HARVARD FOREST

SUMMER RESEARCH PROGRAM

Abstracts from the 8th Annual
Harvard Forest Summer Research Symposium
16 August 2000

EIGHTH ANNUAL HARVARD FOREST SUMMER RESEARCH PROGRAM

16 August 2000

HARVARD FOREST, FISHER MUSEUM

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IES Forum on Opportunities in Ecology

Personnel at the Harvard Forest

Photography by Jim Gipe

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 provides office and laboratory space, computer and greenhouse facilities, and a lecture room and lodging for seminars and conferences. Extensive records including long-term data sets, historical information, original field notes, maps, photographic collections and electronic data are maintained in the Harvard Forest Archives. Residences include Fisher House with room for groups of twenty, and four houses and ten rental apartments for visiting researchers, students and post-doctoral fellows.

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

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

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

Summer Research Program

The Harvard Forest Summer Student Research program, coordinated by Edythe Ellin and assisted by Robin Siewers, attracted a diverse group of students to receive training in scientific investigations, and experience in long-term ecological research. Students work closely with faculty and scientists, and many conduct their own independent studies. The program includes weekly seminars from resident and visiting scientists, discussions on career issues in science (e.g. career decisions, ethics in science), and field exercises on soils, land-use history, and plant identification. An annual field trip is made to the Institute of Ecosystem Studies (Millbrook, NY) to participate in a Forum on Careers in Ecology. At the Annual Summer Student Research Symposium students present major results of their work.

EIGHTH ANNUAL HARVARD FOREST SUMMER STUDENT SYMPOSIUM

16 AUGUST 2000

HARVARD FOREST—FISHER MUSEUM

9:30 AM	**INTRODUCTION**	
9:45	Ion-mediated Response to the Hydraulic Conductivity in *Carpinus caroliniana*	Shelly DuPlessis
10:00	ExPloring Modern Timber Harvesting as a Form of Disturbance Across the North Quabbin Region	Andrew Finley
10:15	Historical Biomass Accumulation in an Old Growth Hemlock Forest	Nicole Smith
10:30	Historical Woodland Cover in Southeastern Massachusetts: a Spatial Analysis of Factors Controlling Woodland Distribution	Erin McCarty
10:45	Applying Historical Ecology to Conservation: a GIS Approach	Mindy Syfert
11:00	**COFFEE BREAK**	
11:15	The Relationship Between Soil Respiration and Soil Moisture in the Organic Soil Horizon	Catherine Angeloni
11:30	Depletion of a Labile Carbon Pool Comparing and Contrasting the Ninth and Tenth Year Results of the Soil Warming Experiment	Sam Stratton
11:45		Kate Capecelatro
12:00	Regeneration Ten Years After a Simulated Hurricane	Sarah Martell
12:15	Bole Respiration in Deciduous and Coniferous trees in Central Massachusetts	Sean Brown
12:30	The Effects of Hemlock Woolly Adelgid Infestations on Avian Community Composition and Dynamics	Morgan Tingley
12:45	**LUNCH**	
1:45	Carbon Sequestration in Live Trees: a Methods Analysis of Dendrometry in Harvard Forest	Shane Heath

2:00	Calibration of Time Domain Reflectometry (TDR) Specific for Harvard Forest Soils	Felicia Frizzell
2:15	Variations in Songbird Nest Predation by Height in Mixed Oak Forests	Scott Demers
2:30	Variation in Charcoal Production Among Different Vegetation Types	Matthew Kirwan
2:45	Composition, Structure, and Dynamics of Hemlock Stands with Various Levels of Hemlock Wooly Adelgid Infestation in Connecticut	Aaron Weiskittel
3:00	The Impact of Hemlock Woolly Adelgid Infestation on Nitrogen Cycling and Microenvironment in Eastern Hemlock Forests	Anthony D'Amato
3:15	**CONCLUDING REMARKS**	
5:00	**BARBEQUE**	

The Relationship Between Soil Respiration and Soil Moisture in the Organic Soil Horizon

Katie Angeloni

Soil respiration, the sum of root respiration and microbial decomposition, is dependent on temperature and soil moisture. There is a positive correlation between soil respiration and soil temperature. Soil respiration is reduced under anaerobic conditions due to oxygen limitations and reduced under dry conditions due to moisture stress. The optimal condition for soil respiration is found somewhere in between these two conditions. Studies have shown that small rain events that moisten the leaf litter correspond to pulses of soil respiration.

The objective of this experiment was to look for a correlation between soil moisture in the leaf litter and organic soil horizon, and carbon dioxide flux. Three soil blocks were collected from the field. These blocks were wetted to simulate rain events and soil respiration and moisture were measured as the soil blocks dried. Soil respiration was measured by using a dynamic chamber system attached to an Infrared Gas Analyzer, and soil moisture was measured by using dc half-bridges.

There was evidence that when 200 ml of water was sprinkled on the soil samples, which primarily wetted the leaf litter, a small, short-term pulse in soil respiration was measured immediately after this wet-up event. As the soil blocks dried down there was some corresponding decrease of soil respiration.

These results showed some evidence that an increase in soil moisture in the leaf litter corresponded to an increase in soil respiration; however, more tests are needed to better define this relationship.

The Effects of Increased Atmospheric Nitrogen (N) Deposition on the Understory of a Temperate Forest

German Arellano

Air pollution continues to increase as automobiles and certain industrial processes emit NO_x and NO_y into the atmosphere. These pollutants eventually settle out of the atmosphere onto the biosphere. At the Harvard Forest, the effect of increased N deposition on the understory within hardwood and coniferous stands was studied. Three major 30*30 m plots were established within each stand: control, Low N, and High N. Fertilizer additions of NH_4NO_3 are applied as six equal applications over the growing season: 150 kg N/ha and 50 kg N/ha in the High and Low N plots, respectively. Within each major plot, five 2*2m plots were created: the understory within these plots was surveyed for abundance (i.e. % coverage), total biomass, and leaf area (LA). Because *Acer pennsylvanicum* (striped maple) occurs in both stands, it was used as an indicator species. Within both stands, understory species abundance, biomass, LA and the population of striped maple were all found to significantly decrease between Control and Low N plots; a small, but still significant, decrease was found between Low and High N plots (Figs. 1, 2). In sum, it was found that increasing levels of N deposition can cause understory life to suffer. These findings have potentially negative implications (e.g., forest decline, lower crop yield) for forests and agricultural areas proximate polluted areas.

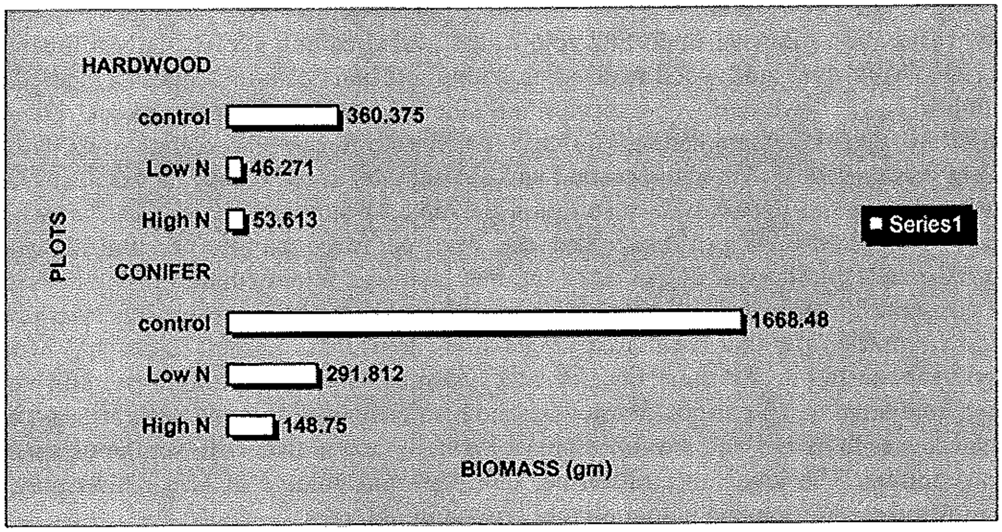


Fig.1 A comparative plot of Total Biomass vs. Plots between Hardwood and Conifer Stands. Note the sharp decrease in Biomass between Control & Low N plots.

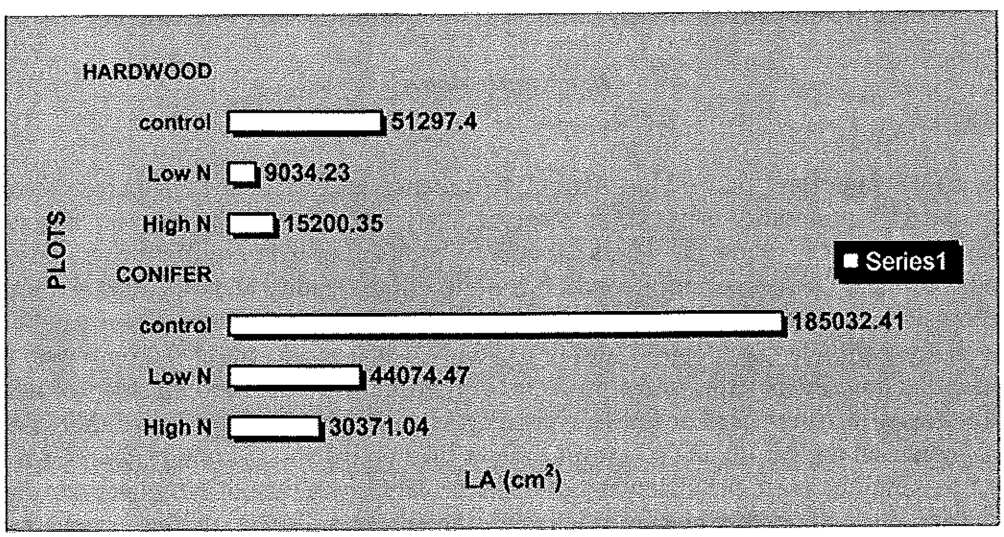


Fig. 2 A comparative plot of Total Leaf Area vs. Plots between Hardwood and Conifer Stands. Again, note the sharp decrease in Leaf Area between Control & Low N plots.

