Front Cover: Stone walls and hardwood forest, Prospect Hill tract
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INTRODUCTION TO THE HARVARD FOREST

Since its establishment in 1907 the Harvard Forest has served as a base for research, education and demonstration 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 economics and vegetation development. Today, this research legacy continues as staff scientists and visiting scientists seek to understand historical and modern changes in the forests of central New England resulting from human and natural disturbance processes. This research 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, a virgin forest of white pine and hemlock that was 300 years old when it blew down in the 1933 Hurricane, the 100-acre Matthews Plantation in Hamilton, Massachusetts, which is comprised of diverse conifer plantations, and the 90-acre Tall Timbers Forest in Royalston, Massachusetts. In Petersham a complex of buildings that includes Shaler Hall, the Fisher Museum and Torrey Labs provide office and laboratory space, computer, greenhouse, and growth-chamber facilities, and a lecture room and lodging for seminars and conferences. An additional six houses and apartments provide housing for staff, visiting researchers and students. Extensive records of plant research, long-term data sets and historical information 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, with the Director reporting to the Dean of FAS. The Harvard Forest administers the Graduate Program in Forestry that awards a Masters degree in Forest Science. Faculty at the Forest offer courses through the Department of Organismic and Evolutionary Biology (OEB), which awards the PhD degree, and through the Freshman Seminar Program. Close association is maintained with the Department of Earth and Planetary Sciences and the Graduate School of Design (GSD) at Harvard and with the Department of Forestry and Wildlife Management at the University of Massachusetts, Ecosystem Center at Woods Hole, and Complex Systems Research Center at the University of New Hampshire.

The staff of approximately 35 work collaboratively to achieve the research, educational and management objectives of the Harvard Forest. A sub-group of researchers meet monthly to discuss current activities and to plan future programs. Regular meetings with the HF LTER science team and with the Harvard Forest Advisory Committee provide for an infusion of outside perspectives. Forest management and physical plant activities are undertaken by our three-man Woods Crew and directed by the Forest Manager. The Coordinator of the Fisher Museum oversees many of our educational, audio-visual and outreach programs.

Funding for the base operation and staff at the Harvard Forest is derived from endowments, whereas research activities are supported with grants primarily from the federal government. Major research support comes from the National Science Foundation, Department of Energy (NIGEC), U.S. Department of Agriculture, and the Andrew W. Mellon Foundation. Our Summer Program for Student Research is supported by the Research Experience for Undergraduates program at NSF, the Northeastern Consortium for Undergraduate Science Education (Pew Charitable Trust) and the R. T. Fisher Fund of Harvard Forest.
RESEARCH ACTIVITIES

Research at the Harvard Forest addresses basic questions concerning the development and dynamics of all components of forest ecosystems, with an emphasis on eastern North America. These studies take advantage of the excellent research facilities and detailed histories of the 3000-acres of forest that comprise our main study area. We involve scientists and students from other institutions to bring additional perspectives to our research program, and we place results from studies in Petersham into a broader context through regional studies and comparative research in other ecosystems.

Modelling Hurricane Effects on Forest Ecosystems

Wind disturbance, creating gaps in forest canopies ranging from a few trees to broad-scale blowdowns, is a major source of forest dynamics in temperate and tropical regions. Studies of the role of wind in structuring the pattern and composition of forests have been a research focus at the Harvard Forest for over 50 years and are a central theme of our LTER program. Ongoing efforts are examining wind regimes comprehensively by (1) establishing historical patterns of hurricane occurrence and conditions, (2) documenting impacts across a wide range of spatial scales, (3) experimentally manipulating forests to simulate wind effects, and (4) examining forest response on physiological, community and landscape levels. Examination of sites in New England (Harvard Forest) and Puerto Rico (Luquillo Experimental Forest) provides a geographic basis for comparison whereas the LTER research program contrasts the effects of natural disturbances such as wind with human impacts including agricultural land-use, forest cutting, and atmospheric pollution.

Comparison of Hurricane Disturbance Regimes in Tropical and Temperate Forest Regions

In this project Emery Boose, David Foster, and Marchetere Fluet are applying a meteorological model recently developed by Emery to reconstruct wind conditions during important hurricanes in New England and Puerto Rico, 1600 A.D. to the present. These regions represent contrasting meteorological and ecological settings, thus enabling the examination of trends and characteristics unique to low and high latitude environments. Our objectives include: (1) reconstructing important historical storms in detail; (2) studying correlations between predicted wind characteristics and forest damage; (3) establishing useful measures for comparing different hurricanes in terms of their effects on forests; (4) investigating the effects of local topography on wind damage; and (5) determining regional gradients in hurricane frequency, intensity, and wind direction.

The model is based on general observations derived from meteorological studies of many hurricanes. Model parameters are calibrated for a particular storm using data on the storm’s track, size, and intensity. The model testing is achieved by comparing predictions to additional meteorological or historical data. The model predicts sustained wind speed and direction for specified locations and times; it can also calculate cumulative values, such as maximum wind speed or total wind energy, over a time series.

To date we have carried out detailed reconstructions of Hurricane Hugo over Puerto Rico and the 1938 Hurricane over New England, two storms with widely different meteorological characteristics. Hurricane Hugo was a category 3 hurricane with maximum sustained winds of 110 knots as it passed over the extreme eastern tip of Puerto Rico on September 18, 1989. Damage to the Luquillo Experimental Forest (LEF) in northeastern Puerto Rico was severe.
Our reconstruction of Hugo predicts peak winds in the LEF from the north, with a fairly strong east to west gradient caused by the weakening of the storm as it passed over the Luquillo mountains. Our assessment of actual damage across the LEF, from analysis of infrared aerial photographs, confirms these predictions.

The 1938 Hurricane was a category 3 hurricane as it passed over western New England on September 21, 1938. Rapid forward motion of the storm and the influence of temperate cool air masses (both typical of New England hurricanes) make this storm rather different from Hugo over Puerto Rico. Regional forest damage across New England, compiled on a town by town basis by the Northeastern Timber Salvage Association (NETSA), agrees fairly closely with predicted maps of maximum wind velocity.

Coordinated Studies of Experimental Windstorms

As part of the LTER effort a 1-ha area of red maple-red oak forest was experimentally pulled down in 1990 in order to evaluate forest response to disturbance. The manipulated area was thoroughly studied for baseline conditions before the experiment and is matched by a control area and an experimental clear-cut of similar proportions. Results from the second field season are presented below.
Physiological and Demographic Mechanisms of Tree Regeneration Following Hurricane Blowdown

In this project Gary Carlton and Fakhri Bazzaz are examining forest regeneration on forest floor microsites created by the simulated hurricane blowdown. Their focus is on the response of tree seedlings to spatial and temporal fluxes of five environmental factors: light, temperature, carbon dioxide, water, and nitrogen. This work is based on a conceptual model of forest regeneration as a process initiated by disturbance, progressing simultaneously along two pathways, and culminating in a recognizable response by the forest community (Fig. 1).

