

THE HARVARD FOREST 1997 - 98

Harvard University



ANNUAL REPORT OF THE HARVARD FOREST 1997-1998

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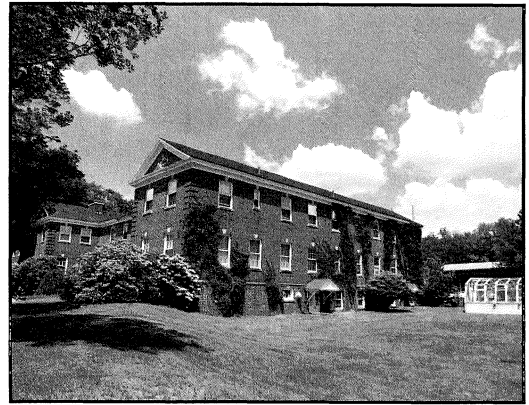


Photography by Jim Gipe

PERSONNEL AT THE HARVARD FOREST 1997-8

Marc Abrams	Bullard Fellow	Ruth Ann Kern	Research Associate
Audrey Barker Plotkin	Research Assistant	Matt Kizlinski	Research Assistant
Debra Bernardos	Research Assistant	Joan Kraemer	Clerk Typist, part time
Emery R. Boose	Information and Computer System Manager	Christopher Kruegler	Administrator
Jeanne Boutelle	Part-time Custodian	Oscar P. Lacwasan	Custodian
Jeannette M. Bowlen	Accountant	Deborah Lawrence	Research Associate
John Boyer	Bullard Fellow	Richard A. Lent	Assistant Information and Computer System Manager
Matthias Burgi	Post-doctoral Fellow	Lisa Marselle	Summer Cook
John S. Burk	Research Assistant	Glenn Motzkin	Plant Ecologist
Susan L. Clayden	Research Assistant	John F. O'Keefe	Museum Coordinator
Willard Cole	Woods Crew	David A. Orwig	Forest Ecologist
Thia L. Cooper	Summer Program Assistant	Diego Perez-Salicrup	Post-doctoral Fellow
Sarah Cooper-Ellis	Research Assistant	Dorothy Recos-Smith	Secretary
Elaine D. Doughty	Laboratory Assistant	William H. Romme	Bullard Fellow
Natalie Drake	Palynologist	Emily Russell	Visiting Scholar
Robert W. Eberhardt	MFS Candidate	Mayra I. Serrano	Research Assistant
John A. Edwards	Forest Manager	Ben Slater	Research Assistant
Barbara J. Flye	Librarian/Secretary	Charles Spooner	Woods Crew
Charles H.W. Foster	Associate	P. Barry Tomlinson	E. C. Jeffrey Professor of Biology
David R. Foster	Director	Susan Trumbore	Bullard Fellow
Donna Francis	Research Associate	Dennis F. Whigham	Bullard Fellow
Janice Fuller	Research Associate	Ian Turner	Bullard Fellow
Jennifer D. Garrett	Research Assistant	John Wisnewski	Woods Crew
Julian Hadley	Research Associate	Steven Wofsy	Associate
Brian R. Hall	Research Assistant	Maciej A. Zwieniecki	Research Associate
Linda Hampson	Accounting Assistant		
Donald E. Hesselton	Woods Crew		





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 (HF LTER) program, which was established in 1988 through funding by the National Science Foundation (NSF).

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 provide office and laboratory space, computer and greenhouse facilities, and a lecture room and lodging for seminars and conferences. An additional nine houses provide accommodation for staff, visiting researchers, and students. Extensive records including long-term data sets, historical information, original field notes, maps, photographic collections and electronic data are maintained in the Harvard Forest Archives.

Administratively, the Harvard Forest is a department of the Faculty of Arts and Sciences (FAS) of Harvard University. The Harvard Forest administers the Graduate Program in Forestry that awards a 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 Forestry and Wildlife Management 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, Department of Energy (National Institute for Global Environmental Change), U.S. Department of Agriculture, NASA, and the Andrew W. Mellon Foundation. Our summer Program for Student Research is supported by the National Science Foundation, the A. W. Mellon Foundation, and the R. T. Fisher Fund.

NEW STAFF

Matthias Burgi has joined us from the Federal Institute of Technology, Switzerland and is working with Emily Russell and other staff in the Pocono region of Pennsylvania and the Berkshires of Massachusetts; Diego Perez-Salicrup received his PhD from the University of Missouri - St. Louis and is working on the NASA Land Use Land Change (LULC) project in the southern Yucatan of Mexico with Deborah Lawrence who recently received her PhD from Duke University; and Robert Eberhardt, a recent graduate of Swarthmore College, is a MFS candidate working with David Foster on vegetation and land-use on outer Cape Cod. Research Assistants joining the Harvard Forest staff include Audrey Barker Plotkin, who received a MFS degree from the University of Maine and is replacing Sarah Cooper-Ellis coordinating LTER vegetation studies; Debra Bernardos, a graduate of the University of Massachusetts, who is analyzing historical changes in wildlife in Massachusetts; and Brian Hall, who received his MS from Syracuse University and is analyzing land-use and vegetation data on Cape Cod and the coastal islands. Linda Hampson was hired as accounting assistant, filling in for Jeannette Bowlen who has been on maternity leave; and Thia Cooper joins the staff as summer program assistant.

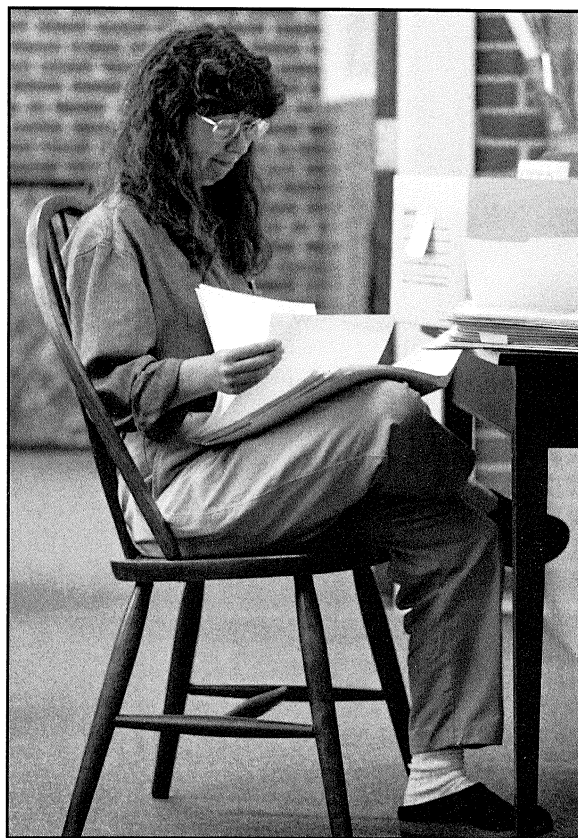
RESEARCH ACTIVITIES

Land-use History and Ecosystem Change

History and Conservation on Cape Cod and the Islands

Much of our recent work has focussed on the importance of land use on the structure, composition, and function of forest in central Massachusetts. As compared to the central part of the state, Cape Cod, Martha's Vineyard, Nantucket, and Block Island supported denser Indian populations, were settled by Europeans at an earlier date, had different forest types and geology, and may have undergone distinctly different land-use practices. We are currently in the initial stages of investigating how historical and modern land use has affected and is still shaping that coastal region's vegetation in an effort to understand the factors controlling modern landscape variation and to provide a sound basis for conservation activities. The coastal landscape is a high priority for conservation by local, regional and national organizations because it supports many uncommon plant and animal communities and rare species and is highly threatened by development.

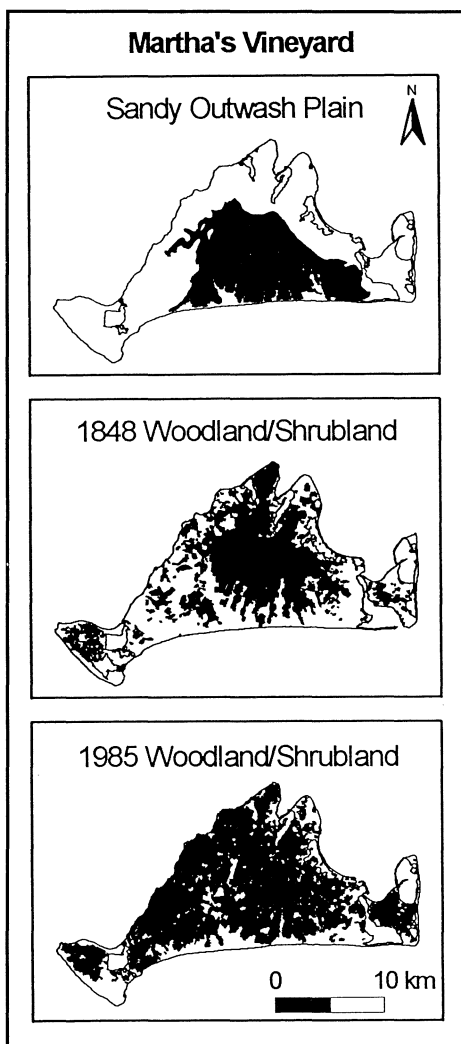
To characterize the physical, biological, and social setting of the region Brian Hall has been gathering modern and historical data and developing GIS overlays depicting geology, hydrography, roads, land-use, and land cover (from 1780 to present), and important natural areas. The land cover and land-use maps enable us to depict the



Audrey Barker Plotkin

historical fragmentation of the forested landscape and to identify currently forested areas that have received contrasting land-use activity and have been covered by contrasting vegetation in the past. Brian is also analyzing land-use related statistics from tax evaluations and state census data.

Two major efforts are using these historical data to understand modern vegetation patterns and ecosystem characteristics, to anticipate future changes in the landscape, and to make recommendations for conservation activities. At the request of the Department of Environmental Management David Foster and Glenn Motzkin are investigating the land-use history of Manuel F. Correllus State Forest on Martha's Vineyard, the largest protected area on the island and one of the best examples of coastal scrub-oak barrens. Using field surveys of soils and vegetation and a wide range of historical sources the study is identifying site-specific relationships between the history of plowing, tree planting, forest cutting, and fire and current vegetation structure and composition for this >5,000 acre site. Results will be utilized in the Commonwealth's efforts to manage this property for unique natural communities, biodiversity, and recreation.



On outer Cape Cod, historical maps and aerial photographs are being used by Rob Eberhardt on his MFS project that will examine landscape patterns of vegetation in relation to site factors, land-use history, fire, and other disturbances. Although the Cape is much more heavily forested than the Correllus State Forest, historical records show that it was extensively cut and widely open in the 18th and 19th centuries and thus the current forest is still recovering from a history of very intensive use. Separating out the effects of human activity, fire, hurricanes, and soil differences will be a major challenge for Rob as he conducts a study that is similar in scope to that led by Glenn Motzkin on the Montague Sand Plain. Much of Rob's work is being conducted on the Cape Cod National Seashore with the cooperation of the National Park Service.

Figure 1. Changes in woodland cover on Martha's Vineyard from 1848 to 1985 in relationship to the distribution of coarse, sandy soil. At the peak of agriculture in the 19th C, when more than 15,000 sheep grazed the Island, the better agricultural soils along the west, east and southern coast were deforested and the largest area of woodland and shrubland occupied the outwash plain on the area now comprising the Manuel Correllus State Forest. Despite the increase in population and tourism this century the decline of agriculture and wood use has resulted in a major increase in forest area and age.



Glenn Motzkin

The landscape of central Massachusetts is much more heterogeneous than coastal areas in terms of soils, geology, and microenvironment and in a related study Glenn, David, Paul Wilson, and Art Allen recently finished an analysis of the Prospect Hill Tract in which they evaluated the importance of current environmental conditions and past disturbances such as farming, the 1938 hurricane, and the 1957 fire in determining modern vegetation patterns. Their results indicate that land-use history continues to influence vegetation even >100 years after farm abandonment and despite more recent major disturbances such as the 1938 hurricane. This work is paralleled by a study conducted by Jana Compton from the University of Rhode Island that concluded that persistent changes in soils and nutrient cycling resulting from historical land-use are also apparent on Prospect Hill.

Old-growth Forest Composition and Dynamics on Wachusett Mountain, Massachusetts

In 1995, over 130 acres of old-growth forest were discovered on Wachusett Mountain in eastern Massachusetts. This site contains the highest peak (608 m) and some of the oldest forests east of the Connecticut River in Massachusetts and it provides a unique opportunity for research on long-term forest disturbance and vegetation dynamics. Over the last several years, Dave Orwig, John O'Keefe, and David Foster have written several reports depicting the current composition and stand dynamics for the Massachusetts Department of Environmental Management. During the summer of 1997, Dave Orwig and summer student Sarah Picard concluded an intensive study of four old-growth stands on the upper slopes of the moun-

tain that differed substantially in aspect, structure, and composition.

Old Indian old-growth: This hardwood forest is comprised of beech, red oak, red, sugar, and striped maples, and yellow birch with thickets of mountain maple, striped maple, and witch hazel. Red oaks are the oldest and largest trees, with several individuals > 64 cm dbh and exceeding 300 years old. Many beech and yellow birch are > 150 years old, while the red and sugar maples are typically smaller and less than 100 years old.

Eastern Talus and Southern Talus old-growth: These forests are located on steep, rocky slopes where basal area and density are quite low. Yellow birch and red oak are most abundant in the overstory above mountain maple, striped maple, and yellow birch. Large red oaks 150 - 250 years old occur among yellow birch, some of which exceeded 250 years of age, including the oldest tree found on the mountain, a yellow birch 369 years old.

Hemlock old-growth: Shade-tolerant hemlock dominate this forest with scattered red oak and other hardwoods. Due to the high density of hemlock, there is no sapling layer and only a sparse herbaceous layer. Structurally, hemlock occurred across a broad range of size and age classes. Many red oak and black birch trees exceed 200 years in age and one red oak is over 300 years.