Bole Respiration in Deciduous and Coniferous Trees in Central Massachusetts

Sean E. Brown

Wood respiration plays an important role in the global carbon cycle. Only a few studies (e.g., Ryan *et al.,* 1994) have compared wood respiration in conifers and deciduous trees. I studied three trees, 21 to 26cm dbh in each of two hardwood species, red maple (*Acer rubrum)* and red oak *(Quercus rubra)* and one coniferous species, eastern hemlock (*Tsuga canadensis)* in central Massachusetts, USA. Average bole respiration was measured 1 m aboveground and did not vary significantly between species ($p>0.05$). However, hemlock had the lowest bole respiration per unit surface area (0.86 $g/m^2/hr$) while oak and maples were higher (0.98-0.99 $g/m^2/hr$). Red oak respired twice as fast per unit sapwood volume compared to red maple (4.88 vs. 2.21g/m^3 /hr) and hemlock was intermediate (3.99 g/m^3 sapwood/ hr). Assuming a constant % sapwood and respiration rate throughout the tree, the species showed similar estimated total respiration per unit basal area (15.94-17.37 g/m^2 /hr). Large (72-cm dbh) hemlock boles measured two years earlier at the same time of year had much lower respiration per unit volume (0.51 g/m^3 /hr) when compared to 26 cm-dbh hemlocks. The results suggest that the sapwood and cambium of ring porous species such as red oak are more physiologically active than diffuse porous species such as red maple, or conifers. The lower respiration per unit sapwood volume of larger trees may reduce the carbon used in wood respiration and help maintain growth in old trees.

Ryan, M. G., Lincher, S., and Rose, M. 1994. Dark respiration of pines. Ecological Bulletins (Copenhagen) 43: 50-63.

Tree Response to Canopy Gaps: a Demographic Study of Branches

Kate Capecelatro

Canopy gaps are an important part of the natural disturbance regime of the temperate forests of New England. Gaps provide temporary increases in resource availability, benefiting not only regeneration, but also the existing stand. Trees along gap edges experience contrasting light environments. Branches on the gap-facing sides of these trees experience conditions of high light quality and quantity, while branches on the forest-facing side experience lower light conditions of shading from the branches of neighboring trees. If light is unequally available to opposing sides of a canopy, is the architectural response over time for the canopy to expand and maintain itself in the direction of high light? In an ongoing study of tree responses to light environments in forest gaps at the Harvard Forest, C. Muth has documented that canopy height and depth are greater on the gap-facing sides of canopies than on the forest-facing sides. Hardwick (1986) has said that a tree may increase the efficiency of resource capture by way of reproduction of new branch and leaf units from ones situated in resource-rich environments and discarding those situated in resource-poor environments.

This summer 2000 study addressed three questions: For trees along gap edges, (1) does a difference exist between the number of branches on the forest- vs. gap-facing sides of a tree? (2) does a difference exist between the number of dead branches on the forest- and gap-facing sides of a tree? (3) does the age structure of branches differ between forest- and gap-facing sides of tree, i.e., can the higher number of observed branches on the gap-facing side of trees be attributed to increased growth of new branches or increased survival of pre-existing branches?

Answering these questions involved a count of live and dead branches on the gap- and forest-facing sides *Fagus grandifolia, Betula alleghaniensis,* and *Acer rubrum,* and a harvesting and aging of branches from the gap- and forest-facing sides of *Fagus grandifolia* and *Betula alleghaniensis* in experimental gaps created at the Harvard Forest in 1987.

Results indicate that trees along gap edges have more branches on the gap-facing side than on the forest-facing side, as well as that a greater percentage of dead branches exists on the forest-facing side than on the gap-facing side. *Betula alleghaniensis* responds to gap with increased growth, whereas *Fagus grandifolia* exhibits increased survival. Overall, trees along gap edges respond to the increased light availability with increased growth and survival of gap-facing branches.

The Impact of Hemlock Woolly Adelgid Infestation on Nitrogen Cycling and Microenvironment in Eastern Hemlock Forests

Anthony W. D'Amato

The infestation of eastern hemlock (*Tsuga canadensis)* dominated forests in southern New England by the introduced hemlock woolly adelgid (HWA; *Adelges tsugae*) has provided the opportunity to study the changes in nitrogen cycling and microenvironment associated with the decline and mortality of a dominant tree species. Data were collected at eight hemlock-dominated sites with varying levels of HWA infestation and stand deterioration throughout the Connecticut River Valley. Each site contained three 20 x 20 m plots in which soil temperature was monitored at 1 and 5 cm depths. Nitrogen mineralization and nitrification rates in organic and mineral soils were estimated using *in situ* soil core incubations. A sub-sample of these soil cores was analyzed for gravimetric soil moisture. In addition, hemispherical photos were taken at each site and used to calculate percent open sky. Nitrogen mineralization, nitrification, and NH_4-N and NO_3-N pool sizes increased in stands experiencing HWA infestation. Both soil temperature and percent open sky increased in the stands with HWA infestation while gravimetric soil moisture decreased in these stands. These data suggest that nitrogen mineralization and nitrification rates have increased in response to the microenvironmental changes associated with HWA infestation. As stands continue to deteriorate and nitrogen uptake is further reduced, the potential for nitrogen leaching from these ecosystems will increase. Presumably, the extent of this increase in nitrogen loss will be determined by the nitrogen uptake capacity of the vegetation replacing eastern hemlock.

Variations in Songbird Nest Predation by Height in Mixed Oak Forests

Scott A. Demers

Nest predation is a major mortality factor in open nesting songbirds. Yet, most studies regarding nest predation have been done on the ground and in shrubs. Important data is missing regarding nest predation and types of predation above shrub height. I analyzed data from this summer and two previous years to answer the following question: How does the predation of nests vary by height in eastern mixed oak forests? Artificial nests, baited with zebra finch and plasticine eggs, were set out in ground/shrub grids as well as in climbing trees with ground, shrub, sub-canopy and canopy levels. The eggs were put out in May, June, July, and left exposed for 12 days, the approximate incubation time for many eastern forest birds. Annual predation rates appeared to fluctuate with changes in rainfall in the corresponding summers. Bird predation, defined by complete removal of both eggs, appeared to by higher in the upper strata as well as in the May trials. Small mammal predation, defined by chewed plasticine eggs, trends were higher in the lower levels, although still evident in the higher strata, suggesting that small mammals such as *Peromyscus leucopus* (white-footed mouse) climb trees and prey upon songbird nests. These trends suggests that there are differences in predation levels at different heights and that small mammals are capable of climbing into the canopy and preying upon songbird nests.

Ion-mediated Response to the Hydraulic Conductivity in *Carpinus caroliniana*

Shelly Du Plessis

The process of long-distance water transport has received considerable attention for many years and remains one of the most fundamental processes in plants. The Cohesion Theory maintains during transpiration water columns in the xylem are pulled up through stems by capillarity leaving behind negative pressures in the xylem conduits. Recent work on the hydraulic conductivity of temperate deciduous hardwoods at the Harvard Forest in central Massachusetts may suggest a new, alternative method of water transport. We perfused small concentrations KCl through three-year stems at a constant pressure gradient for ten minutes then switched to pure water and measured the conductivity. In *Carpinus caroliniana*, the average conductivity increased by 59% with the addition of 10mMKCl and was restored with pure water (Fig. 1). When the end walls of the conduits were removed, the response to KCl was eliminated suggesting that the end walls are critical in regulating the flow of water through xylem vessels. We think gels are located at the vessel end walls, which can shrink and swell in the presence of ions to effectively regulate water flow. This may explain the increased flow rate through the stem. Historically, wood has been viewed as a dead tissue that functions to pipe water through its vessels without changing its resistance. However, our findings regarding the oscillatory behavior of the hydraulic conductivity in *C. caroliniana* and other species suggest otherwise. Future studies must re-examine the basic processes of water transport in vascular plants in light of this new evidence to better characterize water flow and water relations at the whole plant level.

Exploring Modern Timber Harvesting as a Form of Disturbance Across the North Quabbin Region

Andrew Finley

Myriad ecological disturbance factors contribute to the present species composition and structure of the North Quabbin Region's (NQR) forest landscape. Researchers describe with some certainty how geophysical, wind, fire, insect, disease and some human driven disturbances (e.g., forest clearing for agricultural planting) influence forest succession. Timber harvesting is a disturbance which has and will continue to sculpt the NQR's forest landscape. In the NQR large clearcuts in the late-1700s followed by agricultural land clearing and then subsequent field abandonment has produced an even-aged mixed species dominated forest landscape. As this forest reaches economic maturity, we are witnessing a different form of timber harvest disturbance in the NQR.

In an effort to characterize this round of timber harvesting, we developed a spatial database of all timber harvests in the NQR from 1984 to 2000 that includes 2158 harvest events. In this 17-year period, 26.1 percent of the NQR's forest experienced some form of timber harvest and 10.1 percent of these areas have