Preliminary results indicate that the light environment is extremely heterogeneous following hurricane blowdown and microsites differ in availability of water and other resources. Microsites also influence the demography of tree seedlings through effects on the fine-scale distribution of seeds. Mortality of planted birch seedlings is greatest in pits, due primarily to burial by soil and rocks sloughing from mounds. Seedlings on mounds experience winter frost heaving and summer water stress, and seedlings planted under residual herbaceous vegetation are strongly inhibited by low light levels. Residual saplings of all major tree species responded to canopy removal with substantially increased diameter growth. The abundance of sprouts and saplings suggests that surviving vegetation may be the predominant regeneration pathway following hurricane blowdown in this forest.

During the 1992 growing season Gary will be obtaining data on soil nutrient availability and carbon dioxide concentrations on the various microsites. He will also harvest seedlings of five tree species to determine growth, carbon allocation, and physiological response to conditions on each microsite. Ultimately, physiological and demographic results will be combined with environmental data to derive a resource-based model of tree regeneration following hurricane blowdown.

Fig. 1. Conceptual model of temperate forest regeneration following hurricane blowdown. Two major regeneration pathways are represented by large arrows. Microsite environments influence each stage of the pathway of regeneration from seed but exert lesser influence on the pathway of regeneration from surviving vegetation.
In the experimental blowdown Gary Carlton is using gridded frames to map out fine-scale microtopography and to release and track tree seed as part of an experiment on seed dispersal. The root mound of the tree pictured here extends nearly 2 meters above the ground surface.

Tree Sprouting in Response to Contrasting Disturbance Regimes

The ability of hardwoods to sprout following cutting has been extensively investigated from a stand regeneration and timber quality perspective. However, much less is understood about sprouting in response to wind damage or the role of vegetative reproduction in natural stands. In a new study Ann Lezberg is comparing the sprouting response of hardwood species on the experimental blowdown, an adjacent clearcut and the undamaged control area. Among other factors, Ann is exploring the relationship between sprouting propensity and species, tree size, and type of damage (cutting, snap, uproot, bend, lean, no damage).

In order to understand the changing role that sprouts play through forest development, Ann will track a subset of individuals. The number and survival of sprouts per tree will be monitored, and individuals will be measured for height, shoot growth, diameter, herbivory, and phenological characteristics. A number of physiological parameters (water relations, carbon gain, leaf chemistry) and structural characteristics (branching patterns and leaf morphology) will be assessed in the future.

In a related study, Dr. Peter Del Tredici of the Arnold Arboretum, is investigating the morphological basis of vegetative reproduction among woody plants in collaboration with Ann and Barry Tomlinson. This project involves describing the anatomical origin of "reiterative" shoots in mature plants and developing a system for classifying sprout growth based on detailed morphology. This project has a field and a greenhouse component. In the experimental blowdown the precise origin of the vegetative regrowth from damaged trees is described, focusing on the origin from stump, root collar (crown), or root tissue. The greenhouse project will be undertaken at the Arnold Arboretum using seedlings of various species growing naturally in the Harvard Forest. Seedlings will be manipulated experimentally by tipping, decapitation, and girdling, to stimulate the production of reiterative shoots. The species to be studied include: Fagus grandifolia, Castanea dentata, Kalmia latifolia, and Betula populifolia. Anatomical work will be done in the histology lab at the Harvard Forest.
Trace Gas Fluxes from the Simulated Hurricane

A group from MBL Ecosystems Center (P. Steudler, J. Melillo, M. Castro), Allegheny College (R. Bowden) and University of New Hampshire (J. Aber), initiated a study focused on the long-term response of the forest to simulated hurricane blowdown, in terms of soil nitrogen dynamics and trace gas fluxes of $\text{N}_2\text{O}$, $\text{CO}_2$ and $\text{CH}_4$.

Carbon dioxide, $\text{CH}_4$ and $\text{N}_2\text{O}$ exchanges showed seasonal patterns with maximum fluxes occurring during July and August. No substantial change in the emission of $\text{CO}_2$ from the blowdown plot occurred compared to the control plot during the first year. However, post-blowdown $\text{CH}_4$ uptake rates were initially greater from the disturbed plot than from the control but were less beginning in July. A substantial reduction in $\text{N}_2\text{O}$ emissions occurred in the blowdown plot during the first year.

Dynamics of Downed Wood in Old-growth Forests Following Disturbance

Coarse woody debris (CWD) is an important structural component of many forest ecosystems. Little is known, however, about the characteristics of CWD in northeastern old-growth forests, owing mainly to the modern scarcity of this forest type. As part of his PhD thesis Peter Schoonmaker has examined the changes in CWD in the old-growth white pine and eastern hemlock forest at the Pisgah tract following the 1938 Hurricane. The study was designed to: 1) determine the pattern of damage (windthrown, snapped, orientation) to individual stems as controlled by species, size and topographic position; 2) document the spatial distribution of CWD across a topographic gradient; and 3) quantify the long-term dynamics of CWD by comparing volume of CWD.

The distribution of CWD across the transect is highly variable with an average of 220.5 m$^3$ ha$^{-1}$ and is dominated by large $\text{Pinus}$ and $\text{Tsuga}$ stems that are only moderately decayed. The study suggests that coarse woody debris is an important component of old growth coniferous forests in New England and that catastrophic disturbances generate large inputs of material that may persist more than 100 years. These results will provide a useful basis for comparison with log decomposition research being conducted by Charles McClaugherty of Mount Union College as part of the HF LTER.
Historical Ecology

Land-use and Forest History in Central New England

A series of integrated studies are investigating the history of human activity in central New England and relating it to changes in the structure, composition and dynamics of forests in this region. By utilizing contrasting techniques and sources of data, and by addressing a broad temporal range from pre-settlement conditions to the present these studies seek to expand on results obtained for Petersham by R. T. Fisher, H. M. Raup, E. Gould and others. A major objective is to apply the resulting understanding of forest and landscape history to current studies in ecosystem change and modern efforts in land management and preservation.

Post-settlement Changes in Vegetation and Land-water Interactions in Central New England

The extent to which European settlement, deforestation and agricultural practices altered the original vegetation of central New England is largely unknown. Equally uncertain is the impact of land-use activity, changing vegetation and altered upland conditions on lake environments. Two basic concerns include: (1) the magnitude of the change from pre-settlement conditions resulting from contrasting land-use practices (e.g. agriculture, industrial activity, urbanization), and (2) the extent to which the reforested landscape has returned to original conditions in terms of forest structure and composition and lake trophic status.

In a study focusing on the Connecticut River Valley, and eastern Massachusetts extending to suburban Boston, David Foster, Taber Allison and Michael Binford of the Graduate School of Design are examining regional trends in land-use, vegetation, and lake history (Fig. 2). Sediment cores selected from small lake basins are being analyzed for physical (percent organic matter, particle size distribution, charcoal), biological (pollen, algae) and chemical (carbonates, macronutrients) characteristics. Changes in these variables through time and between regions are being correlated with land-use changes. To date results are available from Silver Lake in Athol, Green Pond and Lake Pleasant in Montague, White Pond in Concord, Lily Pond in Witrwick, and Big and Little Mirror Lake in Ayer (Fig. 2).