The age-structure of trees in these four areas is extremely unusual as several red oak, black birch, and yellow birch are very near the maximum longevity for these species (Table 1). Of particular significance is the number of red oak exceeding 250 - 300 years old. In summary, Wachusett Mountain is a significant ecological site due to the wide range of forest types located at different aspects, each containing a high percentage of mature hardwood species.

Table 1. Stand characteristics and range of ages in four old-growth areas on Wachusett Mountain.

Species	Old Indian	Eastern Talus	Southern Talus	Hemlock
Beech	103-236 years	—	156-217	—
Eastern hemlock	—	—	—	115-255
Red oak	170-322	75-222	98-262	125-305
Red maple	36-192	27-94	36-101	104-169
Sugar maple	48-207	53-148	36-166	—
Yellow birch	51-186	24-369	24-166	—
Total Density (ha ⁻¹)	470	385	590	590
Basal area (m ² /ha)	34.0	17.6	27.3	61.2
Aspect	N - NW	E	SE -S	W
Slope (%)	20-40	35-40	35-40	30-40

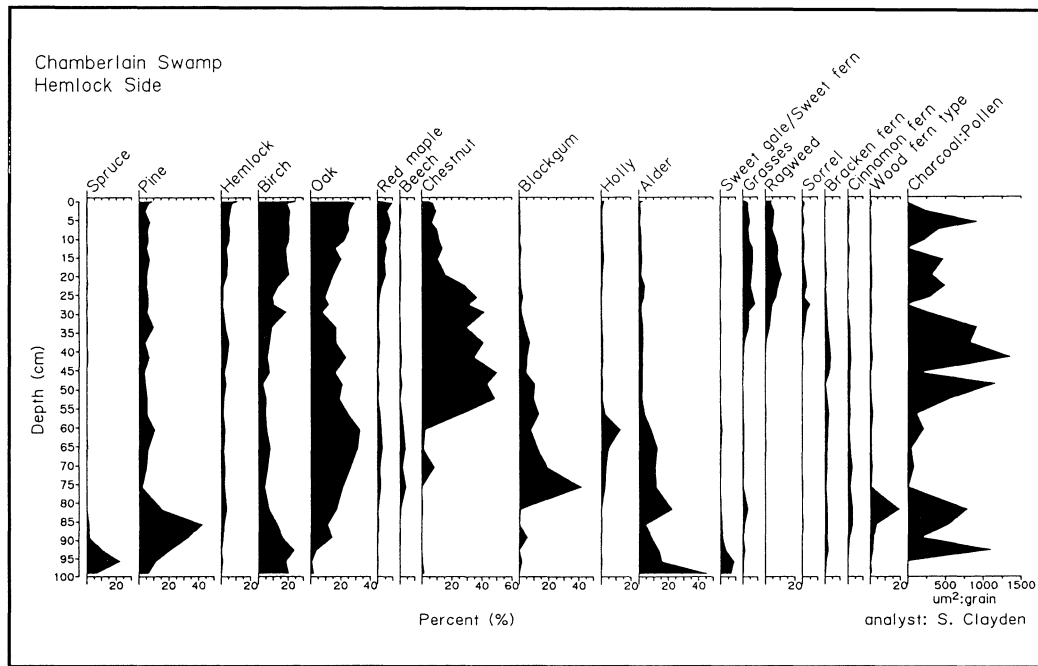


Figure 2. Pollen diagram from the Prescott Peninsula, New Salem, Massachusetts, depicting relatively local changes in the vegetation over the past 10,000 years. The forest changed remarkably approximately 3000 years ago, as oak declined and chestnut migrated into the region. The high values for charcoal suggest that fire may have been an important factor maintaining the abundance of both oak and chestnut in the landscape.

Interpreting Stand Dynamics Using Paleoecology

Although long-term studies, such as the historical research described above provide many insights into forest processes, in order to extend the record of vegetation and environmental change over many generations of trees and many centuries we often use the analysis of fossil pollen and other material that is contained in wetland and lake sediments. One approach that we have been pursuing is to analyze extremely small pools or ponds in order to look at very local dynamics of forests and to understand the human and environmental factors that drive forest change over time. One particularly intriguing issue surrounds the history of oak, which is a valuable timber and wildlife species that, although abundant across eastern United States, has shown a decline in reproduction and abundance on many sites over this century. Among the central questions of interest: What factors allowed oak to become abundant initially? How long has it been abundant? Is, and why, might it be declining?

In order to address these and related questions Susan Clayden, David Foster, Dave Orwig, Natalie Drake and Elaine Doughty are working on the Prescott Peninsula of the Quabbin Reservation in central Massachusetts where an extensive forest composed of red, white, and black oak grades abruptly at the western margin of a small swamp to a hemlock stand on its eastern edge. We analysed pollen from cores taken from both the oak and hemlock margins of the swamp to reconstruct the history of both stands. The record from the hemlock side begins approximately 10,000 years ago, a cold period when spruce and then pine forest

were common (Fig. 2). Subsequently, wetland species such as blackgum, holly, and alder were abundant and then declined as oak became dominant, implying a general drying of the landscape. Oak was replaced approximately 3000 years ago by the arrival of chestnut which rapidly dominated the pollen for more than a millennia until it declined with European settlement. Other hardwoods, predominantly birch and red maple, expanded with the disturbance of settlement, and hemlock increased in the modern sediments.

The pattern of oak dominance prior to the rise of chestnut, followed by the extended period of chestnut dominance, is mirrored in the pollen record from the oak side of the swamp. The two records diverge following settlement when oak rises to 70 percent of the modern pollen sum on the oak side. From both of these sites charcoal levels are moderately high compared with other records from central Massachusetts, suggesting that fire may have helped to maintain the oak and chestnut stands. To place this local record in the context of landscape vegetation patterns we are comparing it with a sediment record from Lily Pond, an 8-acre-pond located 3 miles to the north, which collects pollen from a larger area. This regional record shows none of the changes in oak and chestnut that are captured in the local record. Questions emerging from these two distinct records include: how do stand-scale patterns in vegetation merge to contribute to broader scale patterns; how are the different scales of vegetation represented in the pollen record; and how they have changed over time?



Susan Clayden and Jenifer Garrett in the Paleo Lab

Lake Response to Land Use and Climate Change

Donna Francis continued paleolimnological studies of the influence of landscape change on lake ecosystems in New England with the assistance of Jennifer Garrett, Elaine Doughty and summer students Kevin Clarke and Eron Drew. Changing vegetation, human activity, and other disturbances can produce changes in the chemistry and plant and animal biota of a lake, many of which are reflected in the materials that collect in lake sediments. Comparison of a site with relatively little land-use history (North Round Pond, NH) and a pond whose watershed was once in farmland (Pecker Pond, NH) documents that forest clearance and agriculture resulted in increased exports of sediment and nutrients with resultant changes in water chemistry and aquatic organisms.

We are also interested in comparing the rate and timing of responses of terrestrial vegetation and aquatic biota to landscape change, using aquatic insects in the family Chironomidae, which produce abundant fossil remains and are useful indicators of environmental conditions. In Aino Pond in central Massachusetts, analysis of pollen and chironomid remains from the same core suggests a more rapid response by the insects than the vegetation to an environmental change (either climate or land clearance). Neither the vegetation nor the chironomid returned to pre-disturbance assemblages despite recent de-

cades of recovery in forest cover, indicating lake systems and vegetation have not recovered from the impacts of broad-scale human activity.

Research assessing fossil chironomid assemblages as paleotemperature indicators in southern New England is being undertaken with Janice Fuller and others to examine whether pre-European vegetation change across central Massachusetts may be due to a climatic fluctuation known as the Little Ice Age (AD 1450 - 1850). A calibration set of surface samples from Massachusetts and Connecticut is being collected to assess the relationship between water temperature and chironomid assemblages in this region.

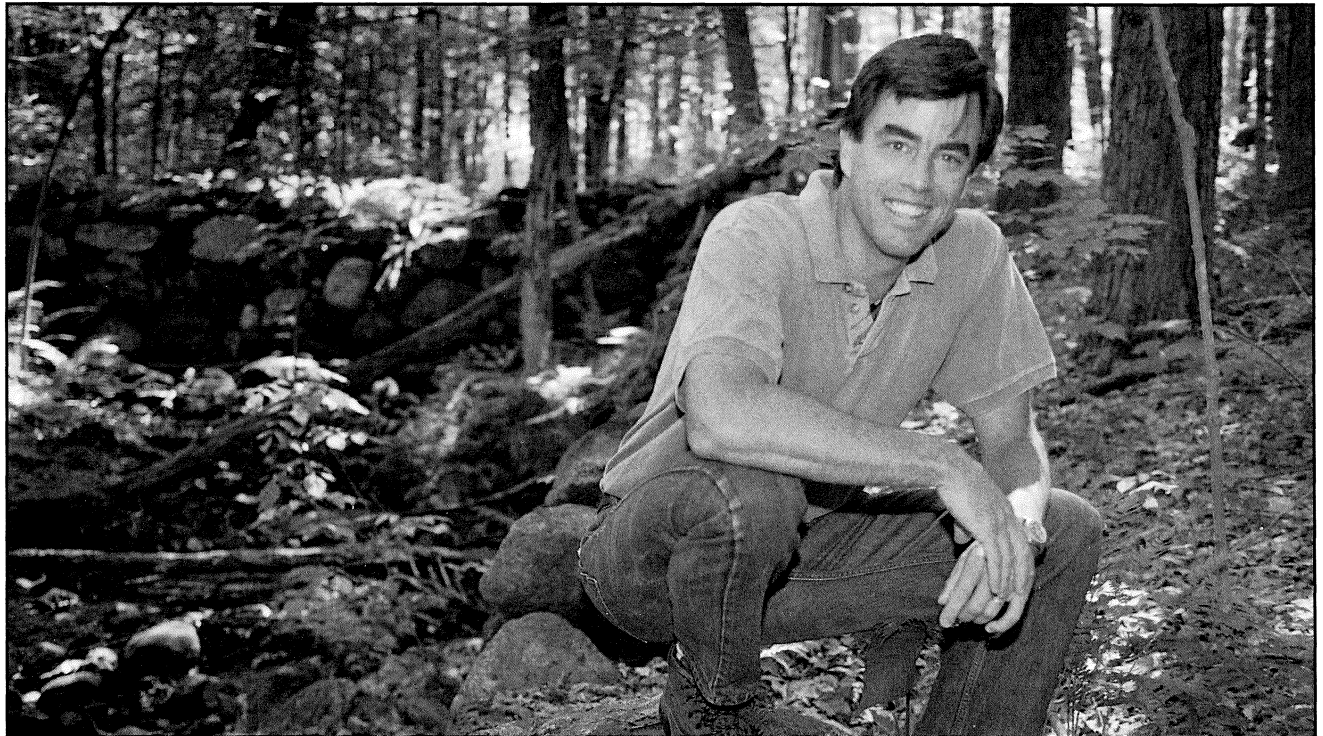
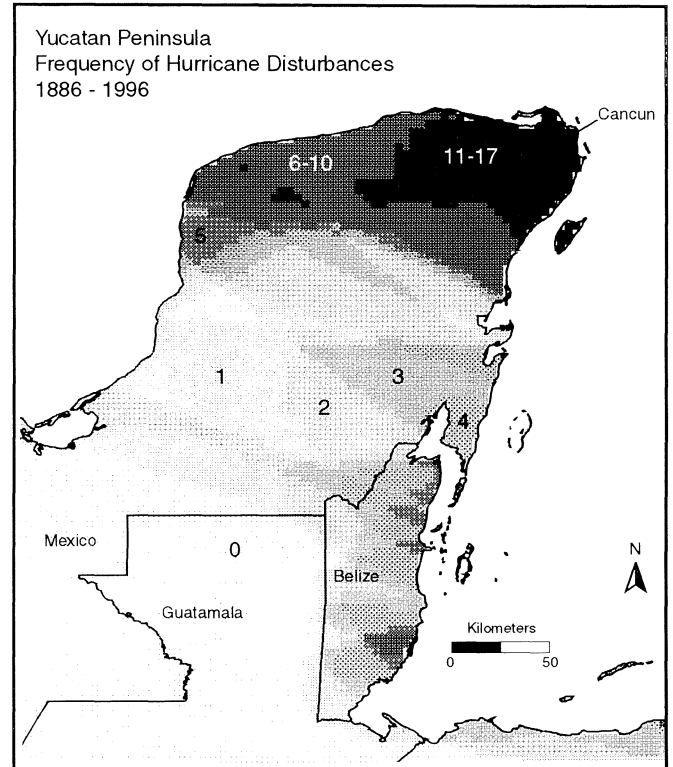
Regional Changes in the Poconos and Berkshires

Matthias Burgi and Emily Russell initiated a regional study of post-settlement land-use and land-cover changes in northeastern Pennsylvania and western Massachusetts to investigate the factors responsible for variation in vegetation over this region and changes since European settlement. The development of forest composition is being studied using pollen records, written sources and forest survey data. Results from this study will expand the regional analysis of the LTER program and will provide a useful comparison with the recently completed analysis of forest change in central Massachusetts.

Land Use and Land Cover Change (LULCC) in the Yucatan

Diego Perez-Salicrup has begun extended field studies in the southern Yucatan region of Mexico in an area centering on the Calakmul Biosphere Reserve as part of the NASA LULCC project that involves Clark University (Billie Turner, PI), ECOSUR, and Harvard Forest. Working with David Foster, Diego is analyzing the factors controlling landscape variation and dynamics in vegetation patterns and rates and patterns of vegetation recovery from different land-use activities, fire and wind storms. The multi-disciplinary project involves remote sensing, social and economic analysis, and historical and ecological studies. The landscape and stand-level analysis initiated by Diego and David will be greatly strengthened by the addition of Deborah Lawrence who will be focussing on ecosystem processes.

