

HARVARD FOREST
SUMMER RESEARCH PROGRAM



*Abstracts from the 16th Annual
Harvard Forest Summer Research Program
14 August 2008*

SIXTEENTH ANNUAL HARVARD FOREST SUMMER RESEARCH PROGRAM

14 August 2008

HARVARD FOREST FISHER MUSEUM

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*Photography by Suzanne Whitney, Harvard Forest Staff and
2008 Summer Program Participants*

INTRODUCTION TO THE HARVARD FOREST

Since its establishment in 1907, the Harvard Forest has served as Harvard University's rural laboratory and classroom for research and education in forest biology and ecology. Through the years, researchers have focused on forest management, soils and the development of forest site concepts, the biology of temperate and tropical trees, plant ecology, forest economics, landscape history, conservation biology, and ecosystem dynamics. Today, this legacy of activities is continued as faculty, staff, and students seek to understand historical and modern changes in the forests of New England and beyond resulting from human and natural disturbance processes, and to apply this information to the conservation, management, and appreciation of natural ecosystems. This activity is epitomized by the Harvard Forest Long Term Ecological Research (HF LTER) program, which was established in 1988 through funding by the National Science Foundation (NSF).

Physically, the Harvard Forest is comprised of approximately 3000 acres of land in the north-central Massachusetts town of Petersham. These acres include mixed hardwood and conifer forests, ponds, streams, extensive spruce and maple swamps, fields, and diverse plantations. Additional land holdings include the 25-acre Pisgah Forest in southwestern New Hampshire (located in the 5000-acre Pisgah State Park), a virgin forest of white pine and hemlock that was 300 years old when it blew down in the 1938 Hurricane; the 100-acre Matthews Plantation in Hamilton, Massachusetts, which is largely comprised of plantations and upland forest; and the 90-acre Tall Timbers Forest in Royalston, Massachusetts. In Petersham, a complex of buildings that includes Shaler Hall, the Fisher Museum, and the John G. Torrey Laboratories provide office and experimental space, computer and greenhouse facilities, and lecture room for seminars and conferences. Nine colonial-style houses provide accommodations for staff, visiting researchers, and students. Extensive records, including long-term data sets, historical information, original field notes, maps, photographic collections, and electronic data are maintained in the Harvard Forest Archives.

Administratively, the Harvard Forest is a department of the Faculty of Arts and Sciences (FAS) of Harvard University. Faculty associated with 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 Departments of Biology, Natural Resource Conservation, and Computer Science at the University of Massachusetts, the Ecosystems Center of the Marine Biological Laboratory and the Complex Systems Research Center at the University of New Hampshire.

The staff and visiting faculty of approximately fifty work collaboratively to achieve the research, educational, and management objectives of the Harvard Forest. A management group meets monthly to discuss current activities and to plan future programs. Regular meetings with the HF-LTER science team, weekly research seminars and lab discussions, and an annual ecology symposium provide for an infusion of outside perspectives. The seven-member Facilities Crew undertake forest management and physical plant activities. The Coordinator of the Fisher Museum oversees many educational and outreach programs.

Funding for Harvard Forest operations is derived from endowments, whereas major research support comes primarily from federal and state agencies (e.g., National Science Foundation, Department of Energy, Commonwealth of Massachusetts Department of Conservation and Recreation), private foundations, and individuals.

The Harvard Forest Summer Student Research program, coordinated by Edythe Ellin and assisted by Suzanne Whitney, attracted a diverse group of twenty students to receive training in scientific investigations, and experience in long-term ecological research. All students worked closely with researchers while many conducted their own independent studies. The program included weekly seminars from resident and visiting scientists, discussions on career issues in science, and field exercises on soils, land-use history, and plant identification. Students presented major results of their work at the Annual Summer Student Research Symposium in mid-August.



Summer Research Students 2008

16TH ANNUAL HARVARD FOREST SUMMER RESEARCH PROGRAM SYMPOSIUM

14 AUGUST 2008, FISHER MUSEUM

8:45 a.m. – 5:00 p.m.

8:45 Aaron Ellison Welcome

Session I: Water Dynamics, from Trees to Landscapes (Betsy Colburn, Moderator)

9:00	James Onstad	Harvard University	Giraldo, Huggett & Hobbrook	Hydraulic mechanisms controlling leaf senescence in sugar maple (<i>Acer saccharum</i>) and red oak (<i>Quercus rubra</i>)
9:15	Lee Dietterich	Harvard University	Huggett, Giraldo & Holbrook	Calcium deficiency and whole plant water relations in sugar maple (<i>Acer saccharum</i> Marsh.)
9:30	Israel DeIToro	University of Texas at El Paso	Sobczak	Influence of wetlands on stream chemistry and macroinvertebrate communities along a river continuum
9:45	Mathew Quattrocelli	Tulane University	Colburn & Brooks	Chemical analyses suggests effects of alteration in Massachusetts headwaters
10:00	Christine Urbanowicz	Gettysburg College	Colburn & Brooks	Examining the impacts of past land use on headwater stream morphology
10:15	Jhessye Moore-Thomas	University of Central Florida	Barker-Plotkin & Boose	Investigating water table levels affected by topography and clearcut forest harvest