Fig. 2. The topography (above) and town boundaries (below) of the area in central Massachusetts that is the focus of paleoecological, limnological, and historical study. The region ranges in elevation from approximately 30 m a.s.l. in the Connecticut River Valley to over 500 m in the Berkshire Mountains. The location of the Harvard Forest (HF) is indicated as are current sites of pollen and lake sediment analysis (triangles). The towns of Ashburnham, Barre and Deerfield, referred to in Figure 3 are indicated by their first letter.
Geographical Variation in Land-use and Vegetation

Despite recognition of the general pattern of land-use history in central New England, involving deforestation for agriculture in the late 18th through mid-19th C, followed by farm abandonment and reforestation into the 20th C, little is known about geographical variation in this process or the influence of past land-use on the structure and composition of the modern vegetation. D. Foster, C. Mabry and G. Motzkin have undertaken a study to (1) document forest vegetation across central Massachusetts from the height of agricultural activity (1830) to the present; 2) examine the relationship between physiographic, edaphic, and cultural factors and patterns of land use; and 3) identify the relationship between landscape history and modern vegetation.

The study region consists of 30 towns in central Massachusetts spanning a cultural and ecological gradient from the Connecticut River Valley to the Eastern Uplands. Historical maps of vegetation, land-use and cultural features are prepared and then digitized on a Geographic Information System. Physiographic and soil characteristics are also mapped.

Initial questions include: (1) what environmental and social factors determined the distribution of residual forest area at the height of agricultural activity; (2) how did these and subsequent forest patterns vary regionally; and (3) what aspects of the modern vegetation are related to this history?

Related to this regional study F. Gerhardt, G. Motzkin, C. Mabry and D. Foster are examining floristic patterns of forest composition that relate to land-use in the town of Petersham and on the Harvard Forest. Vegetation data collected through extensive field sampling are analyzed with regard to detailed historical information and soil characteristics.

Rich Boone is coordinating a related study of soil morphology of the vegetation plots to: (1) validate land use records on the basis of morphological signatures left in the soil profile after pasturing and cultivation; (2) examine the effect of prior land use on soil fertility, site productivity, and floristic composition of the present forest; and (3) provide a resource base for future studies. Additional work funded by the Mellon Foundation will evaluate the legacy of different land use on nitrogen availability and the partitioning of soil organic matter into different kinetic fractions.

Fig. 3. Contrasting soils, environments and histories of land-use lead to distinctly different patterns of forest cover for three towns in the regional study area. Ashburnham, in northern Worcester County was subjected to moderately intensive farming in the mid-19th C and is largely residential today. Barre, in central Worcester County was extensively cleared and continues to support farms on north-south trending ridges. The broad valley bottoms in Deerfield provide excellent soils and fresh meadows that are still used extensively for agriculture today. See Figure 2 for town locations.
Tropical Land-use History and Forest Dynamics

In a project that is complementary to land-use studies in New England and the hurricane research in Puerto Rico, Marcheterre Fluet and David Foster are investigating the history of human disturbance in the Luquillo Experimental Forest of Puerto Rico. Supported by the U. S. Forest Service this project is quantifying the effects of past timber extraction, forest clearance and agriculture on the vegetation through use of aerial photographs from 1936, 1960 and 1988, and forest inventories, maps and deeds from the time of U.S. Government acquisition of the lands in 1920-40. Marcheterre is interpreting aerial photographs to make vegetation maps for the past 60 years. The maps are digitized onto the Geographic Information System where analyses are determining the physiographic and geographic controls on land-use, sequences of vegetation change, the long-term influence of human activity on forest vegetation, and forest ecosystem responses to natural disturbances, including wind and landslides.

Preliminary results confirm that the Luquillo Experimental Forest was subjected to extensive agricultural activity, timber harvesting and charcoaling through the early 1900s. Decreasing gradients of land-use intensity with increasing elevation interact with natural disturbance patterns to generate a complex and dynamic vegetation pattern. These results are being integrated into the Luquillo LTER project involving R. Waide, A. Lugo and F. Scatena and the Mellon Foundation project on land-use in temperate and tropical forest regions coordinated by Steven Hamburg.

Developmental and Reproductive Biology

Barry Tomlinson concentrated on an analysis of seed cones of the southern conifer family Podocarpaceae, assembled during field work (1989-90) in the South Pacific, with support from the National Geographic Society. Developmental study confirms a consistent constructional pattern in the ovular complex of cones in most genera that supports the interpretation of the unusual cone morphology in this family as being related to a distinctive method of pollen capture. The survey also demonstrated the way in which the mature seed complex is variously adapted for dispersal by animals. The basic structural unit is modified in different taxa by changes in the relative timing of meristematic activity in different parts of the cone, a classic case of heterochrony.

Other research on conifers included a study of cone morphology in Libocedrus from New Zealand, in which developmental study demonstrates that the structure usually interpreted as the homologue of the ovuliferous scale in Pinaceae appears after pollination and is a device to protect developing seeds. These results confirm our interpretation of the absence of an ovuliferous scale in the Cupressaceae and continue to demonstrate that developmental information combined with a functional approach is greatly clarifying seed cone morphology in Coniferales.

During the period 1965-1980, in collaboration with the late Martin H. Zimmermann, extensive analyses of vascular systems in plants generated over 10,000 microscope slides, mainly of serial transverse sections. A large part of the year was spent in re-organizing this collection.

Podocarpus totara (Podocarpaceae). Native to New Zealand. Scanning electron micrograph of young ovulate cone prior to pollination. Fertile bract to left subtends the unique structure (epinatum) that inverts and encloses the ovule (nucellus and integument projecting to right). This orientation has been shown to be important in the unique pollination mechanism (photo by Tokushiro Takaso).
Soils and Ecosystem Studies

Organic Matter Controls of Soil Processes

Rich Boone and Knute Nadelhoffer are evaluating controls of soil organic matter storage by manipulating above- and below-ground detritus inputs to a mixed hardwood stand on the Tom Swamp tract. Manipulations (3m x 3m plots) include: 1) exclusion of leaf litter; 2) exclusion of roots; 3) no detritus inputs; and 4) doubling of leaf litter (all annually), plus 5) one-time removal of the forest floor and A horizon (impoverishment treatment). This year Rich and Knute completed installation of field treatments, established baseline conditions for potentially mineralizable carbon and nitrogen, and began a tree inventory and stem map of the field site. These plots will serve as a long-term resource for examining controls on both active and stable fractions of soil organic matter. Additionally, the plots should provide information on the influence of soil organic matter on profile development and the recovery of soil fertility after impoverishment.