Figure 3. Along with fire and human activity, hurricane impacts are a major disturbance that controls vegetation structure and dynamics across the Yucatan Peninsula. A reconstruction of tropical storms shows a very clear gradient in frequency from north to south.



David Foster



Wildlife Studies

History of Wildlife in Massachusetts

Among the most conspicuous items in our daily newspapers are stories pertaining to human conflicts with wildlife: bears in backyards and birdfeeders, moose on highways, beavers flooding houselots, and seagulls and geese fouling public water supplies. Remarkably, one of the consequences of the recovery of forest areas across New England during the past 150 years has been a gradual and widespread recovery of many native animals species. This increase in native animals has profound effects on nature as well as people and is mirrored by a corresponding decline in many species common on agricultural lands and shrubby vegetation as our land becomes more forested. As the management and conservation interests surrounding these changes in wildlife populations increase, Debra Bernardos along with David Foster and Glenn Motzkin have launched a major effort to understand the very long-term history of wildlife from the time of European settlement to the present and to determine the specific causes behind these historical population fluctuations. The total number of species investigated is approximately twenty-five, but they fall into four major patterns: species that declined with forest clearance and then recovered in the last 100 years, species that were extirpated from the region, species that increased with the habitat afforded by agricultural activity and have subsequently declined, and those new species that were not native but have migrated recently in from other parts of the U.S.

Examples of these patterns include: deer, eastern

timber wolf, grassland birds, and coyote. For instance, the white-tailed deer was abundant in Massachusetts forests prior to European settlement, but declined dramatically after settlement and nearly disappeared in the mid-1800's. It began to recover during the 1900's and now has a state-wide population of eighty thousand. In a significant variation on this pattern, the eastern timber wolf was abundant prior to settlement, but declined rapidly and was extirpated by hunting and trapping in the late 1800's (Fig. 4).

In contrast, grassland birds existed in very low numbers prior to settlement and increased with land clearing and the increase in grassy and shrubby habitat (Fig. 5). Species such as bobolink, meadowlark, and grasshopper sparrow reached their peak in the mid 1800's, at the height of agriculture in New England, and began to decline thereafter. Presently, a few of these birds have been listed as endangered or as threatened. On the other hand, the eastern coyote was not an original Massachusetts species, but was restricted to the Great Plains and Midwestern U.S. and Canada at the time of European settlement. It naturally extended its range eastward and into the state during the 1950's and can now be found in almost every town in Massachusetts. Debra has gathered data on historical wildlife distribution and abundance through intensive library research at the University of Massachusetts and has received current data on wildlife populations from the Massachusetts Division of Fisheries and Wildlife and the Massachusetts Audubon Society.



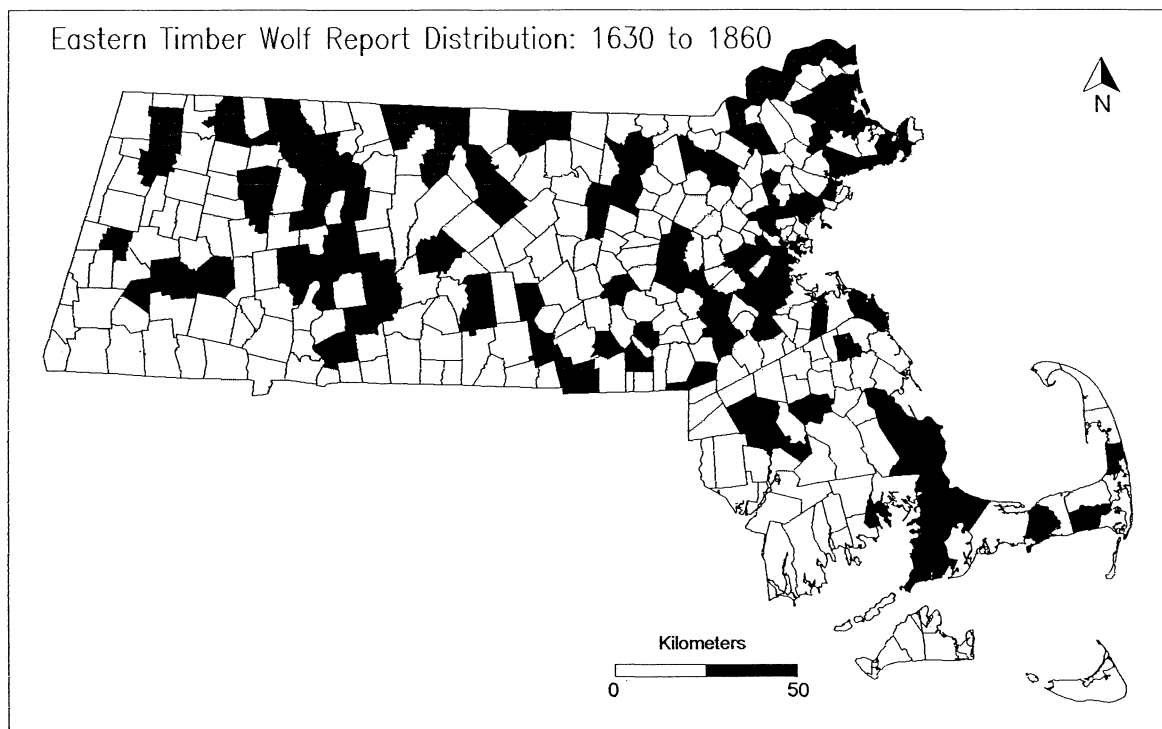


Figure 4. Town histories from across New England are replete with references to bounties issued and paid on wolves and records of wolves menacing wildlife or reported killed. Based on these and other sources we can determine that wolves ranged across Massachusetts in the first two centuries following European settlement.

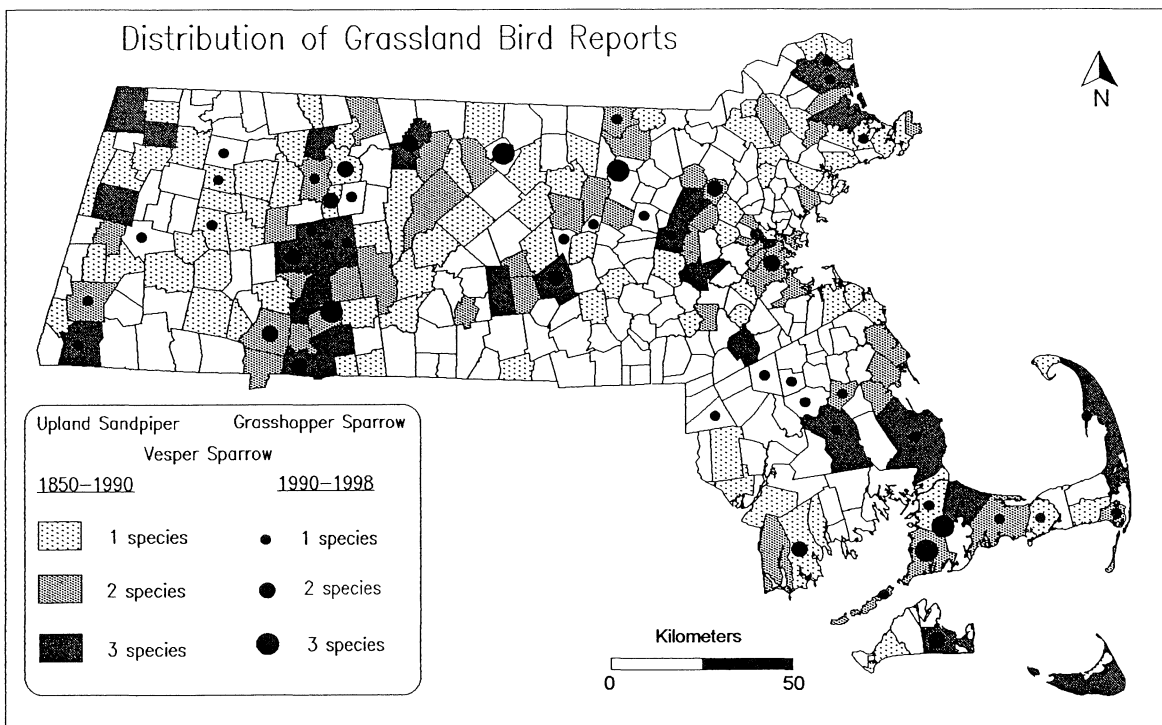


Figure 5. In contrast to the wildlife of forests many grassland and shrubland bird and insect species increased as open habitat was created through agricultural land uses. This map of Massachusetts documents the large reduction in three uncommon species over the last 150 years. Interestingly, the majority of the recent sightings are from newly created artificial sites particularly airfields, air bases, and landfills.



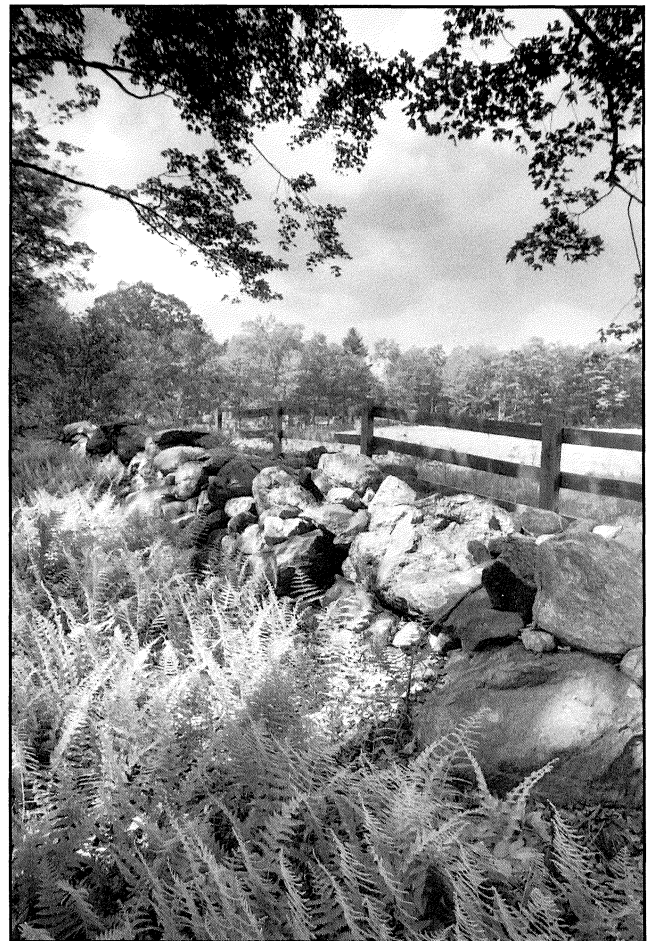
Mice and Songbirds: Vertical Distributions and Predator-Prey Interactions in Oak Forest

The forest ecosystem is complex not only across the landscape, but vertically as well. Ground, shrub, sub-canopy, and canopy differ in structure, light, humidity, temperature, food, predators, and competitors. Changes in vertical structure can have profound consequences for wildlife that actively forage and nest off the forest floor. Cathy Langtimm and Becky Field are examining the ecology of two groups of vertebrates that are found at all levels -- songbirds and white-footed mice. In particular, they are focussing on the possibility that the mice are important predators on bird eggs.

In 1997 they began a study on Prospect Hill of vertical distribution patterns of birds and mice and differences in predation rates of nests at various heights in oak forests. Live trapping demonstrated that mice occur in oak canopies with a pronounced peak in climbing in July through September. In the spring and fall lack of food in the understory and/or lack of leaf cover, which can provide protection from predators, may reduce arboreal activity.

Surveys from May through July identified 35 bird species including Black and White Warbler, Blackburnian Warbler, Black-throated Blue Warbler, Black-throated Green Warbler, Canadian Warbler, Chestnut-sided Warbler, Eastern Wood Pewee, Hermit Thrush, Ovenbird, Red-eyed Vireo, Scarlet Tanager, and Solitary Vireo. In 1998 the study was expanded to Tom Swamp and Quabbin Reservation. Artificial bird nests containing natural and clay eggs at ground, shrub, and subcanopy levels are being used to compare predation rates and to determine the predators.





Broad-scale Disturbance to Forest Ecosystems

Landscape Patterns of Hemlock Woolly Adelgid - Outbreak in Southern New England

Hemlock woolly adelgid (HWA; *Adelges tsugae*), an introduced aphid-like insect from Asia, is expanding across the range of eastern hemlock in New England and has the potential to reduce or eliminate this important late-successional species. In order to understand the rate and factors controlling infestation, Dave Orwig and summer students David Mausel and Jesse Bellemare have mapped the distribution of all hemlock stands (> 3 ha) in a 5900 km² transect through southern New England to characterize the temporal and spatial patterns of damage. During the summer of 1997, we obtained information from 50 stands containing $> 50\%$ hemlock density including forest structure and composition, crown vigor, site characteristics, presence and density of HWA, and the extent and spatial patterns of damage generated by this insect since the time of its arrival in 1985 (Fig. 6). Of the

100 + stands visited, over 80% contained HWA and over 60% had experienced hemlock mortality. In one-third of the stands, more than half of all hemlock have died and $>25\%$ of the stands have had salvage logging. The majority of stands were found on ridge tops, narrow valleys, and hillsides with slopes averaging 25%.

The spatial pattern of HWA damage currently exhibits a distinct south to north trend in decreasing damage and mortality, consistent with the northward migration of the insect. During 1998, Dave Orwig, along with Matt Kizlinski and summer students David Mausel and Erin Largay, will finish sampling the hemlock stands and will start examining mixed hemlock-hardwood forests. This information will be incorporated into a GIS analysis of landscape-level, biological, edaphic, and historical factors that control damage patterns.