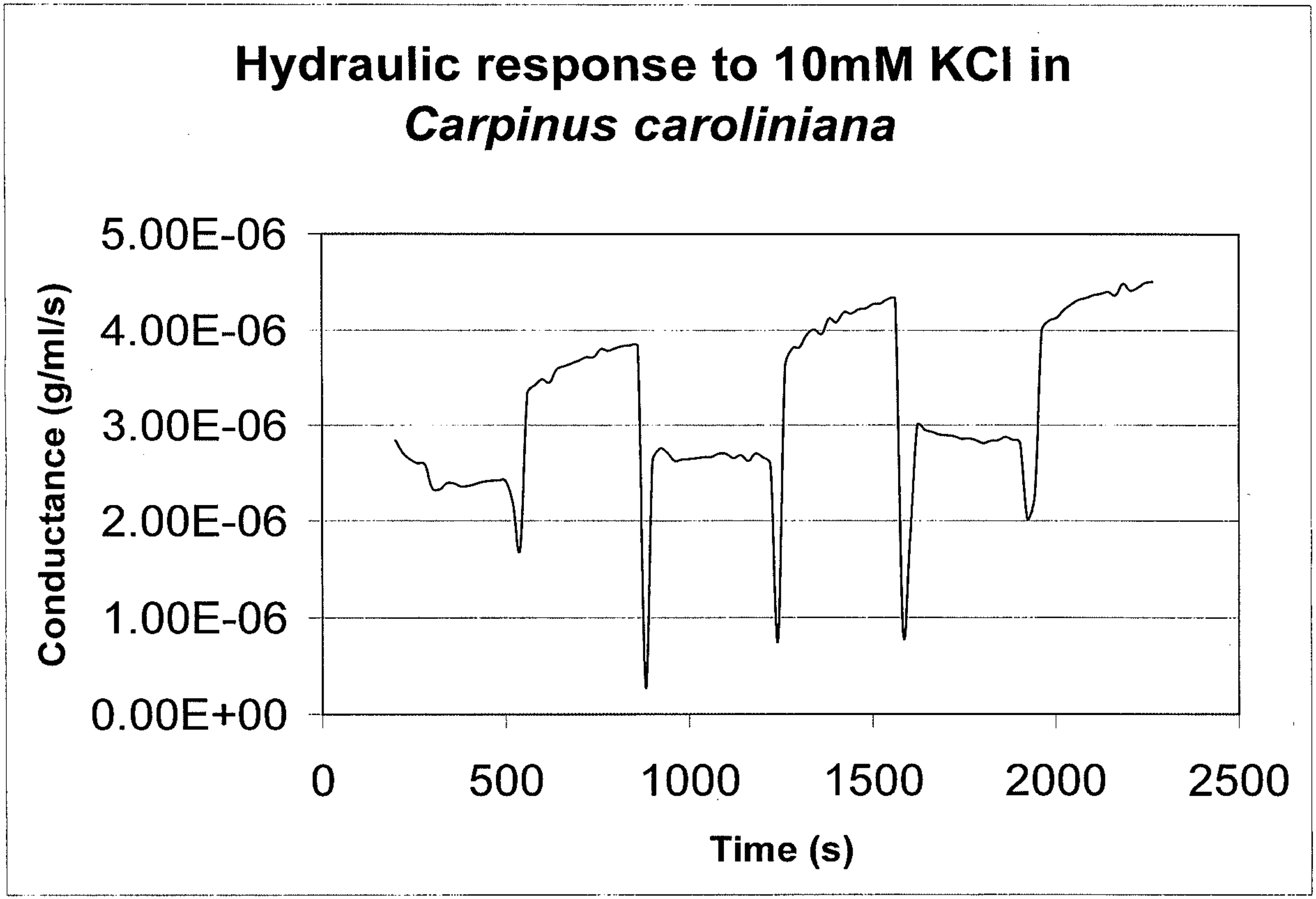


Figure 1. Hydraulic conductivity of a 3 year stem of Carpinus caroliniana (American Hornbeam) with pure water and 10mM KCl at 55 KPa. The peaks represent the flow rates with KCl and the lows represent pure water.

DuPlessis

been entered more than once. The typical timber harvest is 16.1 hectares and removes 44.6 cubic meters per hectare. To understand and describe the occurrence of harvests in the NQR we examined relationships between such landscape features as elevation, slope, aspect, surface geology, historic land use, current forest vegetation type and proximity to roads. Evaluation of this suite of independent variables suggests that timber harvesting is a random occurrence on the NQR forested landscape. We must conclude that other variables explain timber-harvesting disturbance. Perhaps, these are more social oriented variables such as private forest landowner (PFLO) needs and wants, the interaction between PFLOs and foresters or timber buyers, public land policy, mandates, and social values.

Calibration of Time Domain Reflectometry (TDR) Specific for Harvard Forest Soils

Felicia Y. Frizzell

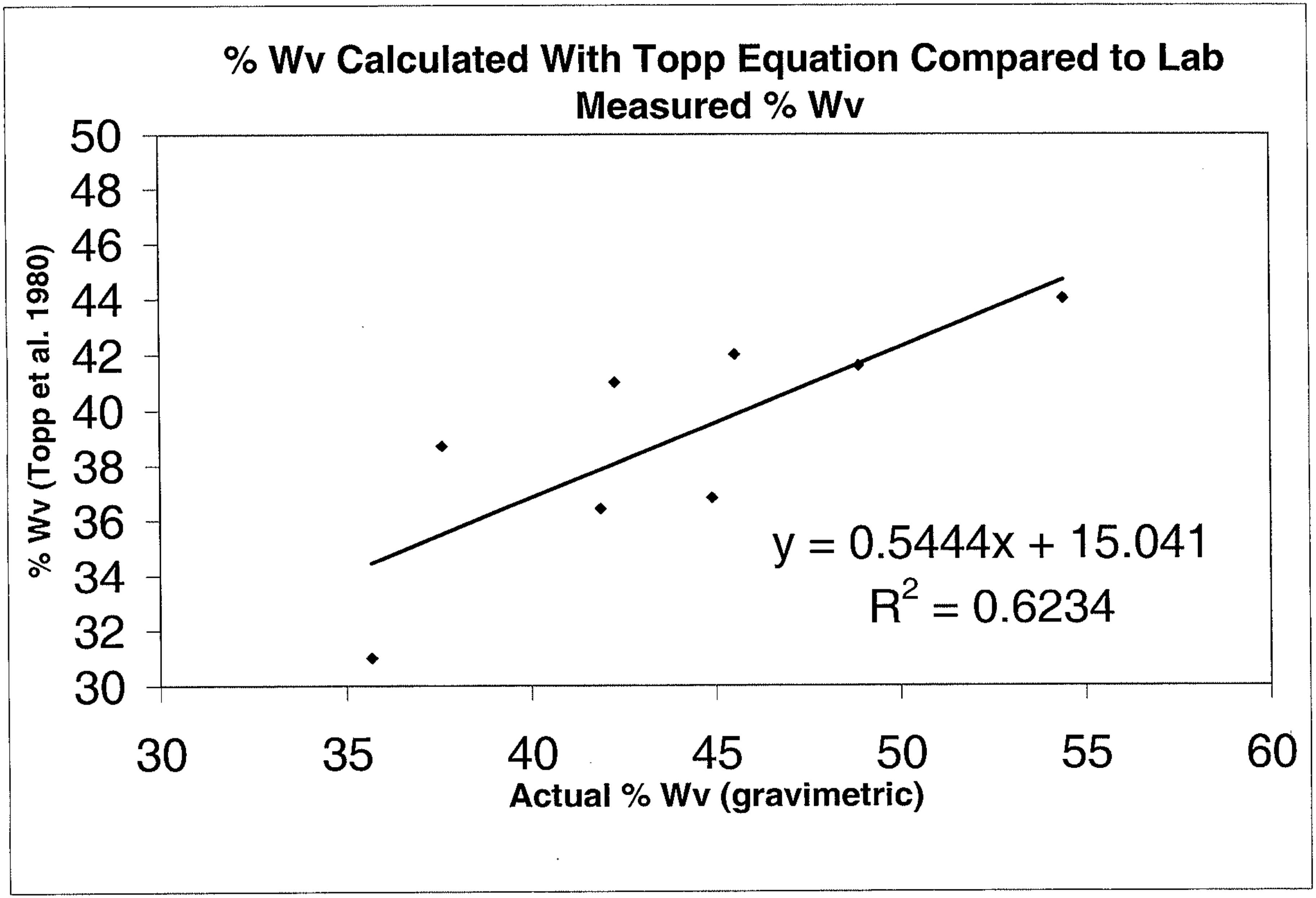
Soil moisture is a key physical characteristic, which governs plant productivity and microbial biochemistry. A standard, non-destructive method of measuring soil moisture in the field is Time Domain Reflectometry (TDR). TDR data are commonly converted to volumetric soil moisture using the Topp equation (Topp *et al.* 1980), which is a generic relationship for a range of soil types. Though the Topp equation is considered fairly accurate, a better estimate of actual soil moisture for a given soil can be achieved by destructive soil sampling and gravimetric measurements of water content in the lab. The goal of this project was to create a new conversion equation for Harvard Forest soils based on paired TDR readings and gravimetrically determined soil water content. Samples were gathered on six different plots at Harvard Forest. The volumetric water of the samples varied directly with the soil moisture measurements calculated with the Topp equation and had a regression line with a r^2 of 0.6234 (Fig. 1). By applying regressions to the graphs that compare volumetric water content obtained from averaged gravimetric measurements to water content measured by TDR, a new empirical function for determining soil moisture was obtained. This formula increases measurement accuracy as it yields measurements that varied directly with the lab measured soil moisture readings and exhibits a regression line with a r^2 of 0.7094 (Fig. 2). Though actual collection of soil samples to determine soil moisture is the most accurate method for determining soil moisture, this destructive process cannot be done for long-term monitoring on a site. The use of TDR in conjunction with a locally calibrated conversion equation is the optimal method for monitoring soil moisture.

Topp, G. C., Davis, J. L. and Annan, A. P. 1980. Electromagenetic determination of soil water content: measurements in coaxial transmission lines. Water Resources Research 16: 574-582.

Carbon Sequestration in Live Trees: a Methods Analysis of Dendrometry in Harvard Forest