Rich Bowden (Allegheny College) monitored CO$_2$ flux from the plots during the summer 1991. Bowden found significant differences in soil CO$_2$ flux among treatments and was able to partition total flux among root respiration and various soil organic matter pools. Annual soil CO$_2$ efflux was 371 g C m$^{-2}$ yr$^{-1}$; relative contributions were 11% for 1-yr-old above-ground litter, 26% for forest floor material excluding 1-yr-old litter, 30% for mineral-soil organic matter, and 33% for root respiration.

Rich Boone collaborated with researchers at eight other institutions on a proposal to replicate this study across a climatic gradient in North America. The other sites include the Colorado Plains Ecological Range, La Selva, Bonanza Creek, H.J. Andrews, Konza Prairie, and Cedar Creek. The proposal (Knute Nadelhoffer, organizer) was submitted to NSF Ecosystems in June 1992.

Nitrogen Saturation of Temperate Forest Soils

Laboratory work was continued to assess the effect of chronic additions of nitrogen on the partitioning of inorganic N among different organic matter fractions. Lignin and cellulose fractions have been isolated from soil samples amended with $^{15}$NH$_4$-N and $^{15}$NO$_3$-N. $^{15}$N concentrations in these fractions will be compared with those in microbial N, dissolved organic N, and extractable NH$_4$-N and NO$_3$-N to determine fractionation. Preliminary data indicate that 40-60% of $^{15}$NH$_4$-N added to the Oe+Oa horizons of a red pine stand is stored in the lignin+cellulose fraction by the end of a 10-week laboratory incubation. Work with Bill McDowell and John Aber (UNH) and their graduate students (Alison Magill, Bill Currie, and Pat Micks) has been started to evaluate the effect of the chronic N additions on the size of the active soil organic matter pool.

Fig. 4. Mean carbon dioxide efflux (upper Fig. A) and soil respiration budget (lower Fig. B) for the litter manipulation plots. Numbers in the lower figure are flux rates (g C m$^{-2}$ yr$^{-1}$) and percentages (in parentheses) of total flux.
Biosphere-Atmosphere Interactions

CO₂ Exchange Between the Forest and Atmosphere

As part of the large project exploring the forest-atmosphere exchange of CO₂, Susan Bassow and Fakhrizadeh Bazzaz are assessing CO₂ assimilation by measuring leaf-level photosynthesis of the canopy trees. Various methods for scaling up from leaf-level to community-level gas exchange are being implemented and the results are being compared to the net ecosystem exchange of carbon as measured at the adjacent EMS Tower. In June 1991, two Canopy Access Towers were built to provide access to various heights within the canopies of red oak, red maple, yellow birch, and white birch. In 1992, diurnal courses of leaf-level photosynthetic rates at two heights within the canopies were measured. Additionally, in order to relate gas exchange to the underlying leaf-level biochemistry and physiology, leaf nitrogen and chlorophyll content and specific leaf weight were measured at the same heights and times through the season. Measurements of integrated light levels and leaf area index (LAI), are used as a first attempt to scale the leaf-level data up to ecosystem level carbon gain.

Forest Carbon Exchange Measured by Eddy-Correlation

In 1989 continuous measurements of trace gas and energy exchange were initiated at the Environmental Monitoring Station (EMS) in the Prospect Hill tract by Steve Wofsky from the Division of Applied Sciences. Diurnal and seasonal courses of net ecosystem CO₂ exchange at the site document that 1) assimilation is closely linked with tree phenology and light availability; 2) respiration is closely tied to temperature; and 3) integrated over the year the forest is a large sink for CO₂. A new project is using chamber measurements and a second set of below-canopy eddy-flux measurements made by D. Fitzjarrald and K. Moore (SUNY) to assess the contribution to net ecosystem exchange made by below-ground respiration, above-ground maintenance and growth respiration, above-ground biomass increment, and photosynthesis.

Trace-gas Fluxes and Concentration Profiles

Bill Munger, Bruce Daube, Mike Goulden and Steve Wofsky have been interpreting concentration profiles and eddy correlation fluxes of ozone (O₃), carbon monoxide (CO) and nitrogen oxides (NOₓ) that have been continuously measured at the EMS for 2 years. These data are providing a detailed picture of atmospheric composition over rural forests in New England.
Harvard Forest LTER Program

The Harvard Forest is one of eighteen sites forming the Long Term Ecological Research (LTER) program sponsored by the National Science Foundation. Each site addresses ecological questions of a long-term nature; collectively the sites undertake comparative studies across ecosystems. Representatives from the LTER sites, U.S. funding agencies and international research groups meet twice annually to develop collaborative studies.

The central theme of the Harvard Forest LTER is a comparison of historically-important physical disturbances and modern chemical disturbance in terms of their effect on forest ecosystem structure and function. One fundamental question is whether chronic, low-level additions of pollutants can result in more long-lasting alterations of ecosystem functions than does the historical regime of disturbance.

The research project involves soil scientists, atmospheric chemists, and ecologists studying physiological, population, community and ecosystem processes. Principal investigators represent the departments of Biology (F. Bazzaz), Earth and Planetary Sciences (S. Wofsy), and Harvard Forest (D. Foster, T. Allison, R. Boone, E. Boone, R. Lent , B. Tomlinson) at Harvard University as well as the Ecosystems Center at 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 (W. Patterson III). The research is organized to maximize the interactions and exchanges among scientists from different disciplines. Four core experiments include: (1) recreation 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. An annual Harvard Forest Ecology Symposium is held to present current research. Abstracts from this meeting are published annually. The program for the 1992 Symposium is shown on the following page.

National Institute of Global Environmental Change (NIGEC)

Harvard University serves as the Northeastern Regional Center for the NIGEC program sponsored by the Department of Energy. The purpose of NIGEC research is to improve the understanding of mechanisms of global environmental change, to develop innovative 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 (Aber, Bazzaz, Boone, Melillo, Wofsy) in addition to faculty from the University of New Hampshire (P. Crill, R. Harriss, O. Klemm, R. Talbot), University of California (C. Bledsoe), State University of New York (D. Fitzjarrald, K. Moore), Environmental Protection Agency (P. Rygiewicz), and Oregon State University (R. Waring, R. McCreight).

Seasonal Reflectance Spectra

HARVARD FOREST, 1991 - 1992

![Seasonal Reflectance Spectra](image)

Figure 5. Richard McCreight and Richard Waring are using an ultralight aircraft (inset) to obtain low-altitude remotely sensed data at the Harvard Forest. Changes in spectral reflectance of the canopy are depicted for seasonal periods of leaf-out, late-spring and mid-summer.

S. L. Bassow and F. A. Bazzaz. Seeing the forest from the leaves: understanding the biological processes controlling carbon dioxide exchange between the forest and atmosphere.