Steve Currie and Matt Kizlinski sieving soils in the Torrey Lab

Ecosystem response to Hemlock Woolly Adelgid

Dave Orwig, along with Matt Kizlinski and David Foster, initiated a project examining ecosystem response to hemlock decline from HWA in southern New England. Healthy hemlock forests typically have slow decomposition and nitrogen (N) cycling rates due to low foliar N content and cool microclimate. However, thinning canopies associated with HWA infestations should reverse this trend as they result in dramatic increases in light levels and soil moisture and temperature. Within the central Connecticut transect, 8 study sites (6 infested with HWA, 2 control sites without HWA), were selected for intensive soil analyses. The infested stands are in an early infestation stage and therefore we will be able to determine the timing and extent of change in overstory composition, microenvironment, and soil conditions that produce fundamental changes in the cycling of nitrogen as the stands deteriorate. During the summer of 1998, with the assistance of summer student Steven Currie, nitrogen mineralization rates were measured at each site using close-topped soil cores to capture the magnitude and duration of N dynamics. In addition, ion-exchange resin bags were used to estimate the spatial availability of N within sites and the extent to which nitrate (NO_3^-) is being lost. Moisture content, soil temperature, and understory light levels will also be measured to assess microenvironmental changes. Additional analyses will include soil texture, pH, bulk density, and C:N ratios. This information should be useful in determining how forest ecosystems respond to the selective removal of a dominant tree species.

Hurricanes in the Caribbean

Hurricanes are one of the most important natural disturbances affecting the forests on Caribbean islands. Emery Boose, Mayra Serrano, and David Foster continued their study of hurricanes in Puerto Rico since European settlement. Historical materials from the University of Puerto Rico and the Puerto Rican National Archives for all recent hurricanes (1886-present; 71 storms) and for all known early hurricanes (1502-1885; 80 storms) were used to create detailed maps of wind damage by town for hurricanes since 1800, and estimates of island-wide impacts for earlier storms. Wind conditions were reconstructed for each of the 71 recent hurricanes using a simple meteorological model (HURRECON), and com-

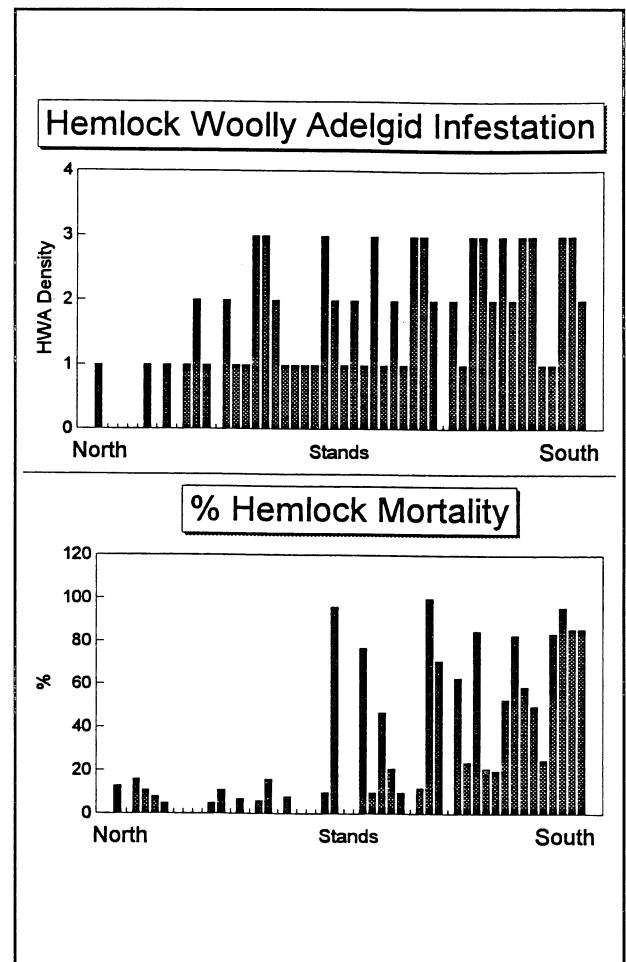


Figure 6. As the infestation of hemlock woolly adelgid moves northward across Connecticut (top) there is a time lag but a parallel trend in the mortality of hemlock in up-land forest.

pared to the maps of actual wind damage and to actual wind observations. On a regional scale, results showed gradients across the island from southeast to northwest in hurricane frequency and intensity, caused by the direction of storm approach (normally from the southeast or east) and the tendency for hurricanes that made landfall to weaken somewhat over the interior. The frequency of historical hurricanes in Puerto Rico was significantly greater than in New England and the most intense storms were far more destructive. On the other hand, the more obvious signs of forest wind damage disappear much more quickly in the LEF, where rates of forest growth and decomposition are much higher than in New England.

Ecophysiology, Biology, and Population Dynamics of Plants

Seedling Response to Nitrogen Deposition

One subtle, but potentially major factor altering forest ecosystem process and characteristics is the enhanced deposition of nitrogen coming from many human sources. Since nitrogen is a limiting nutrient in many forest ecosystems, and may become a pollutant at high levels in aquatic ecosystems, its increasing abundance has been identified as a major global concern. At the Harvard Forest a series of experiments coordinated by John Aber has examined the effects of enhanced nitrogen deposition on a variety of ecosystems functions. In a related study Sebastian Catovsky is using field studies at the Forest for his PhD project "Linking community dynamics and ecosystem function: influence of nitrogen deposition on temperate forests in eastern North America" (Fig. 7). This study is addressing a number questions: (1) How does resource availability influence seedling regeneration within hemlock- and hardwood-dominated stands? (2) How will increased nitrogen deposition influence seedling regeneration in hemlock- and hardwood-dominated stands? (3) How do conifer and hardwood tree species differ in rates of instantaneous and annual carbon uptake? By combining studies of the physiology and population biology of hemlock with analyses of a wide range of environmental factors including nitrogen availability, Sebastian is developing a much clearer understanding of both this important tree species and the potential role of enhanced nitrogen availability in forest dynamics.

Carbon Exchange in Old-growth Hemlock Forests

Julian Hadley continued to collect data on the microclimate and carbon exchange of an old-growth hemlock stand in order to develop a predictive model of the stand's carbon balance. Temperatures of air, wood, and soil were measured in addition to humidity, windspeed, and light above and within the canopy. Data from July 1 to November 15 were combined with measurements of photosynthesis and tree and soil respiration to produce a preliminary model, which predicted a net loss of carbon by the hemlock stand during July and August (Fig. 8). A near-zero carbon balance was predicted for September and October. Carbon loss was predicted for the warmest months of the year because photosynthesis did not increase significantly with temperature above 10 °C, while all types of respiration increased sharply with rising temperature. Nearly half of predicted carbon loss by the hemlock stand

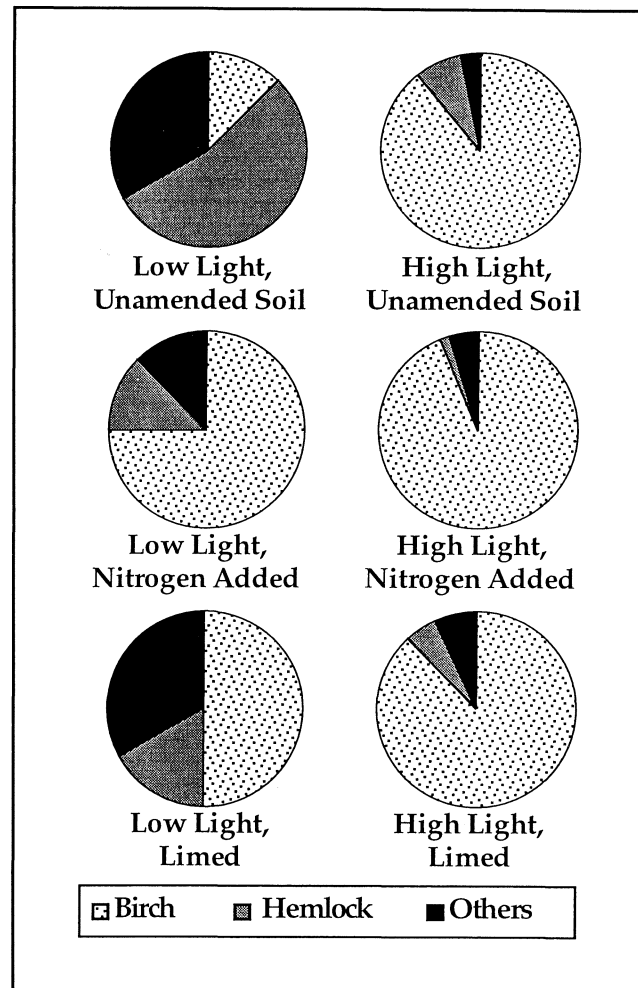


Figure 7. When intact soils are removed from a mature hemlock forest and then treated to contrasting regimes of light, nitrogen or lime (to alter the pH) under controlled experimental conditions, the composition of seedlings that emerge from the soil seed bank is remarkably different. These results confirm the very strong control the microenvironmental conditions may exert on long-term forest composition.

was from soil respiration, and carbon storage may occur in late spring when soils are cooler than in summer, but long days and moderate temperatures still allow high photosynthesis. Julian supervised two summer students during 1997, one of whom (Cristi Braun) completed a senior thesis at Hampshire College on carbon uptake by the aquatic moss *Fontinalis* as it is affected by light and by CO₂ dissolved in streamwater.

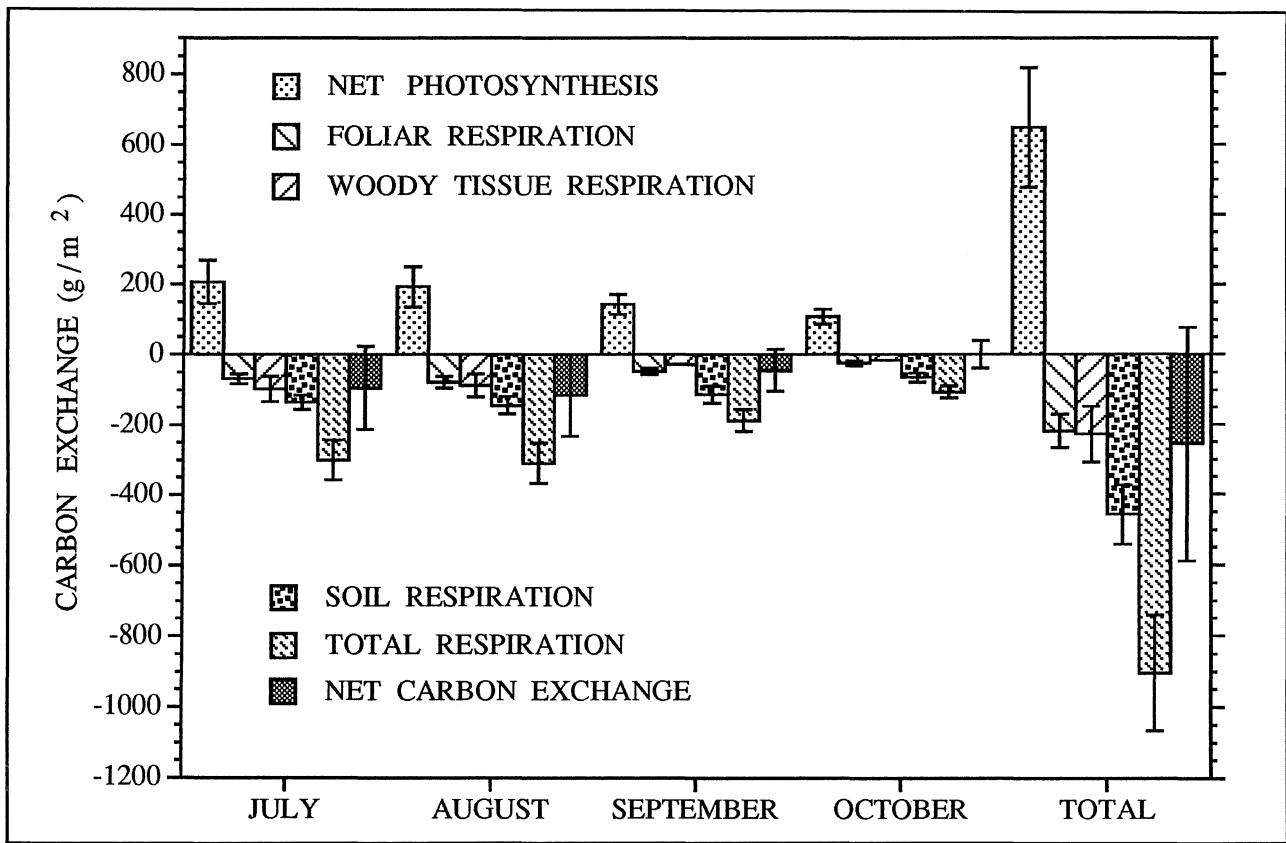
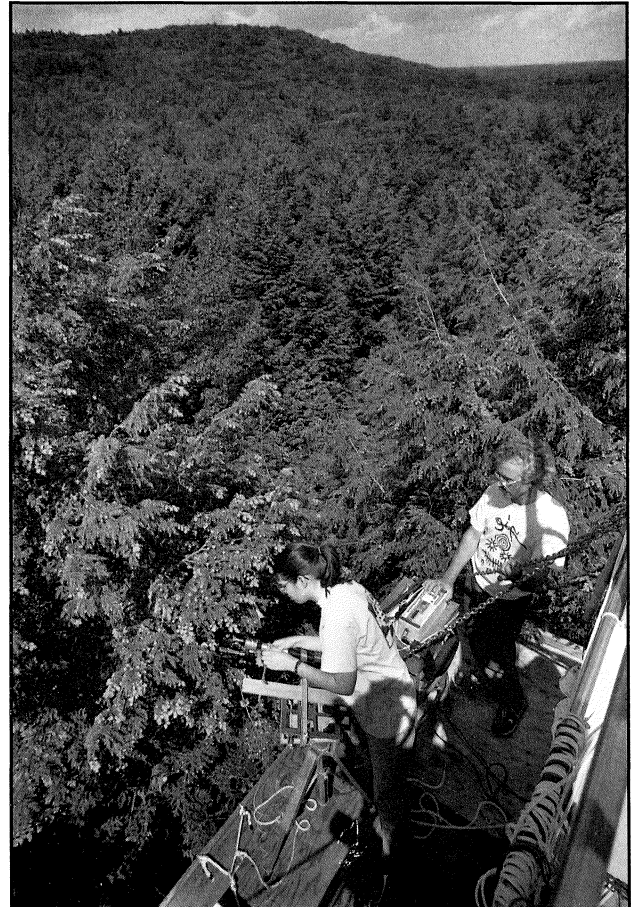


Figure 8. Components of estimated carbon balance of the hemlock forest in July through October 1997, and estimated total carbon exchange for the four-month period. Estimated net carbon exchange for October was zero, so no bar is shown. Error bars represent approximate 95% confidence intervals based on data available; however, only one tree was sampled for woody tissue respiration (four trees for other measurements).

