. *Canadian Journal of Forest Research* 30, 100–111.



Catovsky, S. and F. A. Bazzaz. 2000. The role of resource interactions and seedling regeneration in maintaining a positive feedback in hemlock stands. *Journal of Ecology* 88, 100–112.

Cobb, R. C. 2000. Silvicultural impacts on soil functional processes in a 17-year-old whole tree harvest. Masters thesis, University of Maine.

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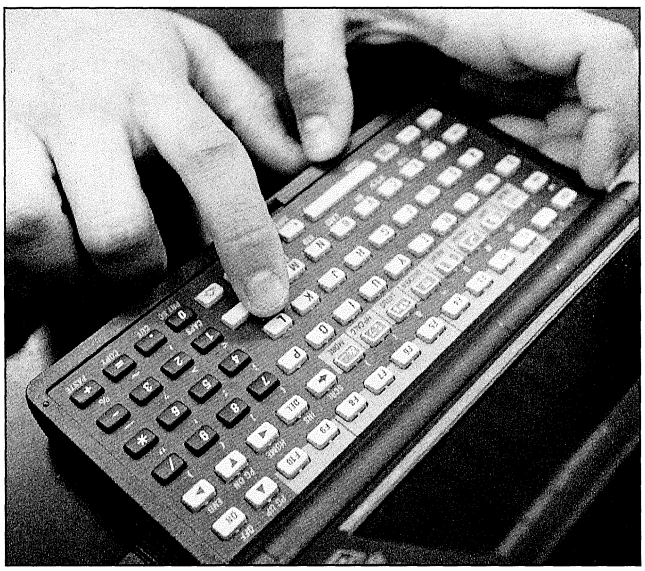

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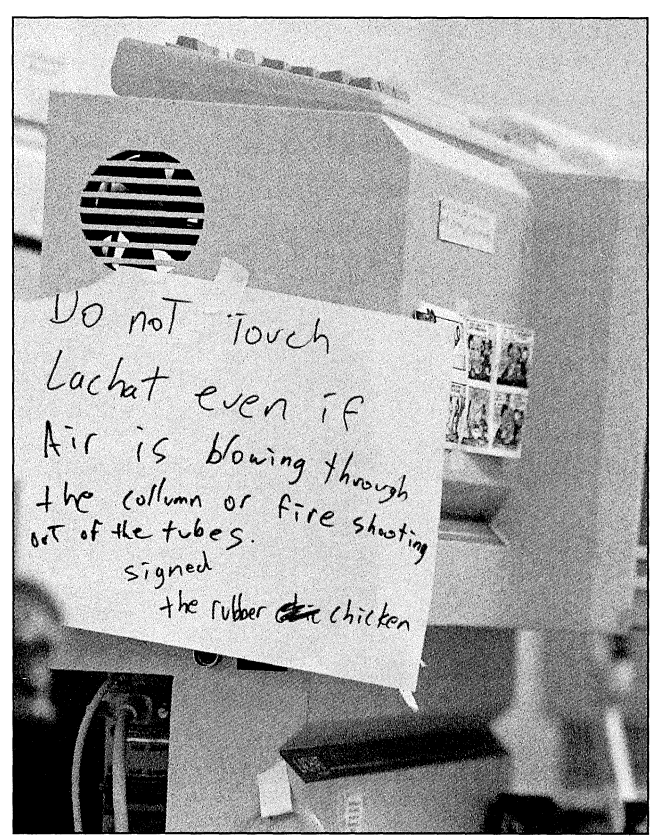