C. S. Bledsoe and P. T. Rhyiewicz. Microbial-root interactions and below-ground root dynamics in heated soils.


J. Cermak, J. Kucera and E. Bednarova. Transpiration of oak and spruce stands on soils with contrasting moisture.


P. Crill and R. Harris. Sources of atmospheric methane in the eastern United States.


D. Fitzjarrell, K. E. Moore, and C-H Lu. Seasonal changes in forest-atmosphere exchange at Harvard Forest.

D. R. Foster. Determinants of the floristic composition of central New England’s woods: separating the effects of land-use history and environmental factors.


F. Gerhardt. The relative importance of land-use history and environmental factors on the modern vegetation of central New England: implications for forest conservation.


S. Hamburg. Integration of history into ecology: a temperate-tropical ecosystem comparison.

J. J. Hendricks and J. D. Aber. The effects of nitrogen availability on fine root substrate.


A. Lezberg, G. Carlton and D. Foster. Tree sprouting in response to disturbance in a hardwood forest.

A. Lezberg and D. Foster. Rooting out the hurricane effects on forest structure: results from a simulated storm.

C. Mabry and T. Korsgren. Fifty years of vegetation change in a central New England forest: general trends versus site variability.

C. Mabry and G. Motzkin. Effects of land-use history on vegetation patterns in central New England.

A. H. Magill and J. D. Aber. Effects of ammonium nitrate amendments on litter decomposition.


F. Paillet. Ecological adaptations of Castanea dentata in eastern forests.


R. Primack. Dispersal and disturbance as factors limiting the distribution of rare plant species.

P. Schoonmaker. Structure and variation of an old-growth conifer forest across a topographic gradient in southwestern New Hampshire: comparison of original reconstructed stands.

P. Schoonmaker. Dynamics of downed wood following the 1938 Hurricane in southwestern New Hampshire.

R. Stafford. The differential effects of disturbance on the development of the old-growth Pisgah Forest.


P. M. Wayne and F. A. Bazzaz. Effects of the daily timecourse of light availability on the sun-shade responses and regeneration of birch seedlings.

G. G. Whitney. Regional patterns of land-use history and vegetation change in central Massachusetts.
BULLARD FELLOWS

The Bullard Fellowship Program in Forest Studies provides up to one year of support for faculty, researchers and administrators from outside institutions to work at Harvard University. Fellows represent a range of fields including biology, forestry, economics and government that focus on forest ecosystems worldwide. During 1991-92 four visiting fellows were supported: Dr. Miguel Martinez-Ramos, Ciudad Universitaria, Mexico who worked in Professor Bazzaz's laboratory in Cambridge, and Dr. Jan Cermak, Brno University of Agriculture, Czechoslovakia, Dr. Ned Fetcher, University of Puerto Rico, and Dr. Steven Hamburg, University of Kansas, based at the Harvard Forest. All four fellows were actively involved in research projects at the Harvard Forest and interacted extensively with faculty throughout the University.

Dr. Martinez-Ramos worked closely with the research group of F. Bazzaz on photosynthesis and carbon gain in understory plants. Dr. Cermak collaborated with F. Bazzaz, N. Fetcher, S. Hamburg, S. Wofsy and A. Lewis (University of Massachusetts) on a project attempting to scale up from tree leaf-level measurements to canopy and ecosystem levels. Jan installed a series of automatic devices for recording stem sap flow and tissue water content in trees adjacent to canopy towers where leaf photosynthesis and transpiration are being measured by S. Bassow. Jan presented lectures on "Large trees: water relations and structure" and "Forest destruction by air pollution in Czechoslovakia" at the University of Miami (Ohio), Smithsonian Institute, Harvard University, University of Massachusetts, University of Delaware, Johns Hopkins University, University of Maine and the Global Agronomic Opportunities Annual Meeting in Denver.

Dr. Steve Hamburg undertook collaborative projects with D. Foster, R. Boone and J. Cermak on land-use history and soil moisture analysis at the Harvard Forest while maintaining active involvement with the Environmental Studies program at the University of Kansas. Working with Buck Sanford from the University of Denver, Steve coordinated a week-long workshop at the Forest funded by the Mellon Foundation on land-use impacts in temperate and tropical forested ecosystems.

Ned Fetcher worked extensively on two projects in the physiological ecology of tropical forests: growth of tropical trees in response to light gradients and leaf carbon gain of tropical tree seedlings. He presented lectures at Boston University, Harvard University and the Woods Hole Ecosystem Center. Dr. Janice Voltzow, Ned's wife and a professor of biology at the University of Puerto Rico, served as visiting marine biologist at the Forest.

Bullard Fellows for 1992-93 include Lloyd Demetrius, Museum of Comparative Zoology, Harvard University; Enos Esikuri, Moi University, Eldoret, Kenya; Glenn Matlack, Henry Foundation, Gladwyne, Pennsylvania; and Victor Teplyakov, Moscow Forest Engineering Institute, Russia.

Jan Cermak explains his stem sap flow measurements to Richard Waring, Sam Goward, and David Foster during a NASA workshop at the Forest
Peter Wayne and Rose Crabbet completed thesis projects supervised by F. Bazzaz and conducted in part at the Forest. Peter undertook a physiological study investigating the effects of the daily timecourse of light availability on photosynthetic response and regeneration of birch seedlings. Results indicated large differences in growth and development in contrasting diurnal regimes, evidently resulting from differences in light quality and the timing of light availability. Rose examined the regeneration of birch in relation to nitrogen availability and form. Work in the Prospect Hill tract showed clear differences in the performance of black, gray, white and yellow birch according to the form (nitrate vs ammonium) and quantity of nitrogen added.

Students continuing their graduate studies at the Forest include Fritz Gerhardt and Russell Stafford, MFS students working with D. Foster; Lisa George, third year PhD student supervised by P. B. Tomlinson; Gary Carlton and Susan Bassow, PhD students working with F. Bazzaz; and Paul Hellmund, PhD student from the Graduate School of Design working with R. Forman. In addition faculty and staff at the Harvard Forest served on thesis committees for students at Harvard University, Hampshire College, University of Massachusetts, Rhode Island School of Design, McGill University, and University of New Hampshire.

During the past year, Fritz Gerhardt designed his MFS research on the relative importance of land-use history to forest vegetation and conservation in the town of Petersham. He also organized field discussions on the use of soil characteristics to identify past land-uses and a discussion group focused on the topics of study design, land-use history, and vegetation dynamics. Last December Fritz met former Bullard Fellow George Peterken in Great Britain where they examined patterns of vegetation and land-use history. In July Fritz helped Steve Hamburg resample quantitative soil pits on formerly cultivated sites in central New Hampshire. He also attended a conference on New England Plant Conservation: The Scientific Basis for Effective Action and the annual Hubbard Brook LTER meeting.

Barry Tomlinson taught Biology 24 "Introductory Plant Biology" in the fall term and conducted his summer course Biology S-105 "Plants of the Tropics" at Fairchild Tropical Garden in Miami. He and David Foster led the Harvard Forest Freshman Seminar Program in which eleven students meet over four weekends in the spring term. David also led Biology 299 "Seminar in Forest Research," an independent study course during both academic terms. John O'Keefe lectured in the Museum Studies program at Harvard and Rich Boone lectured courses in Forestry and Wildlife at the University of Massachusetts.
Summer Research Program

During the past year we increased our efforts to involve students and recent graduates in summer research projects thereby providing them with first-hand experience in ecological investigations. A total of 24 students worked in this program. In addition to their research activities many students conducted independent research and all participated in a weekly seminar program and field excursions to other research sites.