Erica Goss and Julian Hadley measuring leaf-level photosynthesis in the hemlock canopy on Prospect Hill.





Wintergreen (*Gaultheria procumbens*)

Water Transport in Temperate Forest Trees

Maciej Zwieniecki and Missy Holbrook from OEB are investigating the dynamic nature of the water conducting system of trees at the Harvard Forest and have documented significant diurnal changes in the resistance to water transport through the branches of white ash and red maple. They believe that increases in resistance during the day arise from the formation of air embolism in the conducting pathway that result from breakage (cavitation) of the water column under tension. Current work focuses on how these breaks might be repaired and involves developing a variety of non-destructive field techniques that will allow them to monitor changes in the hydraulic capacity of intact tree branches over the course of the day. They are also conducting a series of laboratory experiments that test components of this working hypothesis for embolism repair. Because maintaining an intact water conducting system to supply the leaves is essential for the plant to survive, these studies address a fundamental aspect of how plants respond to the environment and contribute to our understanding of the basic physiology of forest trees.

Population Structure and Response to Land Use

Ruth Kern continued to investigate the mechanisms by which historical land-use exerts a persistent influence on species distributions. Ruth developed a series of detailed distribution maps for 14 clonal species across a land-use boundary on Montague Plain. The ability of these species to colonize former agricultural sites varies considerably. Whereas some species have successfully colonized former fields, others are highly restricted to areas that were never plowed. Interestingly, many of the species produce abundant fruit, and yet there is little evidence of recent seedling establishment for most of the species. By looking at the patch size and distribution of

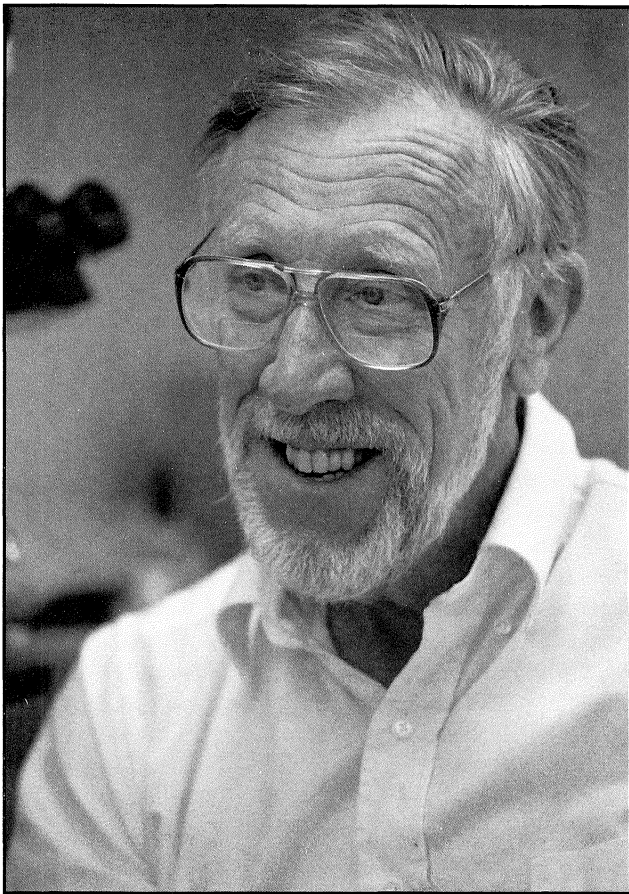
these species and gathering information about their life history strategies, Ruth will identify the different mechanisms by which plants respond to disturbances and help us to understand the importance of site history in determining species distribution patterns.

Light Foraging by Temperate Trees

Christine Muth, a graduate student in OEB, began her thesis work studying the ability of temperate trees to forage for light resources by allocating leaf area to regions of high light in the canopy. This "leaf allocation flexibility" may vary between species and is likely to affect competitive interactions between neighboring trees. Christine conducted a descriptive study to investigate the



Indian Cucumber - root (*Medeola virginiana*)



Barry Tomlinson

effects of neighbor size, distance, and identity on tree canopy position by mapping all tree stems and canopies in a 0.6-ha permanent plot. Most trees had asymmetrical canopies, suggesting "leaf allocation flexibility." Early successional trees (paper birch and white ash) had significantly greater canopy asymmetry than other species. Tree canopies were asymmetrical towards areas of decreasing topography and canopy gaps, and away from large neighbors. These results indicate that tree canopy asymmetry may serve to reduce competition between near neighbors and thereby influence community dynamics.

Plant Biology

Barry Tomlinson continued work on pollen structure in North and South hemisphere conifers. He has shown that conifer pollen structure is closely correlated with methods of pollen capture and provides a functional explanation for pollen diversity, which in conifers is among the widest in seed plants. Work was also completed on the phenology of shoot production in conifers mainly based on material from the Arnold Arboretum. This has shown that taxa with similar architecture may differ

considerably in phyllotactic patterns that change during a seasonal cycle. A comparative study of stem anatomy in climbing palms was continued, including a period of study in collaboration with Dr. Jack Fisher at Fairchild Tropical Garden. The climbing habit has probably evolved independently in seven groups of palms, notably in the group that produces the commercially valuable rattan canes. Some climbing palms have deviated little from a basic stem structure, but rattans show unexpected features that require a functional explanation, especially as the group is highly successful ecologically.

With student assistants work was completed on a catalogue of all scientific illustrations executed by Priscilla Fawcett at Fairchild Tropical Garden, work supported by the Cabot Foundation. Research on woody plants at Harvard Forest from 1965-1980 resulted in a large series (c. 200) of 100-foot 16-mm films made with frame-by-frame photography of serial sections. In order to preserve this record they have been translated onto video, catalogued, and the original films spliced on to larger reels for permanent storage. The films continue to be valuable sources of information and three demonstration films made by the late Martin Zimmermann are commercially available. An earlier effort in desk-top publishing had resulted in the book "The Biology of Trees Native to Tropical Florida," published in 1980. Dottie Recos-Smith began the task of producing a new revised edition, employing much more advanced computer techniques. This involved scanning in old text and re-designing format while allowing an up-dating of information and corrections. This should result in a much more compact and professional-looking format that will still retain the original illustrations by Priscilla Fawcett.



Rattlesnake plantain
Goodyera pubescens

Harvard Forest LTER Program

The Harvard Forest is one of twenty-two 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 to interpret the current 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.

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), and Harvard Forest (D. Foster) 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), Mt. Union College (C. McCaugherty), Rutgers University (E. Russell), and the University of Massachusetts (M. Mulholland). Emery Boose is the LTER Data Manager. The research is organized to maximize the interactions among scientists from different disciplines. Four core experiments include: (1) re-creation of physical disturbances, including catastrophic hurricane blowdown and smaller windthrows; (2) simulation of chronic chemical

disturbance by altering inputs of important pollutants; (3) interactions between physical and chemical disturbances; and (4) repetition of treatments to assess the range of variation in response.

The LTER science group meets approximately monthly. The annual Harvard Forest Ecology Symposium is held to present current research. Abstracts from this meeting are published annually. The program for the 1998 symposium is shown on the following page.

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).



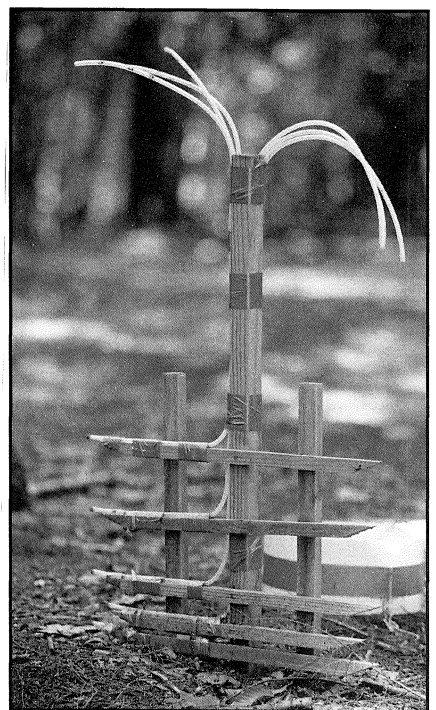
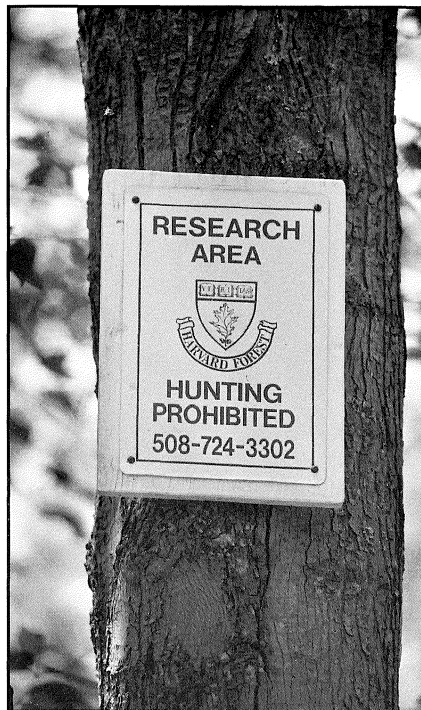
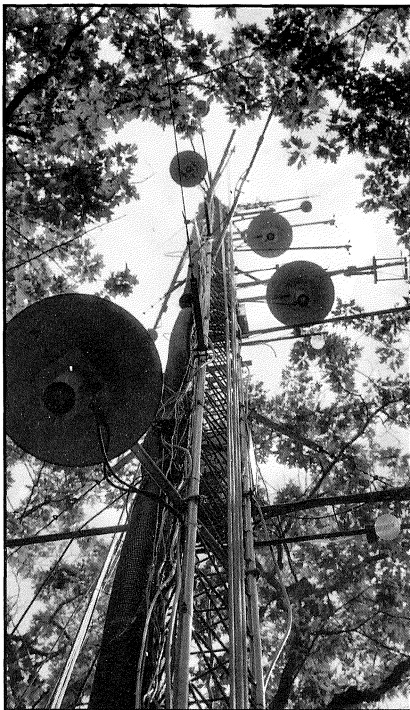
Detritus Input Removal Treatment (DIRT) Experiment. Manipulation of above- and below-ground organic inputs provides insights into the fundamental processes of carbon dynamics in forest ecosystems.