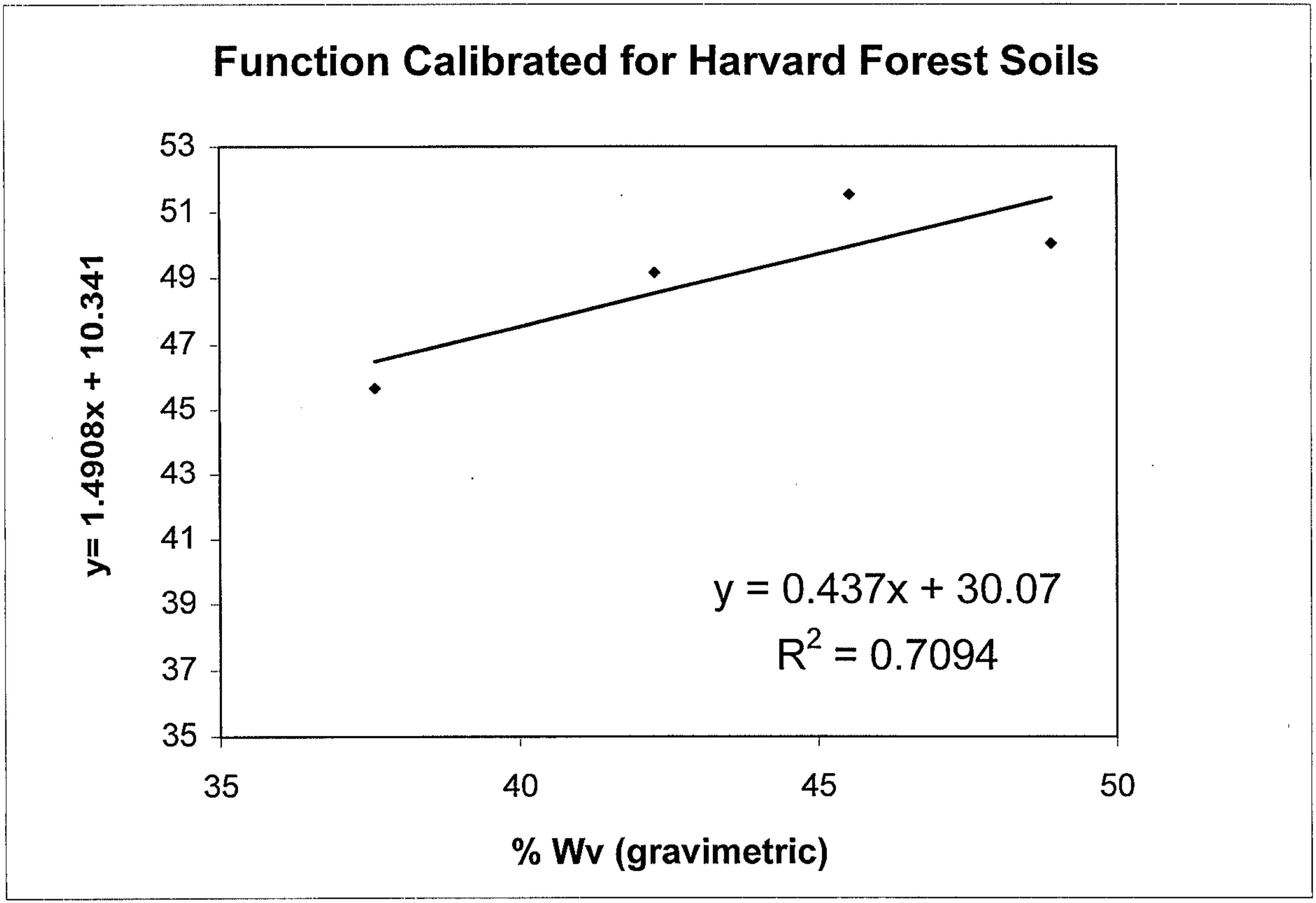
Shane Heath

An independent estimate of the carbon gained in live trees is an important component towards understanding carbon balance for forested ecosystems. The use of dendrometry, in conjunction with species-specific allometric equations, is an established method for determining aboveground woody increment in live trees. Within the fetch of the EMS tower on Prospect Hill, approximately 826 trees (> 10 cm DBH) have been fitted with dendrometer bands since April 1998. Weekly measurements taken during the past 3 growing seasons (1998-2000) have been used to determine live tree carbon sequestration



Frizzell

FIGURE 1



Frizzell

FIGURE 2

in these plots. The current study aims to evaluate the effectiveness of dendrometry with regards to 1) sampling uncertainty; 2) methods bias (spring age and dynamics); 3) site characteristics.

Analysis of the sample size indicates that 800+ trees is more than adequate to produce statistically significant results (95% confidence interval). To examine the effects of spring age on weekly increment readings, a randomly chosen subset of 152 trees was fitted with a second dendrometer band in March 2000. The preliminary results suggest that new bands (1^{st} year) considerably underestimate wood increment by a factor of ~2 relative to the 3-year-old bands. This "under-measurement" factor varied significantly among different tree species but was independent of tree diameter. Red oak, the fastest growing species, had the greatest mean underestimate per stem (kg C), but when the data was normalized by the overall biomass (kg C per kg C gained), red maple and hemlock were the most underestimated (Fig. 1).

Dendrometry is a viable method for determining aboveground wood increment of live trees. In the 2000 growing season to date (through August 8^{th}), the net carbon uptake by live trees, calculated by this method, is approximately 1.32 metric tons C per hectare (Fig. 2). This value is comparable to those calculated in 1998 and 1999 (Barford *et al.*, 2000).

Barford, C., E. Pyle, L. Hutyra, D. Patterson, J. Munger, S. Wofsy. 2000. Net Ecosystem Exchange of CO_2 and Carbon Cycling by the Harvard Forest . **In**: J. Pallant and D. Recos-Smith (Eds.) Abstracts from the 11^{th} Annual Harvard Ecology Symposium, 3 April 2000. P. 20.

Variation in Charcoal Production Among Different Vegetation Types

Matthew L. Kirwan

Charcoal preserved in lake sediments is commonly used as a proxy for evaluating historical fire activity. It is difficult, however, to compare absolute values of charcoal between lakes. Charcoal diagrams from Fresh Pond and Deep Pond (Cape Cod, MA) show similar patterns of fire activity, but Fresh Pond has nearly twice the total charcoal of Deep Pond. Pollen from Fresh Pond is dominated by pine, whereas Deep Pond is dominated by oak. In an attempt to address the difference in charcoal abundance between lakes, this paper explores the relationship between vegetation type and charcoal production. Leaf litter of six species was collected for burning: *Pinus rigida, Tsuga canadensis, Quercus coccinea, Acer rubrum, Fagus grandifolia*, and a grass *Agropyron repens*. The samples were subjected to burning in a muffle furnace and in a prescribed burn. All samples were converted to pure charcoal in the muffle furnace and produced similar amounts of charcoal. Samples in the prescribed burn were converted to a mixture of charcoal, ash and unburned material. Charcoal abundances are shown in Figure 1. Macroscopic charcoal was most abundant in the samples that burned incompletely, *A. repens* and *A. rubrum*. Charcoal abundance was lowest in the samples that burned to near completion, *Q. coccinea* and *P. rigida*. *P. rigida* produced more charcoal than did *Q. coccinea*, making vegetation type a possible explanation for the higher charcoal values in Fresh Pond.

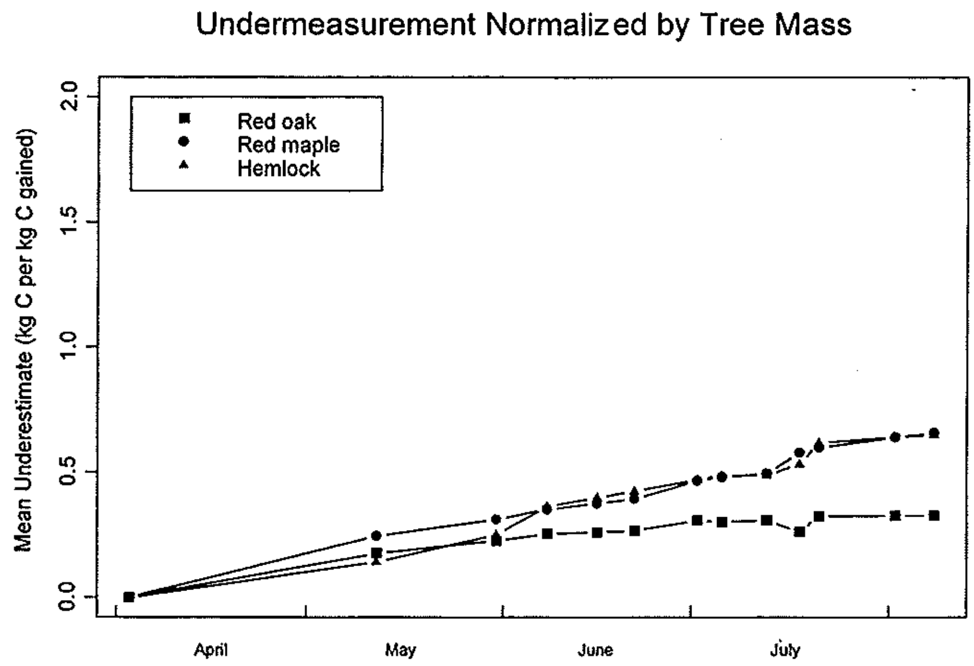


Figure 1. Mean underestimation (kg C per C gained) of tree growth for the 3 dominant tree species in the study area as determined through the double band experiment. Data is for the 2000 growing season (through Aug. 8th).

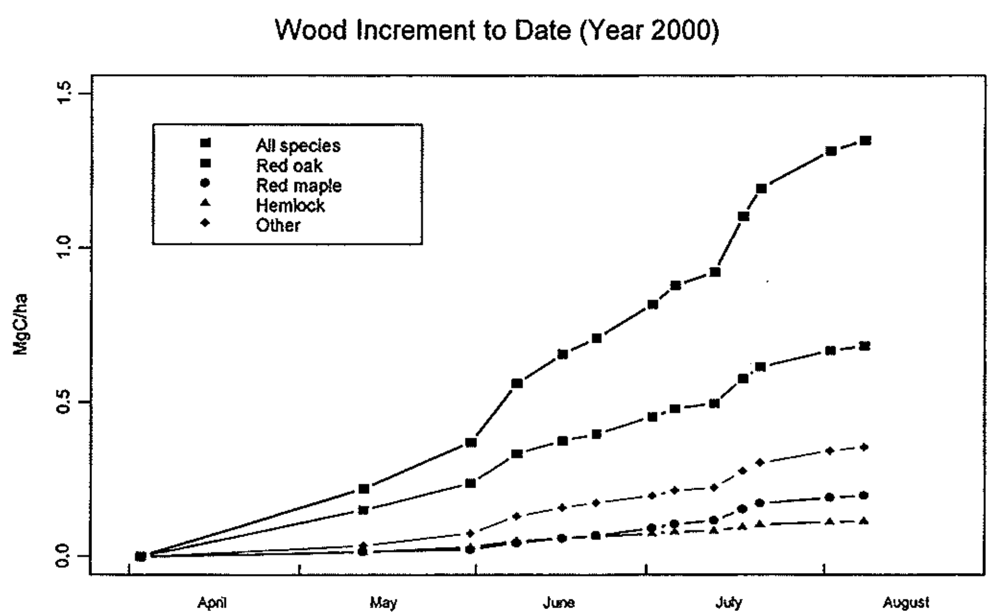
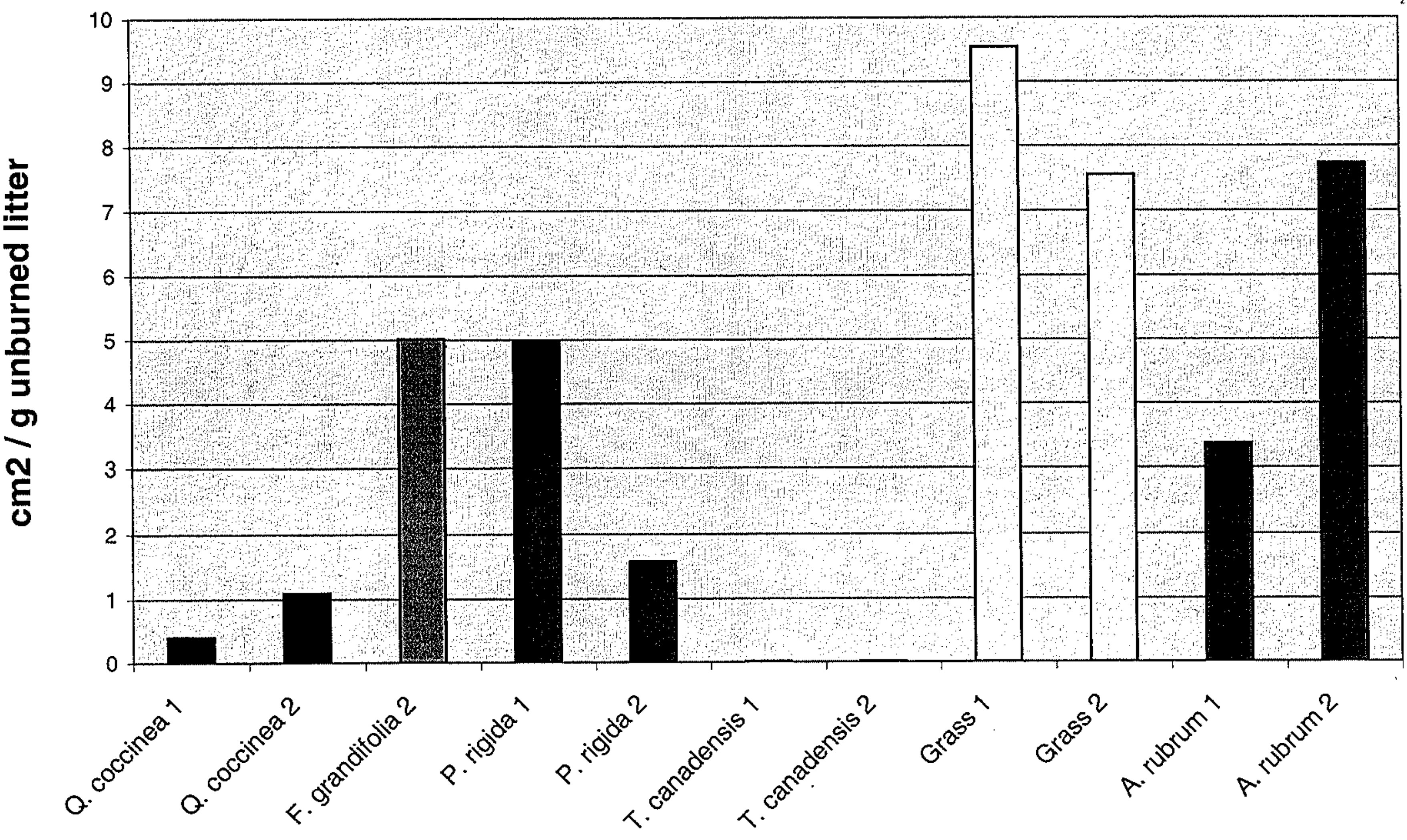