Joel Carlson
University of Massachusetts
Peter Carolan
Harvard College
Scott Cole
Harvard College
Daniel Cramer
Connecticut College
Elliott Gagnon
Harvard College
Alisa Golodetz
Hampshire College
Jennifer Jensen
Brown University
Thomas Jacobsen
Connecticut College
Holly Kretschmar
Harvard College
John Magnino
Quabbin Regional High School
Melinda McCall
University of Massachusetts
Kimberly McCracken
Allegheny College
Cathy Milliken
DePauw University
Mark Potosnak
Harvard College
Gloria Rapalee
University of Massachusetts
Robin Shultman
Hampshire College
Jennifer Sorenson
Allegheny College
Jay Stachowicz
Dartmouth College
Reto Stocker
University of Basel
Jennifer Thaler
Wellesley College
Martha Varnot
Quabbin Regional High School
Meeghan Wallace
University of Massachusetts
Craig Whiting
University of Massachusetts
Peikang Yao
University of Massachusetts
ACTIVITIES OF THE FISHER MUSEUM

The Fisher Museum plays a very important role in the educational mission of the Harvard Forest by providing an outlet for information concerning research activities in the fields of forest biology and management. In addition, the Museum serves as the site for many conferences sponsored by the Forest and outside groups. As Museum Coordinator, Dr. John O’Keefe has primary responsibility for the development of activities and coordination of use of the Museum.

The expansion of the Fisher Museum’s weekend schedule to include both Saturdays and Sundays, initiated in May 1991, proved immensely successful. Visitorship more than doubled over the previous year when the Museum was open only Saturday. The enthusiasm and dedication of our volunteers continue to make weekend operation possible.

In appreciation of the volunteers’ vital contribution to the operation of the Museum, the first Annual Volunteer Recognition Dinner was held in November. A social hour was followed by a delicious buffet dinner by Newton-Ramsdell Caterers. After dinner the successful season was reviewed and plans for the Museum and additional opportunities for volunteers were discussed. Special recognition and awards were given to Helen Gronich who has coordinated the volunteer program since its inception in 1990 and Lisa Hastings who was the most frequent volunteer during the year.

Volunteers have been active in special educational programs as well as preliminary planning for renovation of the second floor of the Museum. The Museum collaborated with the Petersham Craft Center to present two special programs during the summer: a children’s walk led by Ann-Marie Loud and Ann Lezberg and a fern identification workshop led by Peter Strong and John O’Keefe. In October the Museum hosted 40 inner-city, middle school children and six teachers for a weekend in collaboration with the Rainforest Coalition. The visit to Harvard Forest provided the students and teachers an opportunity to explore and study a temperate forest ecosystem as part of this joint Boston Public School/UMASS Boston project. In January, twelve of these students spent a week in Costa Rica exploring and studying the rainforest.

In August the Museum invited Dr. John Padolino of the Pocono Environmental Education Center, to conduct an evaluation of its facilities and activities under the American Association of Museums Museum Assessment Program. Renovation of the second floor exhibits is a major component of the long-range plan recommended by this evaluation. As background for the renovation process, John O’Keefe attended a course in Exhibit Design offered through the Harvard University Commission on Extension Studies. The changing exhibit of “Things to Look For” as visitors walk the trails is now in place. The renovation of the Museum facilities and exhibits would be impossible without the generous support of the Friends of the Harvard Forest.
Meetings, Seminars, Conferences

In October the Fisher Museum hosted the Northeast Region Fiftieth Anniversary Commemoration of the American Tree Farm System and in June the Yankee Division, Society of American Foresters summer meeting. Other meetings at Harvard Forest included the Northeast Forest Economists, Massachusetts Cooperative Extension Service Coverts Project, Massachusetts Project Learning Tree, New England Chapter of the Wildlife Society, Worcester County League of Sportsmen’s Clubs, the Metropolitan District Commission Watershed Management Division, and the New England Fern Conference.

The Harvard Forest Seminar series consisted of a mixture of discussions of articles in preparation or projects under development, reviews of videos for possible acquisition, and formal presentations. Seminar speakers included Jan Cermak, Steven Hamburg, Ned Fitcher and Miguel Martinez-Ramos, all Charles Bullard Fellows; Mark Degorski; Lauren Brown; Mollie Beattie, former Charles Bullard Fellow at the Kennedy School; Louis Zsuffa, University of Toronto; James Beach, Harvard University Herbarium; Lloyd Demetrius, Museum of Comparative Zoology; Robin Chazdon, University of Connecticut; Robert Thorsen, University of Connecticut; Richard Lent, Amherst College; David Publicover, Yale University; Glenn Matlack, Henry Foundation for Botanical Research; Peter Dunwiddie, Massachusetts Audubon Society; and Charles Canham, Institute of Ecosystem Studies. In addition, David Foster, Emery Boose, Richard Boone, Cathy Mabry, John O’Keefe, Fritz Gerhardt, Peter Schoonmaker and Russell Stafford all of Harvard Forest reviewed their current projects.

Harvard Forest was the site for several conferences and workshops during the year:

- Integrating History into Ecology, Mellon Foundation
- Biosphere-Atmosphere Interactions at Harvard Forest, National Institute of Global Environmental Change
- Remote Sensing from Light Aircraft, NASA
- Sustainable Management of Tropical Evergreen Forests, Harvard Institute for International Development
- Biological Processes and Nitrogen Cycling, MBL Ecosystem Center

Friends of the Harvard Forest Annual Meeting
FOREST AND MAINTENANCE ACTIVITIES

Under the supervision of John Edwards the Woods Crew undertakes a diverse range of tasks encompassing silviculture, road and machine maintenance, construction and experimental manipulations. Recent silvicultural activity has focussed largely on conifer plantations with the objective of terminating unsuccessful stands and thereby creating a series of young hardwood stands for future experimental study.

Over the winter three areas were harvested by the woods crew. In the fall we began to clearcut the three and a half-acre mixed hardwood and softwood stand directly behind the Community House. The brush was piled and burned, the pines were sawn and all hardwood was cut for firewood. Our plan is to fence the area and put cattle into the clearcut area and a portion of intact forest. This will allow us to demonstrate past agricultural land use practices as well as to study the effect of grazing on forested areas.

In January we began two cuttings along Tom Swamp Road. Five red pine plantations comprising nine acres were clearcut. These plantations were established in the mid-1920's but were located on till soils and were heavily invaded by desirable hardwood species. Adjacent to these plantations was a 20-acre Red Oak stand that was thinned in 1966 as a demonstration. As a result of this thinning the stand contained a fully stocked understory of hardwood saplings which needed to be released. The clearcut of this area was completed by the end of June with most of the harvested material being processed by local and Canadian mills. Cutting this area has allowed us to create almost 30 acres of unbroken emerging forest that can be used for future research.