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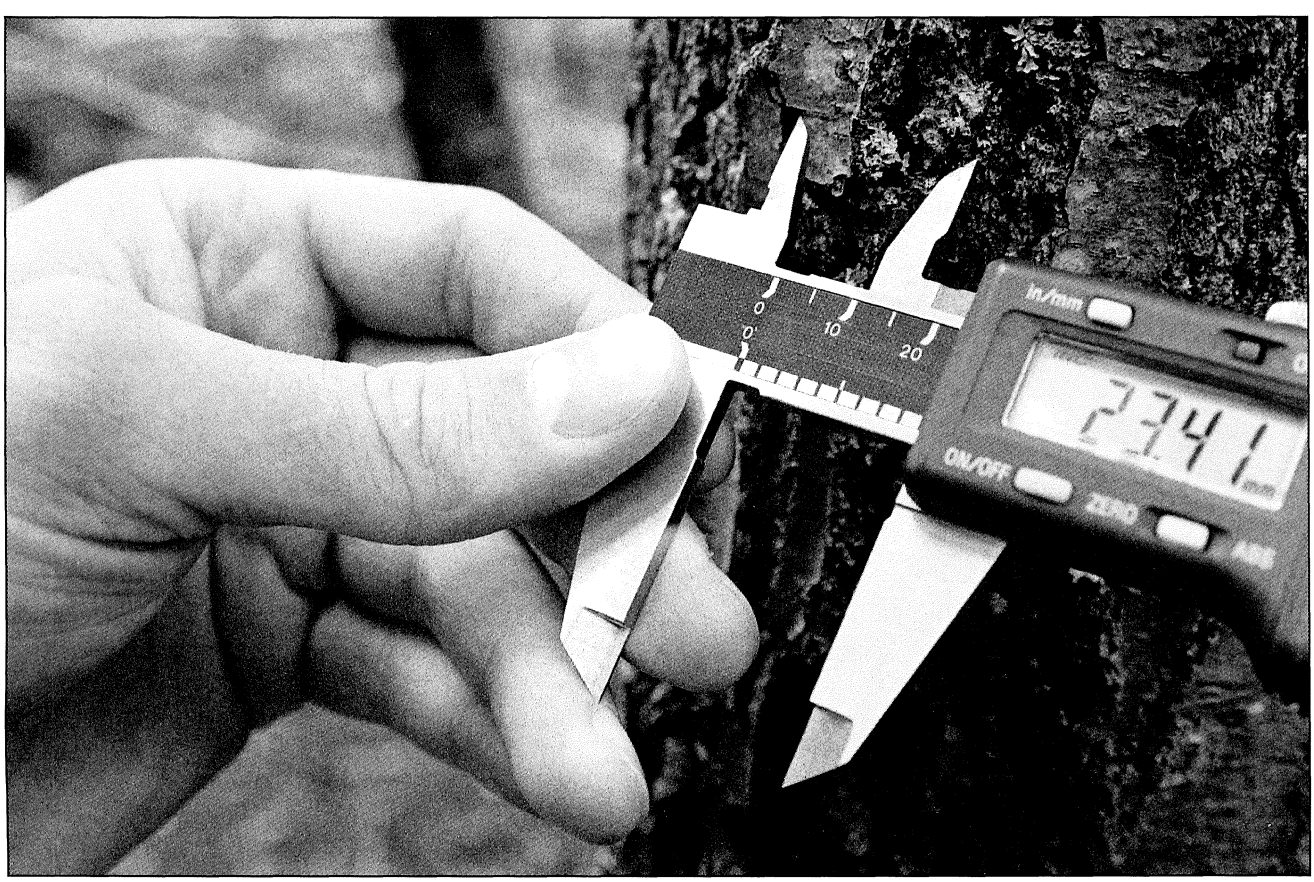

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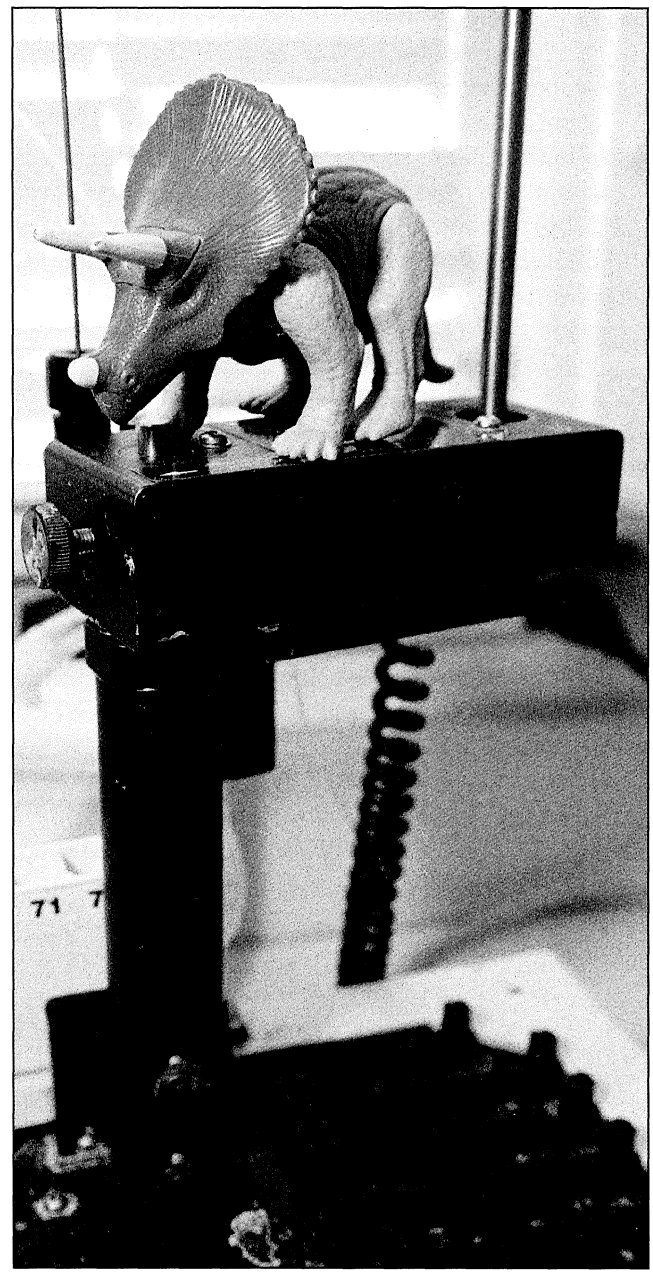