Figure 2. Above ground wood increment of live trees (Mg C/ ha) broken down by dominant species for the 2000 growing season (through August 8th). Total site growth through this date is ~1.32 Mg C/ ha.

Heath

Charcoal Production Open Burn



Regeneration Ten Years after a Simulated Hurricane

Sarah Martell

Every 100 to 150 years, severe hurricanes blow through central New England, yet past studies show us little about regeneration in hardwood forests. The objective of this study was to document sapling and sprout regeneration ten years after the effects of a severe hurricane were simulated in a red oak - red maple (*Quercus rubra - Acer rubrum*) forest. All new stems ≥ 5cm dbh in the 0.8 ha experimental site and 0.6 ha control were measured. Data recorded included regeneration mechanism (saplings, trunk sprouts, and basal sprouts), species, and location.

The number of new stems per hectare was greater in the simulation than in the control: 630 vs. 27. Species richness in the simulation (18 species) was three times that of the control (5 species; Fig. 1). Regeneration in the simulation was dominated by black birch (*Betula lenta*), with only one red oak. The importance of sprouts (58 stems) in the simulation was less than that of saplings (446 stems). The greatest number of stems was found in the center of the site with fewer to the North and South, which is a possible result of edge effect. The presence of sprouts, although less important than expected, differs from regeneration mechanisms of the non-sprouting conifer forests that dominated the landscape at the time of the 1938 hurricane. Stem density has recovered to pre-simulation levels, but the species composition has shifted in the simulation from red oak – red maple to a black birch - red maple forest.

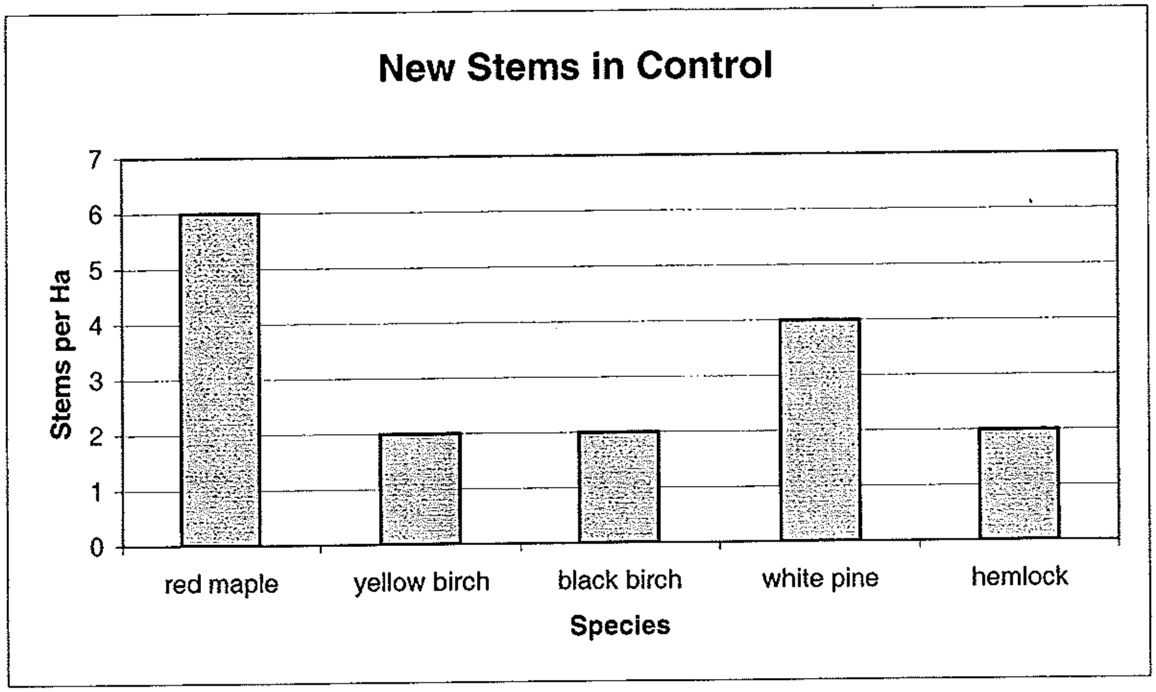
Historical Woodland Cover in Southeastern Massachusetts: a Spatial Analysis of Factors Controlling Woodland Distribution

Erin McCarty

An understanding of the modern landscape requires not only detailed information on the composition, structure and dynamics of the land today, but also information about long-term history. In the current study, we investigated spatial patterns of forest cover in 1830 in a 17 town area in Southeastern Massachusetts to address the following questions:

1) What was the total forest cover and how fragmented were forests in 1830?
2) Was there a relationship between elevation, surficial geology, or slope and 1830 forest cover?
3) How does the distribution of historical woodlands compare with modern forest cover?

Using a zoom transfer scope, 1830 maps were traced onto modern USGS topographic maps. This information was then digitized to into four data layers: Landcover, Roads, Boundaries, and Buildings (including other cultural features). Forest cover in 1830 occupied 29% of the study area and the average polygon size was 176 acres. In contrast, modern forests cover 45% of the landscape with an average polygon size of 39 acres. Although most of the study area occurs below a 20-meter elevation, a disproportionate amount of the higher elevation remained wooded in 1830. In 1830 there was a positive correlation between coarse textured deposits and forest cover. The amount of forest cover on fine-textured deposits varied substantially. There was no correlation shown between slope and forest cover as 96% of the land had a slope of ≤ 5%. The increase in forest cover with elevation supports the idea that higher land was preferentially wooded because of its inconvenience for agriculture. Coarse textured deposits may also have been used as wood lots as they were unsuitable for intensive agriculture. Modern



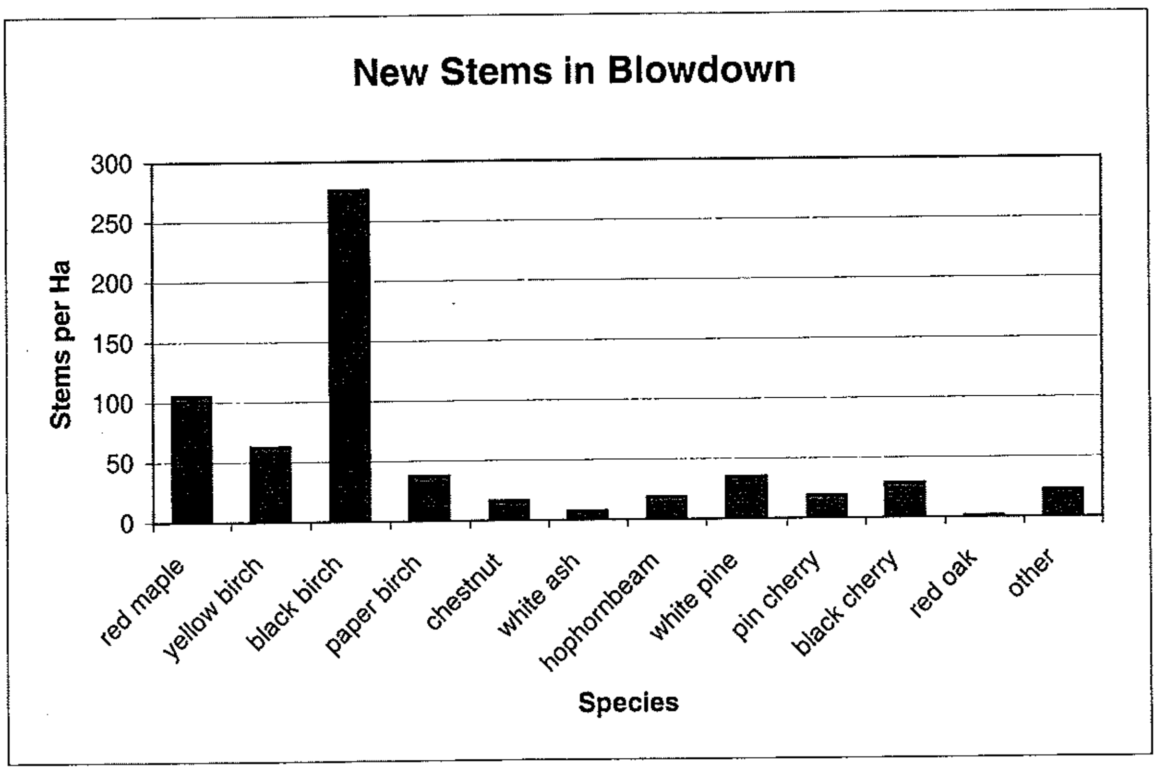


Figure 1. Species composition in the simulated hurricane blowdown at Harvard Forest, Summer 2000.