Our vegetation survey crew focussed their efforts on the Slab City tract and planned to complete their survey this year. The data base and base maps will provide valuable information for research and long-term planning at the Forest.

Other projects completed this year include the removal of asbestos from the boiler room in Shaler Hall, the conversion of the first floor men's room in Shaler Hall to a handicapped accessible bathroom and new exterior lighting around Shaler Hall. The increased research activity at Harvard Forest has overwhelmed the mail sorting area in the Common Room. Consequently our talented woods crew designed a new system in the hall leading to the Fisher Museum and constructed new racks for magazines and periodicals in the Common Room.
ACTIVITIES OF THE HARVARD FOREST STAFF

In addition to their research and educational activities at the Harvard Forest staff members participate in many advisory boards, conferences and committees at the local, regional, national and international level.

Emery Boose serves on the GIS Working Group, Data Managers Committee and Climate Committee of the Long Term Ecological Research program. Emery represented the Forest at the LTER Data Managers Meeting in San Antonio and LTER Coordinating Committee meeting at Trout Lake, Wisconsin. Along with David Foster he presented papers on results from hurricane modelling at the International Association of Landscape Ecology in Corvallis, Oregon and the annual meeting of the Luquillo LTER program.

David Foster serves on the Editorial Board of the Journal of Ecology, as Secretary of the Vegetation Section of the Ecological Society of America, chairman of the GIS Working Group for the LTER program, and Executive Secretary of the Charles Bullard Fellowship Committee at Harvard University. He serves on advisory boards to the Massachusetts Audubon Society, Concord Field Station of the Museum of Comparative Zoology at Harvard, Highstead Arboretum in Redding Connecticut, and Massachusetts District Commission, and is a member of the National Institute of Global Environmental Change (DOE) Northeastern Management Committee. David presented talks at the Roundtable Discussion of Environmental Studies at Harvard University, at the SCOPE Symposium on Legacies of the Columbian Encounter in Seville, Spain, the Annual Meeting of the Luquillo LTER in San Juan, the Mellon Foundation workshop on Integration of History into Ecology at the Harvard Forest, the session of Landscape-Scale Experiments and Modelling at the International Association of Landscape Ecology in Corvallis, a symposium on Conserving New England Lands sponsored by the Graduate School of Design in Cambridge, and a panel discussion with Bill Cronon and Bill Niering on Changes in the New England Landscape at Connecticut College.

John O'Keefe presented seminars on current activities of the Harvard Forest to the Worcester Women's Club and the Athol/Orange Rotary Club. John served as an advisor to Christina Kilday, a landscape architecture student from the Rhode Island School of Design who used the Prospect Hill tract of Harvard Forest as the basis for her senior project. In January, John was appointed Vice-Chair of the Yankee Division of the Society of American Foresters.
Barry Tomlinson continues to serve as Harvard University's representative to the Organization of Tropical Studies and as science advisor to Cambridge University Press for its publication series on tropical forests. He was an invited speaker in the symposium "Evolution on Islands" at the 8th Annual Southwestern Botanical Systematics Symposium in Claremont, California.

In his first year as Emeritus professor, John Torrey oversaw the publication of numerous articles. John devoted considerable time to a book-length manuscript on the history and activities of the Maria Moors Cabot Foundation for Botanical Research at Harvard and continued to improve his collection of British etchings.

Marcheterre Fluet took two trips to Puerto Rico to attend the Annual Meeting of the Luquillo LTER and to conduct historical studies at the USFS Institute of Tropical Forestry and Department of Natural Resources and Aerial Photogrammetry. In her photographic and arts life Marcheterre held workshops on darkroom techniques at the Harvard Forest and staged an exhibition of photographs at the Museum of Fine Arts in Springfield, Massachusetts.

Rich Boone was appointed Adjunct Professor in the Natural Resources Department at the University of New Hampshire, where he serves on the graduate degree committees for five students including William Currie and Patricia Micks who have projects at the Harvard Forest. Rich gave talks on carbon and nitrogen dynamics in temperate forest ecosystems at the University of Massachusetts and Harvard University and outlined a large intersite study of organic matter manipulation to the LTER Coordinating Committee at the Trout Lake, Wisconsin meeting.

Gordon Whitney completed the draft of his book on landscape history of the northeastern U.S. and is coordinating its publication with editors at Cambridge University Press. Gordon presented lectures on historical ecology at the University of Massachusetts and Concord Historical Society. He served as a visiting lecturer in landscape ecology during the spring term in the Yale Forestry and Environmental Studies program.

Dana Tomlin was appointed Associate Professor of Landscape Architecture at the University of Pennsylvania while maintaining his residence in Petersham and appointment as Associate of the Harvard Forest. Dana taught Spatial Modelling and Geographic Information Systems as a visiting lecturer in the Forestry and Environmental Studies program at Yale University.

Steve Wofsy serves as Senior Research Associate in the Department of Earth and Planetary Sciences and is an Associate of the Harvard Forest. As a principal investigator for the DOE-funded National Institute of Global Environmental Change (NIGEC) program at Harvard, Steve is coordinating many of the atmosphere-biosphere studies being conducted at the Harvard Forest. This past year he supervised a major expansion of the Environmental Monitoring Station and the development of a number of new projects in trace gas fluxes and forest response studies.

Ann Lezberg represented the Harvard Forest at the LTER Global Positioning System training workshop in Boulder, Colorado. Ann produced a poster with G. Curiton, D. Foster, and F. Bazzaz for the New England Division of the Society of American Foresters Meeting summarizing first year community response and regeneration following the simulated hurricane blowdown in
the Tom Swamp tract. Ann also has coordinated the effort in recycling both office materials and household items by working with both the Harvard University Recycling Program and the Hardwick Recycling Center.

Jeannette Bowlen enrolled in the MBA Program at Clark University. During the academic year she completed the following courses: Statistical Methods, Management Economics, Management Information Systems and Organization Behavior.

Five new researchers joined the Harvard Forest staff this year. Dr. Richard Lent was appointed as Data Manager/Ecologist. Richard has been a Visiting Professor in the Department of Biology at Amherst College and formerly served as Associate Director of Research at the Cornell University Laboratory of Ornithology, Seatuck Research Program on Long Island. His ornithological research on fitness components in grey catbirds and on habitat use and behavior of breeding birds in disturbed forest environments were initiated in his graduate studies at the University of Vermont (MS) and State University of New York (PhD). Richard brings a strong background in statistical ecology, experimental design and spatial analysis to the Harvard Forest where his diverse research interests should strongly complement the LTER studies.