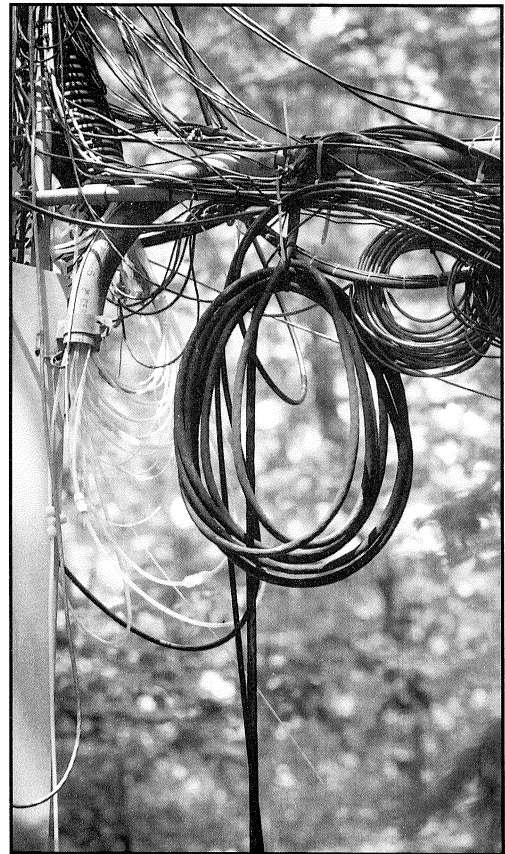
Harvard Forest Ecology Symposium 1998

Titles of Abstracts and Presentations

- Aber, J. What's Missing From Models of N Cycling in Forest Ecosystems?
- Aitkenhead, J. and W. McDowell. Effects of Soil Organic Matter Inputs on Soil Solution Chemistry.
- Barnes, D. and S. Wofsy. Evaluation of Greenhouse and Ozone-Depleting Gases in Rural New England.
- Bernardos, D., D. Foster and G. Motzkin. The History of Wildlife in Massachusetts.
- Berntson, G. and J. Aber. Kinetics of N-Immobilization and the Pool Dilution Technique for Quantifying N-cycling.
- Boone, R., K. Nadelhoffer, J. Canary and J. Kaye. Controls on the Temperature Sensitivity of Soil Respiration.
- Boose, E. and W. Anderson. Topographic Exposure of Large White Pines in Central New England.
- Boose, E., K. Chamberlin and D. Foster. Landscape and Regional Impacts of New England Hurricanes.
- Boose, E., M. Serrano and D. Foster. Landscape and Regional Impacts of Puerto Rican Hurricanes.
- Burk, J. Development of the Harvard Forest Archives, 1997-98.
- Catovsky, S. and F. Bazzaz. Resource Interactions and Seedling Regeneration in Hemlock-Dominated Forest Stands.
- Catricala, C., K. Newkirk, P. Steudler and J. Melillo. Effect of Soil Warming on Microbial and Root Respiration.
- Clayden, S., D. Foster, D. Orwig, N. Drake and E. Doughty. Local Holocene Forest Dynamics.
- Compton, J., R. Boone, G. Motzkin and D. Foster. Soil Nutrients: the Role of Vegetation and Land-Use History.
- Cooper-Ellis, S. A Checklist of Mosses for Massachusetts.
- Cooper-Ellis, S. and D. Foster. Reinterpretation of the 1938 Hurricane.
- Currie, W. and K. Nadelhoffer. Interpreting Time Series Observations in ¹⁵N Redistributions at the Ecosystem Level.
- Czepiel, P., Y. Lin, J. Munger and S. Wofsy. Tracer Experiments to Define the Flux Tower Footprint.
- Dail, B., J. Bortiatynski, E. Davidson, J. Chorover and P. Hatcher. Using NMR to Understand N Retention.
- Donohue, K., D. Foster and G. Motzkin. Land-Use History and Demography of Wintergreen.
- Fitzjarrald, D., K. Moore, R. Sakai, J. Freedman and O. Acevedo. Impact of Forest-Atmosphere Exchanges.
- Foster, D., D. Knight and J. Franklin. Landscape Patterns and Legacies from Large Infrequent Disturbances.
- Foster, D., G. Motzkin and B. Slater. Regional Forest Dynamics in Central New England.
- Francis, D., D. Foster, J. Garrett, E. Doughty and N. Drake. Responses of New England Lakes to Land-use.
- Fuller, J., D. Foster, J. McLachlan, N. Drake and E. Doughty. Impact of Human Activity on Forest Dynamics.
- Fuller, J., D. Foster, M. Mulholland, D. Francis, B. Wolfe, T. Edwards and M. Winkler. Pattern and Cause of Forest Dynamics in Northeastern North America During the Last 1500 Years.
- Gaudinski, J., S. Trumbore, E. Davidson and E. Belk. Partitioning of Soil Respiration Fluxes in a Temperate Forest.
- Hadley, J. A Preliminary Model of the Carbon Budget of an Old-Growth Eastern Hemlock Stand.
- Horri, C., S. Wofsy, M. Zahniser and J. Munger. Nitric Acid and Nitrogen Dioxide Flux Measurements.
- Jenkins, J. and J. Aber. Effects of Hemlock Woolly Adelgid (*Adelges tsugae* Annand) on Ecosystem Processes.
- Kamakea, M., A. Hagerman, A. Magill and J. Aber. Changes in Foliar Polyphenols with Nitrogen Fertilization.
- Kern, R., S. Gale, G. Motzkin and D. Foster. The Effect of Land-Use History on Clonal Plant Distributions.
- Langtimm, C. and R. Field. Mice and Songbirds: Vertical Distributions and Predator-Prey Interactions in Oak Forest.
- Lavelle, N., G. Motzkin and J. O'Keefe. Effects of Winter Storms on *Pinus rigida* and Mixed Hardwood Stands.
- Lent, R. Development of the Harvard Forest Web site: the Common Gateway Interface Comes to Petersham.
- Magill, A. and J. Aber. Long-Term Effects of Nitrogen Deposition on Two Temperate Forest Stands.
- McDowell, W., W. Currie, J. Aber and Y. Yano. Effects of Chronic Nitrogen Amendment on DOC and DON.
- Motzkin, G., D. Foster and P. Wilson. The Role of History and Environment in Complex Landscapes.
- Motzkin, G., W. Patterson and D. Foster. A Regional-Historical Perspective on Uncommon Plant Communities.
- Muth, C. and F. Bazzaz. Tree Canopy Asymmetry and Neighborhood Interaction.
- Nadelhoffer, K., R. Boone, J. Canary and P. Micks. Forest Soil C and N Dynamics in Relation to Plant Inputs.
- Newkirk, K., C. Catricala, J. Melillo and P. Steudler. Soil Warming Experiment at Harvard Forest 1997.
- O'Keefe, J. and N. Lavelle. Regeneration Following Clearcutting of Red Pine Overstory - Year 8.
- Orwig, D. and D. Foster. Forest Response to the Introduced Hemlock Woolly Adelgid in Southern New England.
- Orwig, D., D. Foster and J. O'Keefe. Dynamics of Old-Growth Forests on Wachusett Mountain.
- Orwig, D., M. Kizlinski and D. Foster. Landscape and Ecosystem Analyses of Adelgid Outbreaks.
- Potosnak, M., S. Wofsy, A. Denning, J. Conway, P. Novelli and D. Barnes. Separation of Sources of Surface CO₂.
- Russell, E. Changing Vegetation Patterns Over the Last 500 Years in Forest Transition Areas.
- Savage, K., E. Davidson and E. Belk. Interannual Variation in Soil Respiration Rates at Harvard Forest.
- Sipe, T., R. Bowden, C. McClaughery and M. Kibler. Impact of Land-Use on Forest Soil-Plant-Atmosphere .
- Sundquist, E., et al. Accuracy of Closed-Chamber Soil Gas Flux Measurements.
- Zwieniecki, M. and N. Holbrook. Short term Changes in Xylem Water Conductivity.

Scenes from an Outdoor Laboratory





BULLARD FELLOWS

Marc Abrams' (Pennsylvania State University) interests focus on the role of land-use history and fire in controlling the composition, dynamics, and structure of northeastern forests. He plans to conduct a dendroecological investigation of one or more old-growth forests to increase our understanding of the role of disturbance in the historical development of northern forests and is preparing scientific papers and book chapters. John Boyer's (University of Delaware) research in Missy Holbrook's laboratory in Cambridge investigated water movement to leaves of land plants, work he had begun in Australia.

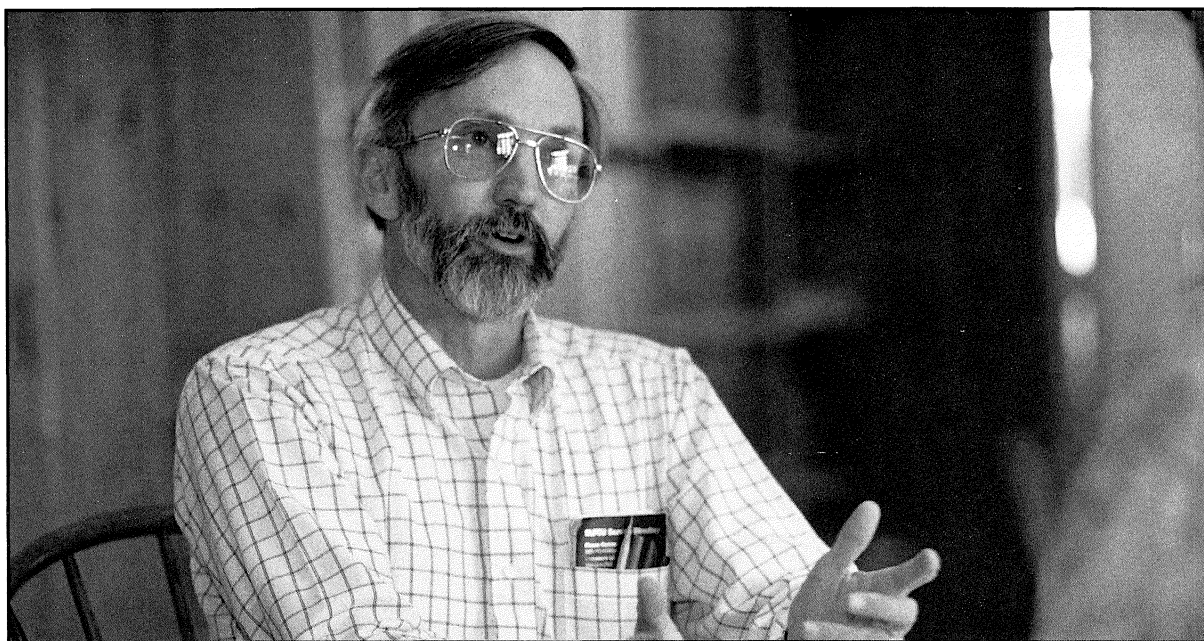
Bill Romme (Fort Lewis College, Durango, Colorado) spent his time analyzing data and writing up research on disturbance ecology in the Rocky Mountains. Specific projects included analyses of fire history and twentieth century vegetation change in forests of the San Juan Mountains, fire history in Mesa Verde National Park, and patterns of postfire succession in Yellowstone National Park following the fires of 1988. He also worked as co-editor of a book on forest fragmentation in the southern Rocky Mountains. Being newcomers to New England, Bill and his family immersed themselves in the natural and cultural history of this "new" part of the world.

Susan Trumbore's activities at Harvard Forest include: (1) continue sampling of soil organic matter and soil CO₂ emissions for radiocarbon analyses; (2) expand methods of sampling and data interpretation to two new field sites; and (3) begin a new project sampling radiocarbon in atmospheric CO₂. Susan and her students developed methods to partition below-ground respiration sources using radiocarbon to separate contributions of decomposing organic matter from root respiration and very

rapidly decomposing substrates and expanded this work to two other eastern sites: Howland Forest, in Howland, Maine, and the Walker Branch Watershed, in Oak Ridge, Tennessee. A new project with Steve Wofsy and John Hayes at Woods Hole will explore the usefulness of radiocarbon measurements for determining the regional importance of fossil fuel sources of carbon dioxide.

Ian Turner (National University of Singapore) reviewed the literature for a book on the ecology of tropical rain-forest trees. Ian joined Peter Ashton's research group at the Harvard University Herbaria, where he finished a manuscript on leaf form of canopy trees from two forests in Brunei and completed a check-list of the vascular plant species of the South China Sea and its shores.

Dennis Whigham (Smithsonian Environmental Research Center) spent his fellowship reviewing literature and writing a review article on the ecology and conservation of woodland herbs. The theme was motivated by ongoing research projects and the fact that there is now considerable interest in woodland herbs from a conservation and biodiversity standpoint. Dennis presented a seminar at Harvard Forest, led group discussions on the ecology of dry tropical forests in the Yucatan Peninsula of Mexico, and development of a national methodology for ecological assessments of wetlands, and presented a lecture at the annual symposium of the Japanese Society for Plant Biology. Dennis played an active role in planning the ESA meetings in Baltimore in 1998. He completed several manuscripts and editorial work on a forthcoming Special Features section of Ecology on nutrient use efficiency in wetlands.



Bill Romme

EDUCATIONAL ACTIVITIES

Barry Tomlinson taught Biology S-105 (Biodiversity of Tropical Plants) at Fairchild Tropical Garden, Miami Florida under the auspices of the Harvard Summer School; Biology 102 (Biology of the Seed); Biology 399 (Topics in Organismic and Evolutionary Biology) with David Baum; and the Freshman Seminar with David Foster. David taught Biology 160 (Forest Ecology) and he served on committees for students in OEB and Graduate School of Design at Harvard, Clark University, and University of Massachusetts.

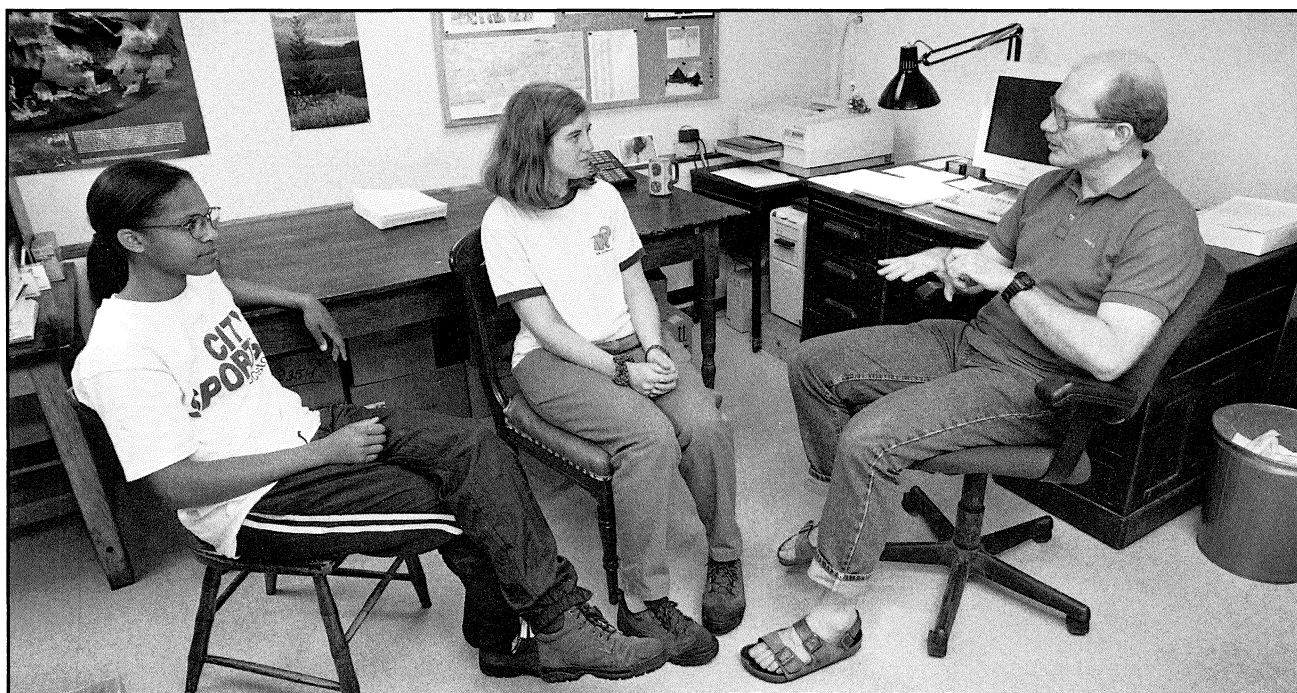
Summer Research Program

The Harvard Forest Summer Student Research program, coordinated by Chris Kruegler and assisted by Thia Cooper, 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 trips on soils, land-use history, and plant identification. An annual field trip is made to the Institute of Ecosystem Studies (Millbrook, NY) to participate in a Forum on Jobs in Ecology. At the Annual Summer Student Research Symposium students present major results of their work. Nine students and three faculty from Mount Union College, Allegheny College, and Franklin and Marshall College joined the Summer Research program for the third year.