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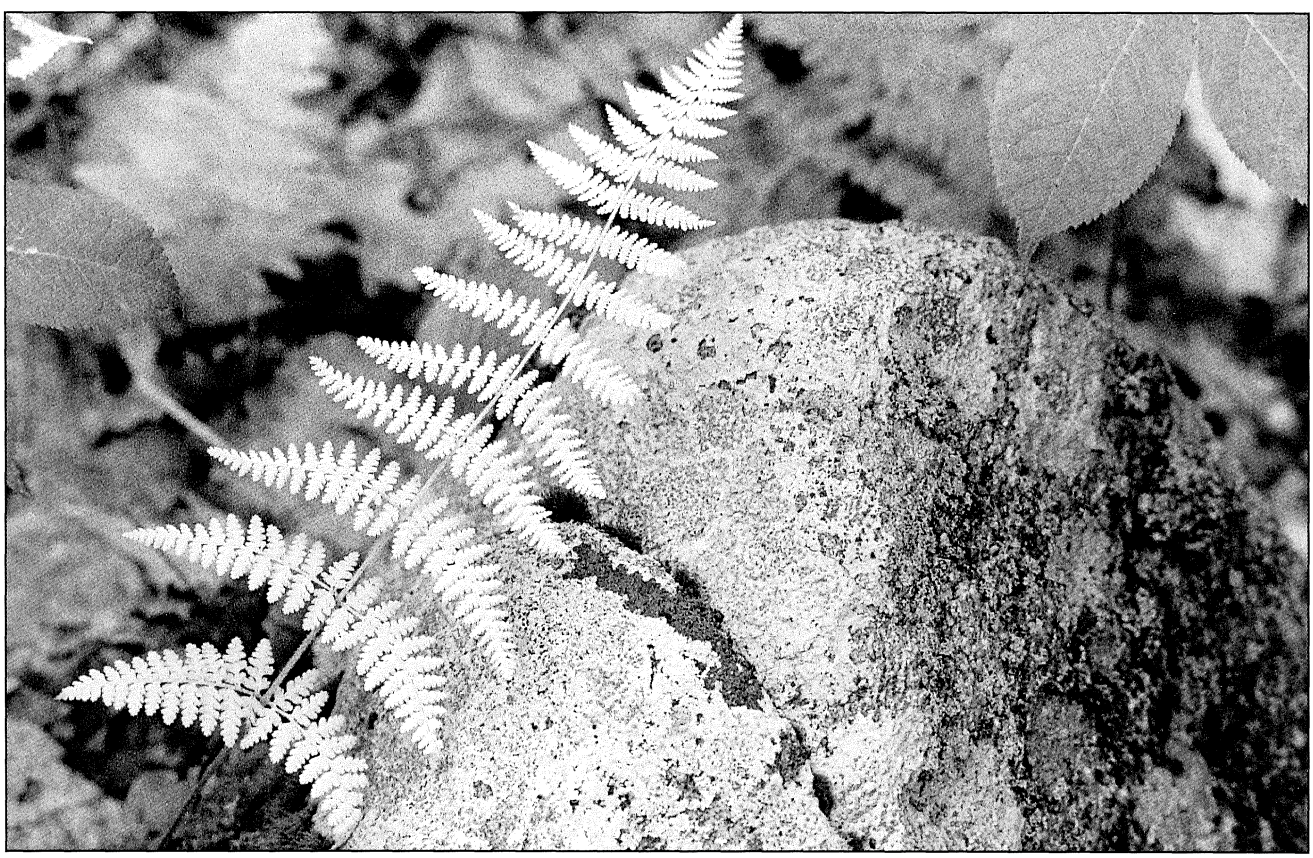

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Petersham, Massachusetts
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