Martel

vegetation is likely to differ on primary vs. secondary woodlands and an understanding of these relationships will help guide conservation.

Historical Biomass Accumulation in an Old Growth Hemlock Forest

Nicole V. Smith

Questions regarding forest biomass accumulation have become increasingly important as the global carbon cycle is examined. Increment cores provide a means to measure historical carbon sequestration of above ground woody biomass. This study estimates annual above ground carbon storage and changes in carbon storage of an old growth hemlock stand in the Harvard Forest, Petersham, MA. I measured annual growth rings of 138 trees in 21 plots and used published regression equations to calculate annual biomass increases from ring widths. These annual increases were summed per plot, and used to estimate Mg carbon fixed/ha/yr.

The Harvard Forest hemlock stand fixed an average of 1.2 ± 0.3 Mg C/ha/yr since 1990. In 1998 and 1999 above ground carbon storage was 1.2 ± 0.34 and 1.1 ± .27 Mg C respectively. These results are comparable to those reported by Barford *et al.* (2000) for the same years, although it appears there are differences in the levels of response to growing conditions between the sites. Peak carbon storage for this stand (after 1900) occurred between 1960 and 1970 (7 Mg C/ha/decade in the 1960s), and has steadily declined since (5.3 Mg C/ha/decade in the 1990s). There are also marked differences between biomass addition per unit basal area between species (Fig. 1), which may have implications for future carbon storage considering the possibility of hemlock woolly adelgid caused tree mortality.

Using increment cores to estimate carbon storage may be useful in long-term ecological research as tree rings preserve the growth records of stands over a relatively long period of time (Fig. 2). It could be particularly beneficial in the climate change debate as growth records span current through pre-industrial revolution conditions – perhaps giving many clues to changes in long term forest carbon storage due to climate change.

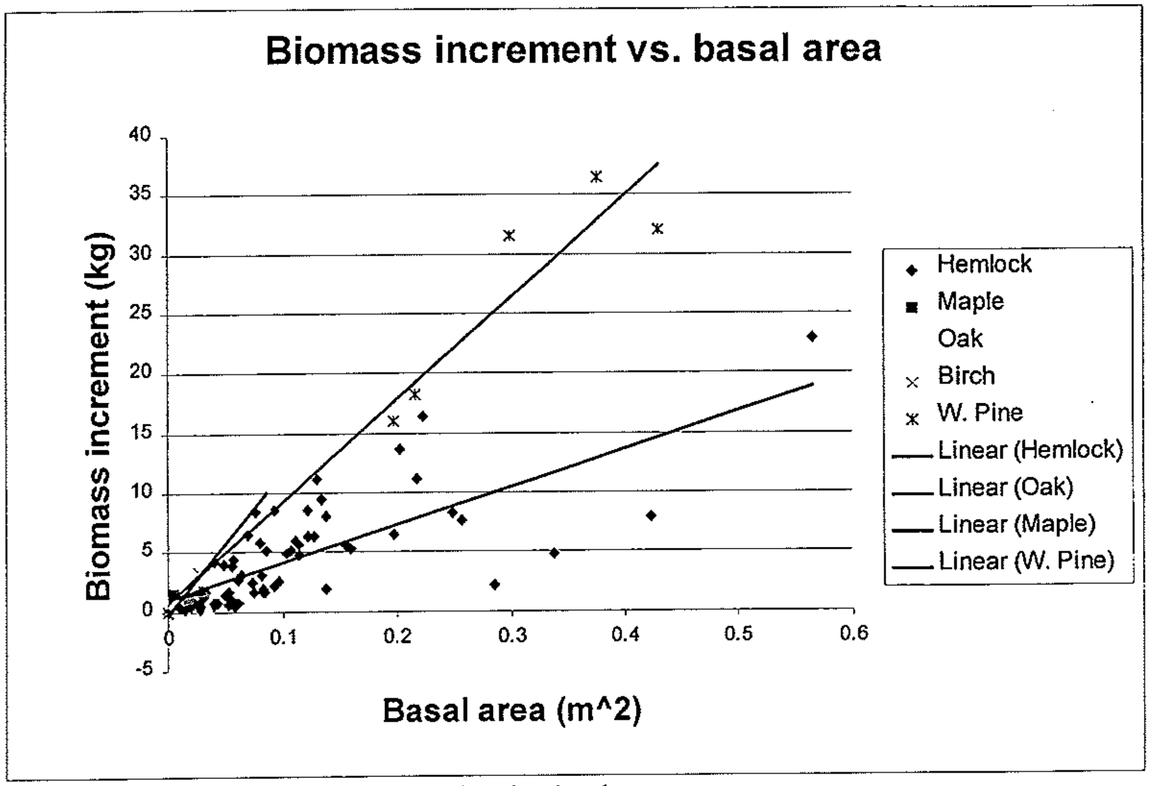
Barford, C., E. Pyle, L. Hutyra, D. Patterson, J. Munger, S. Wofsy. 2000. Net Ecosystem Exchange of CO_2 and Carbon Cycling by the Harvard Forest. **In**: J. Pallant and D. Recos-Smith (Eds.) Abstracts from the 11th Annual Harvard Ecology Symposium, 3 April 2000. P. 20.

Depletion of a Labile Carbon Pool Comparing and Contrasting the Ninth and Tenth Year Results of the Soil Warming Experiment

Samuel M. Stratton

The soil warming experiment was established on July 1st, 1991 to investigate the effects of a predicted increase in temperature due to global climate change on soil processes. Eighteen experimental plots were randomly assigned to one of three treatments. The treatments are Heating (H)—soil temperatures increased to 5° C above ambient soil temperature, Disturbance Control (DC)—same treatment as H plots, but receiving no heating, and Control (C)—no manipulation. Net N mineralization, soil respiration, and

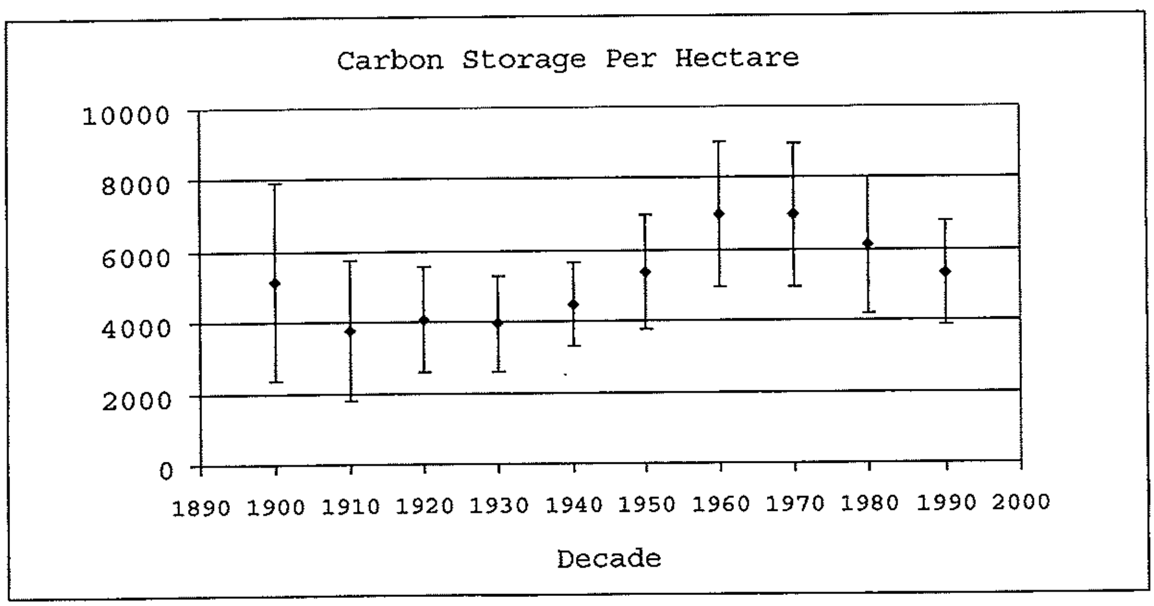
Figure 1



Annual biomass addition by species plotted against basal area.

Figure 2

Decadal carbon storage per hectare measured in kg C.



Smith

soil water NH4 and NO3 have been examined throughout the past 10 years. The CO_2 flux results from 1991-1998 demonstrate a relative difference between H and DC plots. Annual CO_2 fluxes from the H plots were about 20% greater than those from the DC plots through the peak in 1995, decreasing to a difference of about a 10% greater flux from H plots in 1998. In 1999 the difference in CO_2 fluxes from H and DC plots was approximately 0. We hypothesize that the lack of difference between fluxes from the H and DC plots resulted from the depletion of a labile pool of carbon made available to microbes for metabolization by the 5° C increase in soil temperature. However, warm temperatures and very low soil moisture were important and potentially confounding factors in 1999. The 2000 H vs. DC flux data to date was used in comparison with the 1999 data to investigate if the zero-difference trend continued. Thus far the difference in fluxes from H and DC plots is approximately 0 while 2000 has been more than 30% wetter and about 20% cooler than 1999. Our results from 2000, exhibiting similar rates of CO_2 efflux from H and DC plots at the soil warming experiment, after many years of elevated fluxes from the H plots, support the theory that a finite pool of C stored in the soil became available to microbes for metabolization with a 5° C increase in temperature, and that it is now depleted.

Applying Historical Ecology to Conservation: A GIS Approach

Mindy Syfert

The relationship between conservation and historical ecology was studied in 17 towns in southeastern Massachusetts. Past studies have shown differences in modern forest composition between primary and secondary forests, which indicates that history may have persistent influence on present forest composition and dynamics. Land cover maps from the 1830s series in Massachusetts were compared to modern land use data, as well as data on conservation lands and rare species habitat. Our results indicate that current conservation lands incorporate a mixture of primary and secondary woodlands. A relatively significant number of 27% of rare species habitats exist in areas forested in the 1830s. Several of these areas are unprotected and adjacent to existing large protected lands. This suggests that these areas might be priorities for future conservation. This study demonstrates that an understanding of the history of the landscape may be critical to understanding the modern landscape and guiding conservation efforts.