Summer Students, 1998

Katherine Adick
Kenneth Bagstad
Kirsten Bixler
Raoul Blackman
Steven Currie
Valerie Dixon
Joel Dunn
Eron Drew
Erica Goss
Chelsea Halback
Lucy Hutyra
Brian Kessler
Justin Kunkle
Joseph LaCasse
Erin Largay
Dave Mausel
Kristin May
Elizabeth Nastari
Clara Paynter
Delia Santiago
Jessica Scott
Craig Skipton
Laura Schmitt
Kyle Schwabenbauer
Barbara Strom
Tonia White
Matt Wodkowski

Allegheny College
Ohio Wesleyan University
Franklin and Marshall College
University of Edinburgh
State University of New York
Harvard University
Evergreen State College
University of Wisconsin
Wesleyan University
Franklin and Marshall College
University of Washington
Allegheny College
Franklin and Marshall College
Bennington College
Connecticut College
University of Massachusetts
Oregon State University
Mount Union College
Colorado College
Stanford University
Swarthmore College
Western Washington Univ.
Brown University
Allegheny College
Harvard University
Mount Union College
Mount Union College



Valerie Dixon, Christine Muth and Emery Boose

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 and management. The Museum also provides a unique setting for conferences sponsored by the Forest and outside organizations. Dr. John O'Keefe, who has primary responsibility for the development of activities and coordination of the use of the Museum, celebrated his tenth anniversary at Harvard Forest this June.

Thanks to the enthusiasm and commitment of our volunteers the Museum enjoyed another very successful weekend schedule during 1997. The season concluded with the Seventh Annual Volunteer Recognition Dinner in November, at which highlights were reviewed while all shared good food and companionship. Bill and Marianna Berry were recognized as the most active volunteers and Mary Ann Walker received special recognition for her work as volunteer coordinator and her willingness to help out in any capacity, which included providing flowers and hors d'oeuvres for the dinner.

In early August students in Harvard Forest's summer program demonstrated and discussed their research projects with fifty minority high school students enrolled in a science enrichment program at UMASS-Amherst. This is the fourth year of this collaboration and

the Harvard Forest visit continues to be a highlight of the program. In August, for the fifth year we hosted a group of Spanish environmental scientists and administrators attending Real Colegio Complutense, a collaborative program between Spanish universities and Harvard University. In October, Dr. Søren Odum and a group of fifty Danish botanists visited the Fisher Museum as part of a botanical tour of the United States. Later that month we hosted science journalists participating in the Knight Science Fellowship Program at MIT.

Meetings, Conferences, Seminars

Other meetings at Harvard Forest included monthly meetings of the Athol Bird and Nature Club, the Massachusetts Forestry Association, Massachusetts Association of Professional Foresters, Massachusetts Extension Service Coverts Project, Massachusetts Waterwatch Partnership, North Quabbin Regional Landscape Partnership, New England Chapter of the Wildlife Society, Central Massachusetts Social Studies Teacher's Association, the inaugural meeting of the Massachusetts Chapter of the Society of American Foresters, and meetings of staff from the U.S. Forest Service, and Massachusetts Department of Environmental Management.



Interpretation of land-use history along the nature trail

Speakers in the Harvard Forest Seminar series included:

Hank Art	Williams College
Jeff Boettner	University of Massachusetts
Emery Boose	Harvard Forest
David Bowman	Parks Commission, Australia
John Boyer	University of Delaware
Matthias Bürgi	Inst. of Tech., Switzerland
Norm Christensen	Duke University
Don DeHayes	University of Vermont
Robert France	Harvard University
Robert Gardner	University of Maryland
Kevin Griffin	Columbia University
Julian Hadley	Harvard Forest
Anne Hartley	Marine Biological Laboratory
Bill Healy	U.S. Forest Service
N. Michelle Holbrook	Harvard University
Lloyd Irland	The Irland Group, Maine
Richard Lent	Harvard Forest
Andi Lloyd	Middlebury College
Lynn Margulis	University of Massachusetts
Robert McMaster	Smith College
Bill Romme	Fort Lewis College
Charles Ruffner	Pennsylvania State University
Kent Ryden	University of Southern Maine
Franz Seischab	Rochester Inst. of Technology
Ray Spear	SUNY, Geneseo
Sue Trumbore	University of California, Irvine
Ian Turner	National Univ. of Singapore
Jeff Ward	Connecticut Agric. Expt. Sta.
Dennis Whigham	Smithsonian Envir. Res. Ctr.
Maciej Zwieniecki	Harvard University



Sanderson family tomb

Jonathan 1740-1832 Molly 1745-1834
John 1769-1831 Lydia 1779-1867
Horatio 1819-1835



The Sanderson Farmhouse (The Community House).

The Sandersons were proprietors and first settlers on the Prospect Hill Tract of the Harvard Forest.



Fisher House

FOREST MANAGEMENT AND MAINTENANCE

The very successful efforts to complete the Fisher House dominated most of the Woods Crew time this year and 26 students occupied the completely renovated building on June 1. In addition to providing a nice, separate space for students to live, work, and relax in, the building and its grounds make a wonderful extension to the Harvard Forest landscape. In order to complete this project Jack Edwards, the Woods Crew, and outside contractors restored all major systems, the foundation, roof, and many walls, installed new septic systems, completely painted and furnished the entire structure, and undertook a major restoration of the landscaping. Most of the dormitory space in Shaler Hall, which was liberated by this new construction, has been converted to offices for visiting scientists and staff. Forest management activity has been concentrated on the 55-acre softwood plantation on the west side of Harvard Pond, where a total of 65,000 board feet and 300 cords of fire wood have been removed. Work in this area will be ongoing over the next few years to improve stand composition along the pond and salvage dying red pine infested with *Fomes annosus*.

Harvard Forest Archives

John Burk completed the transfer of historical material into the new archive building, which has devel-

oped into an integral facility at Harvard Forest, as over 300 staff members, collaborators, outside researchers, and local residents used archival materials for a variety of studies in this first year of operation. A computer listing of the 3,000 holdings in the map collection was completed, and is now available in electronic and printed form. Other significant recent additions include the Petersham Mapping Project records from the 1970s, two 19th-C atlases of Massachusetts, historical Worcester County land-use records, a Quabbin Reservoir file, and historic aerial photographs of the Swift River Valley. Microfilm duplicates were made of crucial Harvard Forest records, including the tract stand records, and copies of these film rolls are currently stored in the Harvard University Archives in Cambridge and Shaler Hall.

Computers

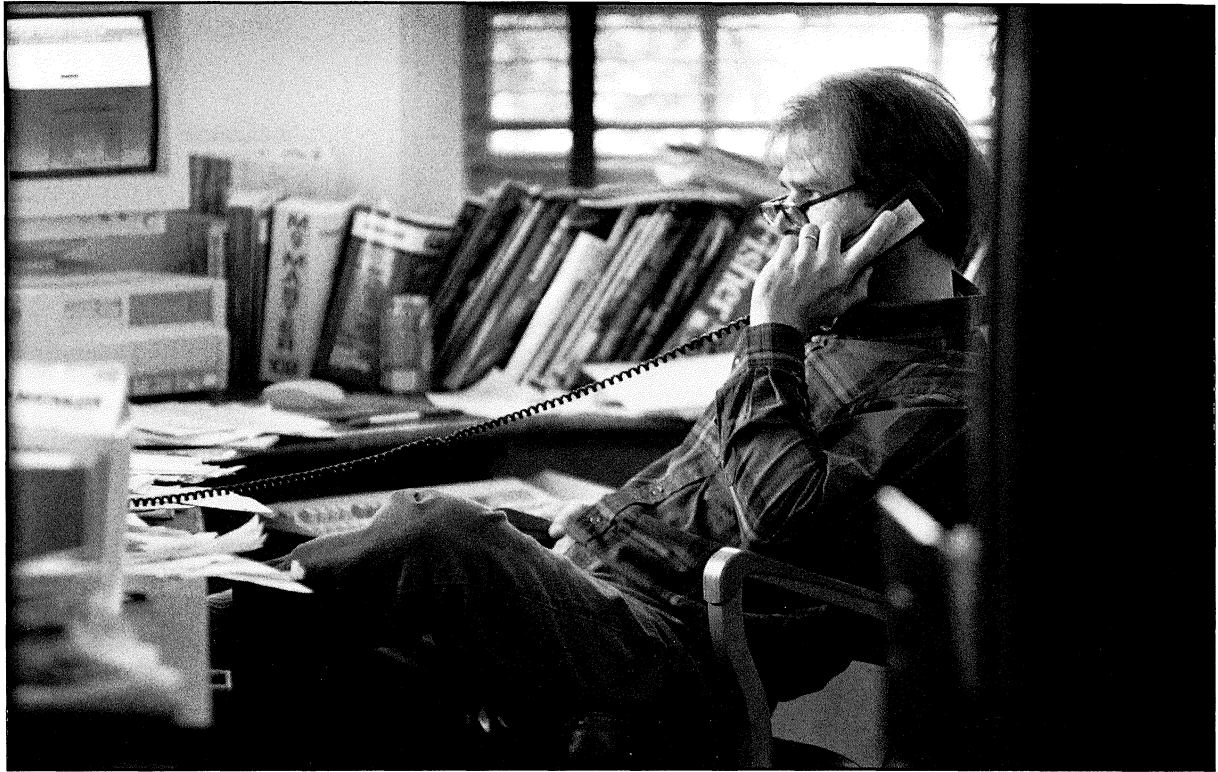
Three computers running Windows NT were installed and existing computers were upgraded to 16 mb of RAM, and are being converted from Windows 3.1 to Windows 95. A new router was installed in Shaler Hall, improving access to the Internet for the 45 computers currently on our network. Technical support for the network connection is provided by FAS Network personnel in Cambridge and locally by Emery Boose.



Fisher House Dining Room



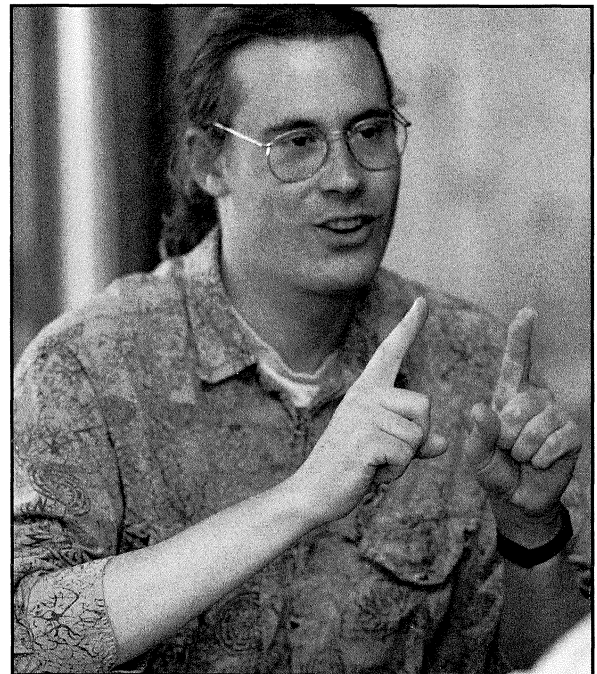
Barbara Flye and John Burk in the Archives



John Edwards

ACTIVITIES OF THE HARVARD FOREST STAFF

Staff recognized by Harvard for service to the University included Dottie Recos Smith (25 years), David Foster (15 years), and John O'Keefe (10 years). Since her arrival, Audrey Barker has been organizing LTER material for the Archives and took a two-week break to get married and travel to the Olympic National Park. Debra Bernardos attended the New England Chapter of the Wildlife Society's first workshop held at the U.S. Fish and Wildlife Service in Hadley and attended the Chapter's business meeting at Harvard Forest in the spring. John Burk attended a records management conference at Clark University. Emery Boose presented a poster on hurricane research at the ESA and gave talks at the Association of American Geographers meeting in Boston and at UMASS. Emery served on an NSF panel for the selection of urban LTER sites and serves on the LTER Climate Committee and as the Forest's Information Technology contact for FAS. Susan Clayden presented a poster at the ESA "Long-term vegetation dynamics of upland oak and hemlock stands, central Massachusetts." Sarah Cooper-Ellis contributed to a chapter on the hurricane experiment for the LTER book and presented a poster on the hurricane experiment at ESA. Sarah also focused on interpreting six years' data on regeneration from the hurricane experiment and reinterpreting the 1938 hurricane in this context.

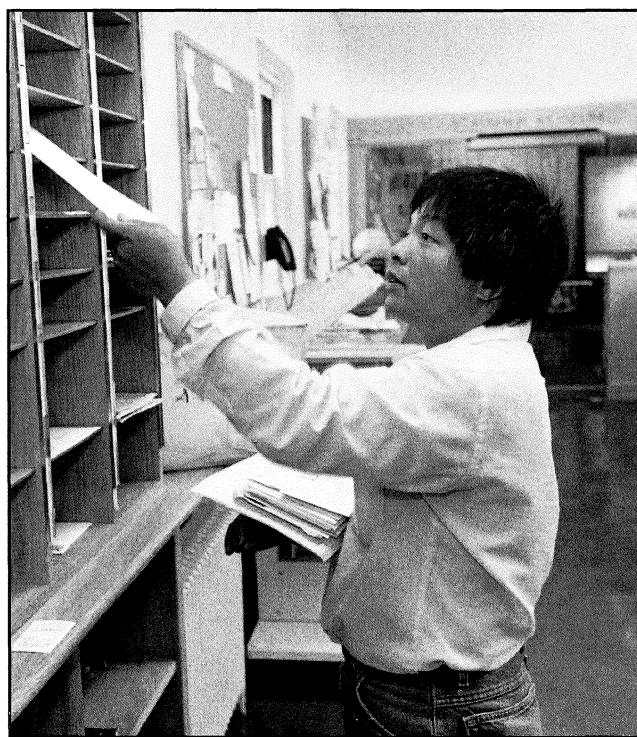


Ben Slater



Don Hesselton and Woody Cole

David Foster attended the LTER Coordinating Committee meeting and workshop on Climate Variability and Ecological Response in Santa Barbara and the symposium on long-term records of hurricane activity at the Bermuda Biological Station for Research. David and John Aber organized a symposium on the Ecological Consequences of Land-use History at the American Association for the Advancement of Science in Washington, DC and spoke along with Steve Wofsy, Monica Turner, and Bob Askins. With Glenn Motzkin he conducted field studies on Martha's Vineyard and he joined Diego Perez-Salicrup, Billie Turner (Clark University), Arturo Gomez-Pompa, and others for field studies in the Yucatan Peninsula. He, Marianne and Christian travelled with the Harvard Alumni Association to the Rio Negro region of Brazil. David continues to serve on the Executive Committee of the LTER program and on editorial boards of *Ecosystems*, *Northeastern Naturalist*, and *Advances in Physical Geography* and on boards at the Conservation Research Foundation and Highstead Arboretum.