Dr. Taber Allison joined the Forest in June as a research scientist in the areas of paleoecology and population biology. Taber has been a professor in Plant Biology at Ohio State University since 1987 and has a PhD in Ecology from the University of Minnesota and Masters of Forest Science from Yale University. Taber will be working on a paleoecological study of changes in vegetation, disturbance processes and human activity over the past 1000 years in central New England. In addition he will continue research on the ecological and evolutionary implications of wind pollination in the genus *Taxus* and in the prairie grasses *Sorghastrum nutans* and *Andropogon gerardi*.

Russell Stafford successfully defended his thesis in the summer for his MFS degree. Russell has been working on a study of heterogeneity in the development of hemlock stands on the Pisgah tract. For this work he has been utilizing permanent plot data and dendrochronological analysis.

During the period September through January, Professor L. Zsufta, University of Toronto, was a visiting scholar at the Forest. He utilized this time to research the environmental consequences of tree breeding progress and plantation forestry.
Cathy Mabry and Glenn Motzkin started in the Fall as research assistants working with David Foster on historical ecology of the central New England landscape. Cathy has a MA in biology from Drake University and considerable background in physiological ecology working with Professor Bazzaz's laboratory. Glenn has a MS in forest ecology from the University of Massachusetts and has worked extensively in wetland classification, rare habitat and community type assessment and vegetation dynamics. During the past year Glenn presented a paper on vegetation dynamics of the Marconi Atlantic White Cedar Swamp in Cape Cod at the New York Natural History Conference on Wetland Ecology. With support from the Nature Conservancy, Massachusetts Natural Heritage Program and Massachusetts Department of Fisheries, Wildlife and Environment, he undertook studies of calcareous fens in western New England and uncommon natural community types in the Connecticut River Valley.

Assistant working with Rich Boone on the Mellon Foundation project on land-use history. Kasey, who has an undergraduate degree in soils science from the University of Massachusetts, has helped to set up the new soils laboratory, attended a two-and-a-half day auto-analyzer training session at Lachat Instruments in Milwaukee, Wisconsin with Rich and began a soil survey of the 1937 permanent forest plots on Prospect Hill.

After 12 years working as a secretary at the Harvard Forest, Fran Phillips left to take a position with the Mahar Regional High School in Orange.

Following nearly two years of hospitalization and illness from multiple sclerosis, Denise Gaudreau died in May of this year. Denise came to the Harvard Forest as a Bullard Fellow from Southampton College in 1988. She stayed as a research associate in the LTER program where she worked with David Foster and Gordon Whitney on the history of vegetation in central New England. Many of her friends and colleagues gathered at the Harvard Forest in mid-July for a celebration of her life and friendship.
Visiting Research Scientists at the Harvard Forest 1991-92

In addition to Harvard Forest researchers a large number of outside scientists made use of Harvard Forest facilities and research sites. Many of these scientists were involved in the HF LTER program or in Harvard University’s Northeast Regional Center of NIGEC (National Institute for Global Environmental Change) project.

John Aber  
Peter Bakwin  
Susan Bassow  
Fakhri Bazzaz  
Mike Binford  
Caroline Bledsoe  
Rich Bowden  
Frank Bowles  
Wally Broecker  
Mark Castro  
Chaur-Fong Chen  
Rose Crabtree  
Patrick Crill  
William Currie  
Bruce Daube  
Peter Del Tredici  
Marty Downs  
Todd Drummey  
Aaron Ellison  
James Ehleringer  
Chris Field  
David Fitzjarrald  
Song-Miao Fan  
Richard Forman  
Alan Goldstein  
Michael Goulden  
Robert Harriss  
Joseph Hendricks  
Shoichi Kawano  
Dave Kicklighter  
Christina Kilday  
Otto Klemm  
University of New Hampshire  
Harvard University  
University of California, Davis  
Allegheny College  
Ecosystem Center - MBL  
Lamont Doherty Observatory  
Ecosystem Center - MBL  
Oregon State University  
Harvard University  
University of New Hampshire  
University of New Hampshire  
Harvard University  
Arnold Arboretum  
Ecosystem Center - MBL  
Ecosystem Center - MBL  
Mount Holyoke College  
University of Utah  
Carnegie Institute  
State University of New York  
Harvard University  
Harvard University  
Harvard University  
University of New Hampshire  
University of New Hampshire  
Kyoto University  
Ecosystem Center - MBL  
Rhode Island School of Design  
University of New Hampshire  
Ann Lewis  
Alison Magill  
Mary Martin  
Charles McClaugherty  
Rich McCreight  
Michael McElroy  
Ernesto Medina  
Jerry Melillo  
Shi-Li Miao  
Patricia Micks  
Kathleen Moore  
J. William Munger  
Knute Nadelhoffer  
Kathy Newkirk  
Fred Paitel  
William Patterson  
Bob Pearcy  
William Peterjohn  
Richard Primack  
Andrea Ricca  
Michael Rogers  
Paul Rygiewicz  
Otto Solbrig  
Paul Steudler  
Robert Talbot  
Karl Tureckian  
Richard Waring  
Peter Wayne  
Brayton F. Wilson  
Steven C. Wofsy  
University of Massachusetts  
University of New Hampshire  
University of New Hampshire  
Mount Union College  
Oregon State University  
Harvard University  
Centro de Ecología y Ciencias  
Venezuela  
Ecosystem Center - MBL  
Harvard University  
University of New Hampshire  
State University of New York  
Harvard University  
Ecosystem Center - MBL  
Ecosystem Center - MBL  
U.S. Geological Survey  
University of Massachusetts  
University of California, Davis  
Ecosystem Center - MBL  
Boston University  
Ecosystem Center - MBL  
Georgia Institute of Technology  
Environmental Protection Agency  
Harvard University  
Ecosystem Center - MBL  
University of New Hampshire  
Yale University  
NASA, Oregon State  
University  
Harvard University  
University of Massachusetts  
Harvard University
PUBLICATIONS


NEW FUNDING

As part of the developing program in soils ecology at the Harvard Forest Rich Boone received a one-year grant of $90,000 from the Department of Energy (NIGEC) to support research on the litter manipulation plots. Rich and Knute Nadelhoffer have used this grant to complete installation of the project and to support intensive monitoring of plots by a team of summer assistants. David Foster and Emery Boose received $65,000 from NSF to supplement LTER activities including installation of a computer-based data management system and collaboration by R. Bowden (Allegheny College) in LTER studies. Small grants from NSF and New England Consortium for Undergraduate Science Education were used to support summer undergraduate assistants. Glenn Motzkin received a grant from the Massachusetts Natural Heritage Program to continue studies of rare plant communities in the Connecticut River area of Massachusetts. Dr. Richard Primack was awarded a two-year grant for $130,000 from the Conservation Biology program of NSF to initiate studies on factors limiting the establishment and dispersal of rare plant species.

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Human Dimensions of Global Change
Long Term Ecological Research
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U.S. Department of Energy
Wharton Conservation Trust

David R. Foster  
Director

Petersham, Massachusetts  
June, 1992
Back Cover: Reclaiming an old field, Prospect Hill tract