The Effects of Hemlock Woolly Adelgid Infestations on Avian Community Composition and Dynamics

Morgan W. Tingley

With the anticipated elimination of the eastern hemlock *(Tsuga canadensis)* due to infestations of hemlock woolly adelgid (HWA, *Adelges tsugae)*, there is concern about how this major forest structural change will affect wildlife — specifically avifauna. In this project, I conducted bird surveys in 10 hemlock stands in central Connecticut during June and July, 2000. The stands, part of Harvard Forest's (D. Orwig) long-term study on HWA, were all more than 64% hemlock by stem density. Standard point counts of bird vocalizations and sightings were conducted within a 50 m radius lasting 10 minutes. Species counts and diversity calculations showed increased diversity in areas of higher hemlock mortality. However, total density (individuals per ha) dropped by 30.4% from areas of low to high hemlock mortality. Some avian species increased in density while other decreased as hemlock mortality increased

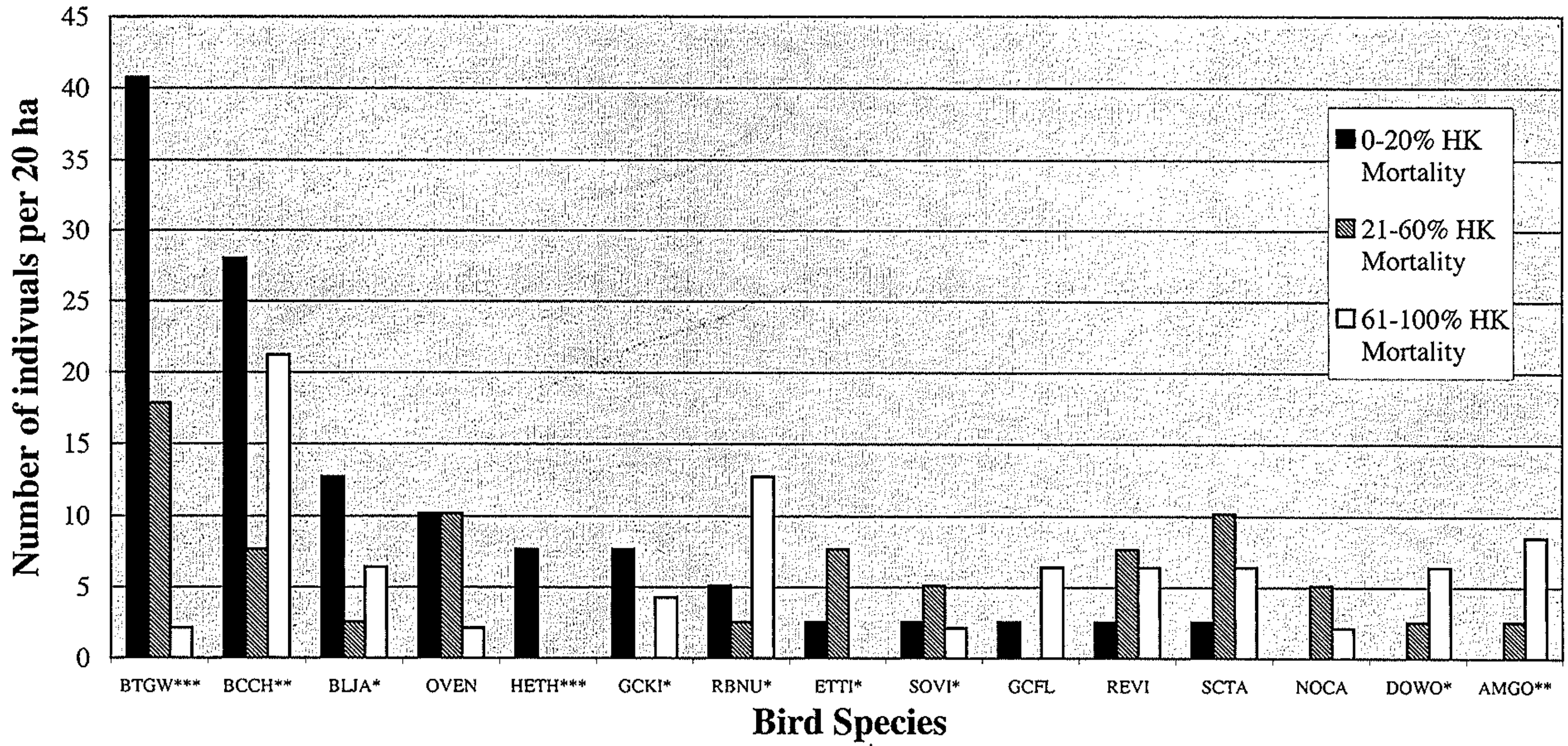
(Fig. 1). Species negatively affected included thrushes and insect gleaners, with the black-throated green warbler *(Dendroica virens)* showing the most significant change (95% decline) with increased hemlock mortality. Species positively affected by hemlock mortality included woodpeckers and edge-associated species. My data indicated that some species are more adaptable to hemlock decline than others, with the black-throated green warbler appearing as one of the least adaptable. Ultimate effects on bird populations will be determined by adaptability of species to the new growth of deciduous hardwoods. These findings may lead to a long-term study of avian community response to structural change from catastrophic infestation in the forest ecosystem.

Composition, Structure, and Dynamics of Hemlock Stands with Various Levels of Hemlock Woolly Adelgid Infestation in Connecticut

Aaron R. Weiskittel

Understanding the characteristics of stands infested with hemlock woollyadelgid (HWA, *Adelges tsugae*) is a critical step in identifying and comprehending the influence this introduced insect will have on ecosystem processes and landscape dynamics. Stand characteristics were examined by establishing three 400 m^2 sample plots within eight recently infested *Tsuga canadensis* (eastern hemlock) stands greater than three ha in size. Stand location ranged from a northwest facing bottomland to a northeast ridgetop. Within these plots, species, dbh, crown class, and vigor were recorded for all trees greater than 10 cm dbh. Increment cores were taken from 24 randomly selected trees in each stand. For each core, age and annual growth was determined. Age ranged from 81 to 116 years, with total basal area between 39 and 62 m^2/ha for all sites (Table 1). Overstory hemlock mortality was between 0 and 7%, with the overtopped crown classes having the highest mortality. All crown classes showed signs of being affected by HWA. The average hemlock trees in sites with high mortality have lost 50 to 75% of their foliage, while the hemlock trees in sites with moderate mortality have lost on average 25 to 50% of their foliage. From 1992 to 1998, hemlock growth on the most damaged sites has decreased over fourteen percent annually. Also between 1996 and 1998, hemlock growth on sites with low mortality decreased nearly 20% annually. Some hardwoods showed signs of release; however, this was not the general trend. *Betula lenta* (black birch) and *Acer rubrum* (red maple) were the primary species regenerating in these stands and will most likely replace the hemlocks. Thus, these hemlock stands show no signs of recovery and will continue to slowly deteriorate, which will significantly alter microenvironment conditions, nutrient-cycling, and decomposition rates of these ecosystems.

Fig. 1: Average Species Density at Different Levels of Hemlock Mortality



Chi-sqiare analysis: * = .05 > p > .01 ** = .01 > p > .001 * = .001 > p**

Bird codes are BTGW, Black-throated Green Warbler; BCCH, Black-capped Chickadee; BLJA, Blue Jay; OVEN, Ovenbird; HETH, Hermit Thrush; GCKI, Golden-crowned Kinglet; RBNU, Red-breasted Nuthatch; ETTI, Tufted Titmouse; SOVI, Blue-headed Vireo; GCFL, Great-crested Flycatcher; REVI, Red-eyed Vireo; SCTA, Scarlet Tanager; NOCA, Northern Cardinal; DOWO, Downy Woodpecker; and AMGO, American Goldfinch.

Table 1. Overstory composition and stand characteristics in central Connecticut hemlock study sites with various levels of HWA infestation.

	Ash Brook	**Crooked Road**	**Devil's Hopyard**	**Higby Mountain**	**Lievre Brook**	**Salmon River**	**Sunrise Resort**	**Willingto n Hill**
Elevation (m)	137	259	76	244	137	50	15	190
Aspect(s)	SE	NE – NW	SW – NW	NE	NW	NW – NE	SW	NE
Slope (%)	10 – 27	15 – 26	25 - 28	22 – 24	15 – 34	3 – 5	75	10
Mean age ± SE	82 ± 6	-	115 ± 9	116 ± 11	81 ± 5	75 ± 8	98 ± 6	99 ± 4
Hemlock importance value	89	78	77	69	82	74	80	80
Average crown vigor	3.3	1.1	2.6	4.3	3.1	1.6	4.2	3.1
% overstory hemlock mortality	2	1	3	4	3	0	7	0
Dead hemlock trees (#/ha)	13	10	5	18	6	4	18	15
Stand density (#/ha)	742	883	500	1167	625	767	1017	717
Basal area of dead hemlocks (m^2/ha)	5	1	19	3	2	<1	5	3
Stand basal area (m^2/ha)	62	61	57	50	48	39	56	57
Dead hemlock saplings (#/ha)	75	42	16	58	58	-	133	8

Weiskittel

2000 Student Summer Program Seminars and Workshops

DATE	PROGRAM	SPEAKER
Wednesday, June 7	Seminar 1: Effect of human and natural disturbances on forest ecosystems	David Foster
Tuesday, June 13	Seminar 2: The Global Carbon Cycle and Harvard Forest: Why we are special	Eric Davidson
Thursday, June 15	Seminar 3: Forest Management Techniques: Beyond Clear Cutting	Jack Edwards
Tuesday, June 20	Workshop 1: Tree and Plant Identification	John O'Keefe and Glenn Motzkin
Thursday, June 22	Seminar 4: What spacial patterns should ecologists be studying so nature has a better chance?	Richard Foreman
Tuesday, June 27	Workshop 2: Ethics in Science: Animal research, authorship, falsifying data	Cathy Langtimm, John O'Keefe
Thursday, June 29	Seminar 5: Private landowners in the forest ecosystem: the biggest missing puzzle piece	David Kittredge
Tuesday, July 4	Vacation	XXXXXXXXXXXXXXX
Wednesday, July 5 to Friday, July 7	Switch Days	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX
Monday, July 10 to Tuesday, July 11	Institute of Ecosystem Studies, Millbrook, N.Y.	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX
Thursday, July 13	Seminar 6: Long-term eddy flux measurements for CO2 at Harvard Forest: can ecosystem models survive when you observe each half hour for a decade?	Steve Wofsy
Tuesday, July 18	Seminar 7: Tundras, tropics, and towns: birds and their habitats	Rebecca Field
Thursday, July 20	Seminar 8: Applying to Graduate Schools	Rob Eberhardt, Cassandra Horii, Rebecca Anderson
Tuesday, July 25	Workshop 3: Writing an Abstract	Tim Parshall
Wednesday, July 26	Workshop 4: Structuring a Scientific Presentation	David Orwig
Tuesday, August 1	Seminar 9: How does water get to the tops of trees? Our latest and greatest on xylem transport	Missy Holbrook
Thursday, August 3	Seminar 10: Maintaining and enhancing bio-diversity on Massachusetts' Wildlife Management Areas	Anne Marie Kittredge
Monday, August 7 to Friday, August 11	Prepare for Student Symposium; Ecological Society of America Symposium in Utah	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX
Wednesday, August 16	Student Symposium	Abstracts Due at 9 AM
Friday, August 18	Final Day of Program	XXXXXXXXXXXXXXX