Oscar Lacwasan

Donna Francis presented "Influence of changing land-use patterns on lake ecosystems in southern New England" at ESA and "The legacy of land-use change on lake ecosystems in southern New England, USA" at the 7th International Symposium on Palaeolimnology, Riedlingen, Germany. Julian Hadley presented his model of hemlock forest carbon exchange at the North American Forest Biology Workshop in Victoria, B.C., Canada. Richard Lent represented Harvard Forest at the LTER Data Manager's Meeting. Ruth Kern presented "Seedling establishment patterns of some Sierran conifers" at ESA and participated in a 3-week study tour of sites in Taiwan and mainland China in June, jointly sponsored by NSF, the Taiwan Forestry Research Institute, Taiwanese National Science Council, and the Chinese Ecological Research Network. The objectives were to provide international scientific exposure to US students and to strengthen the links between the LTER Networks in China, Taiwan and the U.S.

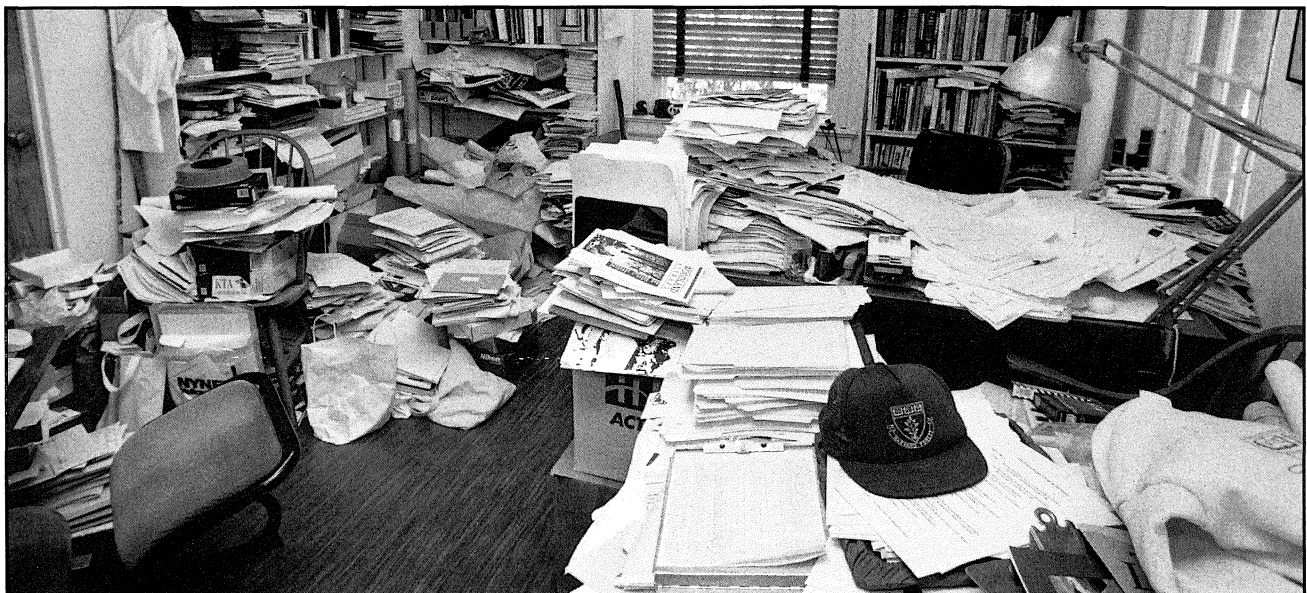
Glenn Motzkin gave a talk on the "Vegetation history and conservation of the pine barrens of the Connecticut River Valley" at the Pine Barrens Research Forum at Brookhaven National Laboratory, and spoke at a conference on Cape Cod for Natural Heritage Program and The Nature Conservancy staff about Harvard Forest studies on the influence of land-use history on modern vegetation and implications for conservation. Glenn presented a poster at ESA on the history and vegetation of central Massachusetts, and led a field trip on the Connecticut River for Northfield-Mt. Hermon's advanced placement Environmental Science class. John O'Keefe and Glenn served on the senior honors thesis committee for Nicole Lavelle at Mount Holyoke College, "Effects of 1996-97 Winter Storms on Pine and Mixed Hardwoods on the Montague Sand Plain in Central Massachusetts." The project developed from work Nicole initiated as a summer

student at Harvard Forest in 1997.

John O'Keefe presented a poster with Amanda Gardner at ESA based on Amanda's work on the influence of microhabitat on seedling establishment in 1938 hurricane blowdown sites and a poster at the American Association of Geographers meeting in Boston on woody species phenology at Harvard Forest. John presented talks on the history of Massachusetts forests at the New England Society of American Foresters meeting in Manchester, NH, University of Massachusetts-Amherst, University of Massachusetts-Boston, and to the staff of the Massachusetts Department of Environmental Management. John serves on the boards of the Massachusetts Forestry Association, Millers River Watershed Council, and Mount Grace Land Conservation Trust, and on steering committees for the North Quabbin Regional Landscape Partnership and Massachusetts Project Learning Tree. He also serves on the Quabbin Science and Technical Advisory Committee and Secretary Trudy Cox's Advisory Board on Environmental Education.

Dave Orwig presented a poster at ESA, "Stand composition and forest dynamics of old-growth forests on Wachusett Mountain, Massachusetts" with summer student Sarah Picard of Bates College. Dave presented talks about the Harvard Forest hemlock woolly adelgid project at Rutgers University and the Inaugural Meeting of the Massachusetts Chapter of the Society of American Foresters, and, with John O'Keefe, gave a talk about Wachusett Mountain old-growth forests at the Massachusetts Forestry Association annual meeting and the Wachusett Mountain Advisory Council.

Barry Tomlinson presented a paper at the AIBS meetings in Montreal honoring Professor Rolf Sattler on his retirement from McGill University. He also gave the Lucy Cranwell lecture to the Auckland Botanical Society in New Zealand, a series recognizing Cranwell's contributions in palynology and paleoecology.



GIFTS AND NEW FUNDING

The generosity of the staff and friends of Harvard Forest has continued to bring to the library shelves many excellent additions. A bound set of Bent's "Life Histories of Birds" added to the Auk journals was an exciting addition donated by James Baird of Petersham.

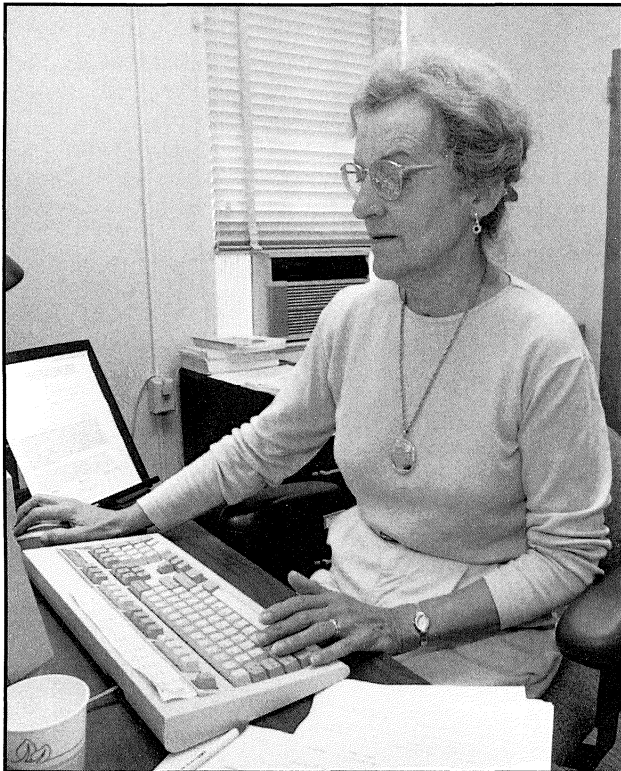
Authors who have donated copies of their books are Prof. James Hardin, North Carolina State University (*Textbook of Dendrology*-8th ed.); Ralph Tiner of the Fish and Wildlife Service (*Wetlands of Rhode Island, Wetlands of Maryland, Field Guide to Nontidal Wetland Identification*); and Carlos Vazquez Yanes, a recent Harvard Forest Bullard Fellow, (*La Reproduccion de las Plantas: Semillas y Meristemos*).

P. Barry Tomlinson donated four books (*The Ecological Implications of Body Size; Energy and Ecology; Ecology, Evolution, and Population Biology; and Caring for the Earth--A Strategy for Sustainable Living*). Marc Abrams, a current Bullard Fellow, has donated a 1941 copy of *Kerfe des Waldes*, a handbook showing colorful, detailed illustrations of insects. Nathaniel Southgate Shaler and the Culture of American

Science by David N. Livingstone was given to the Library by Calvin Stillman. Ann Lewis continued to add to the Library's collection of "Plant Physiology" and five more years of "American Journal of Botany." Richard Goodwin donated two books: *Private Approaches to the Preservation of Open Land* and *Law and the Environment*.

Alan Kabat of the Smithsonian's National Museum of Natural History passed on a copy of "Kritische Formulierung einer Zieldiskussion zum Naturschutz im Wald" which discusses the importance of forests for nature conservation and practical forest management with a conclusion of goals. *Stepping Back to Look Forward*, a newly published book edited by Charles H. W. Foster, has been in constant circulation since a copy was donated by David Foster. Publication of this volume was generously underwritten by the Massachusetts Division of Environmental Management and the Massachusetts Foundation for the Humanities.

The LTER program benefited from an additional supplement to support three new summer interns.



Dottie Recos-Smith



Lisa Marselle

VISITING RESEARCH SCIENTISTS AT THE HARVARD FOREST 1997-98

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	Michelle Holbrook	Harvard University
Jeff Amthor	Lawrence Livermore Lab	David Hollinger	U.S. Department of Agriculture
Peter Bakwin	Harvard University	Lauren Interness	Woods Hole Research Center
Dennis Baldocchi	NOAA/ARL/Oak Ridge, TN	Daniel Jacob	Harvard University
Carol Barford	Harvard University	Doug Karpa	Harvard University
Diana Barnes	Harvard University	Chris Kerfoot	Ecosystems Center - MBL
Fakhri Bazzaz	Harvard University	Melissa Kibler	Gustavus Adolphus College
Beth Belk	Woods Hole Research Center	David Kittredge	University of Massachusetts
Glenn Berntson	University of New Hampshire	Otto Klemm	University of New Hampshire
K. Boering	Harvard University	Cathy Langtimm	U.S.G.S., Holy Cross College
Rich Bowden	Allegheny College	Barry Lefer	University of New Hampshire
Frank Bowles	Ecosystems Center - MBL	Manuel Lerda	SUNY, Stony Brook
Sebastian Catovsky	Harvard University	Alison Magill	University of New Hampshire
Chris Catricala	Ecosystems Center - MBL	Mary Martin	University of New Hampshire
Chaur-Fong Chen	Oregon State University	Charles McLaugherty	Mount Union College
Alan Coleman	Harvard University	Jerry Melillo	Ecosystems Center - MBL
Patrick Crill	University of New Hampshire	Jennie Moody	University of Virginia
William Currie	University of New Hampshire	Kathleen Moore	SUNY, Albany
Peter Czepiel	Harvard University	Mitch Mulholland	University of Massachusetts
David B. Dail	University of Georgia	J. William Munger	Harvard University
Eric Davidson	Woods Hole Research Center	Christine Muth	Harvard University
Bruce Daube	Harvard University	Knute Nadelhoffer	Ecosystems Center - MBL
Peter Del Tredici	Arnold Arboretum	Kathy Newkirk	Ecosystems Center - MBL
Michael Donoghue	Harvard University	Marc Potosnak	Harvard University
Marty Downs	Ecosystems Center - MBL	Ronald Prinn	M.I.T.
Todd Drummey	Ecosystems Center - MBL	Kurt Pregitzer	Michigan Technological Univ.
Bob Evans	U.S.D.A. Forest Service	Michael Rogers	GA Institute of Technology
Rebecca Field	University of Massachusetts	Brian Shelley	College of the Holy Cross
David Fitzjarrald	SUNY, Albany	Timothy Sipe	Franklin and Marshall College
Son-Miao Fan	Harvard University	Paul Steudler	Ecosystems Center - MBL
Richard Forman	Harvard University	Britt Stephens	U.S. Geological Survey
Steven Frolking	University of New Hampshire	Eric Sundquist	U.S. Geological Survey
Julia Gaudinski	UCLA, Irvine	Robert Talbot	University of New Hampshire
Michael Goulden	Harvard University	Matt Thompson	Harvard University
Robert Harriss	University of New Hampshire	Paul Wilson	Univ. of California, Northridge
Joseph Hendricks	University of New Hampshire	Greg Winston	U.S. Geological Survey
Kristiina Hill	M.I.T.		



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