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HARVARD FOREST SUMMER PROGRAM 2000

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Andrew Finley

Tim Parshall - Harvard University
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Sarah Martell

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Paul Steudler and Heidi Lux - Marine Biological Laboratories
Samuel Stratton

Eric Davidson and Kathleen Savage - Woods Hole Research Center
Catherine Angeloni

Michelle Holbrook - Harvard University
Shelly DuPlessis

Robin Siewers (Proctor)

The Institute of Ecosystem Studies presents

A FORUM ON OPPORTUNITIES IN ECOLOGY

Tuesday, July 11, 2000
9:30 a.m. - 3:30 p.m.
at the IES Auditorium

This forum provides undergraduate and graduate students the opportunity to hear firsthand about a wide range of career paths in ecology, including:

- Academia
- Media
- Education
- Consulting
- Applied Ecology
- Industry
- Conservation
- Government
- Research
- Museums
- Activism
- Environmental Law

In the morning session (9:30 a.m. - 12:30 p.m.), speakers representing each field will discuss the rewards and motivations involved in their work.

In the afternoon session (1:30 p.m. - 3:30 p.m.), speakers will join small groups for informal discussions about issues of concern to the student participants.

The forum is open to all students at no charge. Interested individuals should register for the program by calling Susan Eberth (914) 677-7640. Since space in the afternoon session is limited, you are encouraged to register soon.

There will be a break from 12:30 p.m. -1:30 p.m.: please bring your own lunch and beverage.

Institute of Ecosystem Studies
Route 44A
Millbrook, New York

PERSONNEL AT HARVARD FOREST 1999-2000

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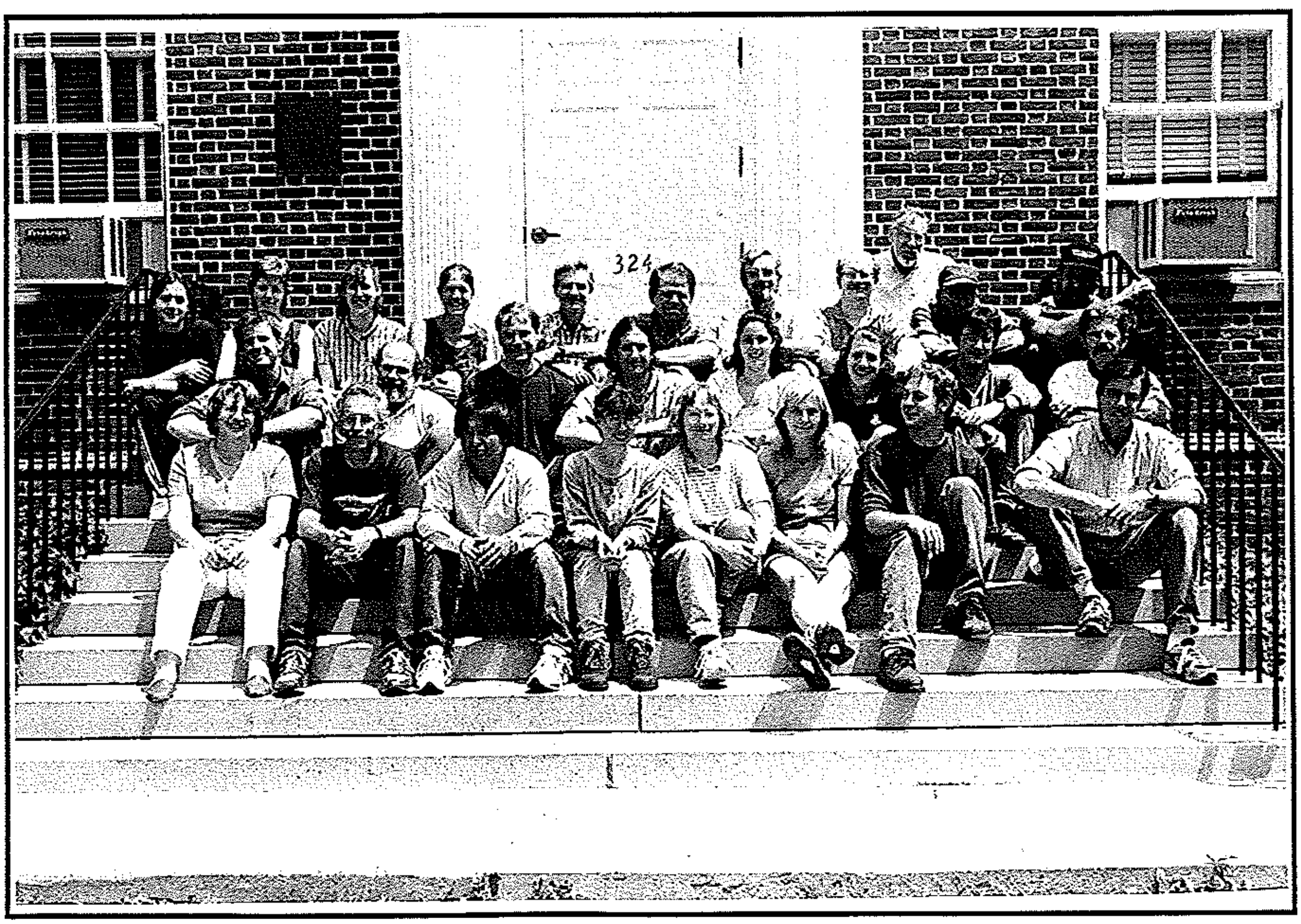
Dorothy Recos-Smith	Staff Assistant
Emily Russell	Visiting Scholar
Stephen Scheckler	Bullard Fellow
Robin Sievers	Summer Program Assistant
Ben Slater	Research Assistant
Charles Spooner	Woods Crew
Mindy Syfert	Research Assistant
P. Barry Tomlinson	E.C. Jeffrey Professor of Biology
Claire Williams	Bullard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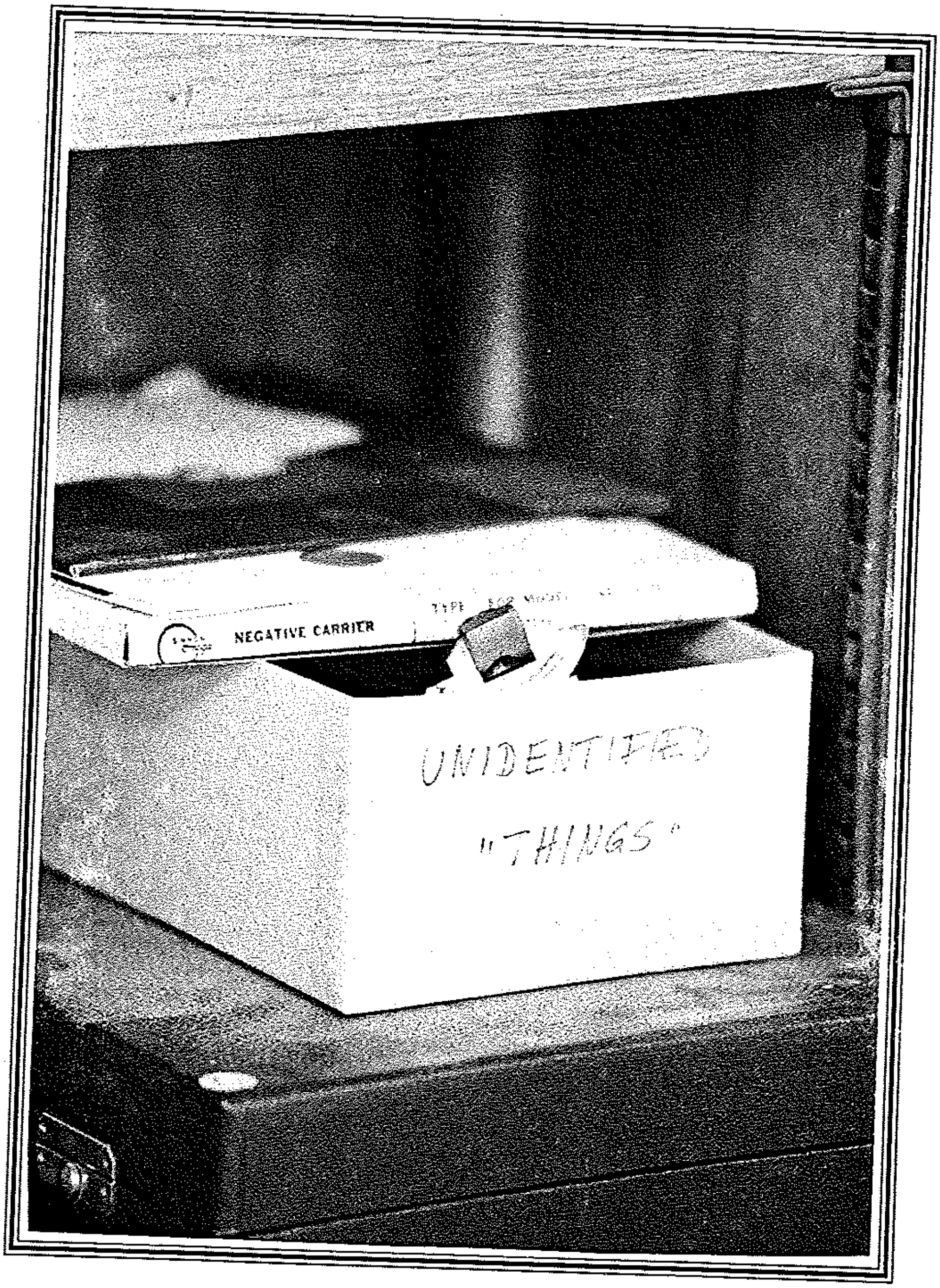
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