BREAK

Session II: Unseen Worlds – Microbial & Soil Ecology (Mike Kaspari, Moderator)

10:45	Katherine Farley	Harvard University	Boynton	Dispersal of yeasts in the <i>Sarracenia purpurea</i> metacommunity
11:00	Adrian Mood	Howard University	Warren	Increases in soil salinity as a result of the de-icing of roads with salt
11:15	Charlotte Chang	Pomona College	Kaspari	Soil salinity in a temperate forest ecosystem impacts ant foraging behavior
11:30	Johanna Weaver	Oberlin College	Kaspari	Soil warming and nitrogen additions influence brown food webs.
11:45	Sarah Betzler	Gustavus Adolphus College	Brzostek, Finzi, & Hobbie	Amino acid production and soil nitrogen assessment in an Eastern hemlock forest

LUNCH

Session III: Forest Dynamics (Brian Hall, Moderator)

1:00	Relena Ribbons	Wellesley College	Orwig	Hemlock forest vegetation dynamics: long-term responses to hemlock woolly adelgid
1:15	Cassandra Rivas	University of Texas Pan American	Barker-Plotkin	Forest type transition directly influences the seed bank
1:30	Samantha Hilerio	Worcester Polytechnic Institute	Ellison & Hart	Canopy type affects habitat preference in web-building and hunting spiders
1:45	Alyssa Hernandez	Cornell University	Ellison	Forest canopy loss affects competition dynamics of carabid beetles (Carabidae)
2:00	Amy Mays	Mount Holyoke College	Stinson	Is glossy buckthorn (<i>Frangula alnus</i>) allelopathic to native New England wetland margin vegetation?
2:15	Joy Cookingham	University of Massachusetts	Hall & Foster	Environmental and historical variables controlling community composition in Southern New Hampshire Blue Hills
2:30	Jonathan Cale	Paul Smith's College	Hall & Foster	A look ahead: projections for the future composition of the Blue Hills Foundation forests

BREAK

Session IV: Community Interactions, Ecological & Social (Primrose Boynton, Moderator)

3:15	Katie Bennett	Teacher, Ashburnham-Westminster Reg. School District	Ellison	Red-green patterns of <i>Sarracenia purpurea</i> as an attractant to ants
3:30	Jonathan Mejia	University of Vermont	Ellison	Measuring niche overlap between spiders and the Northern pitcher plant (<i>Sarracenia purpurea</i>) in Tom Swamp
3:45	Erin Schaeffer	Mount Holyoke College	Record	Linking the past to the present: beaver provide suitable wetland habitat for rare plant swamp lousewort in Central Massachusetts
4:00	Anastasia Yarbrough	University of Vermont	Warren	Which landscape variables are suitable predictors for presence of cavity-nesting birds in human-occupied landscapes?
4:15	Angelica ErazoOliveras	University of Puerto Rico	Kittredge & Rickenbach	It's the network: how personal connections shape decisions about private forest use
4:30	Emma Snellings	Gettysburg College	Kittredge & Rickenbach	Private land, public landscape: how social networks affect landowners' decisions
4:45	Aaron Ellison			The Tick Talk, and Closing Remarks
5:30			BARBEQUE	

Red Green Patterns of *Sarracenia purpurea* as an Attractant to Ants

Katie Bennett

The red and green color patterns of *Sarracenia purpurea* were analyzed to determine the possible correlation between the amount of red-green patterning on the pitcher and the capture of ants as prey. Some ants have been determined to have dichromatic vision, having receptors for UV and green wavelengths, suggesting that ants may be attracted not only by the nectar of *Sarracenia purpurea* but also by the degree of red-green patterning on the pitcher. The contents of one pitcher from each of twenty five pitcher plants with a range of patterns from very little red coloring to a high percentage of red were examined for prey capture on three occasions. The pitchers were then harvested and analyzed with a spectrometer to determine spectral reflectance patterns. The pitchers were then analyzed to determine the ratio of red coloring to green and the total perimeter of red patterns on each pitcher. Pitcher plant mimics (vials painted green with red patterns) were set out as pit traps. These were painted with varying degrees of patterning from 5% to 80% red. Half were treated with a sugar attractant, half remained untreated. Capture was examined.

Data continue to be analyzed. Early data show an increase in the capture of treated mimics from mostly red to mostly green. Untreated mimics, however, had a decrease from mostly red to mostly green. Observations of the mimics in the field suggest that the attractant is more of a factor in ant capture than the patterns. The patterns may be more of a factor in the attraction of flying prey and pollinators. Further trials are planned.



Amino Acid Production and Soil Nitrogen Assessment in an Eastern Hemlock Forest

Sarah Betzler

This project involved measuring the effects of temperature and protein substrate availability on the production of amino acids (proteolysis) in Eastern hemlock dominated soils. In addition, three assays for measuring inorganic and amino acid nitrogen (N) availability in these soils were compared. Soil and soil solution samples were taken from organic and mineral soil in five different hemlock-dominated plots in the Harvard Forest.

To create a proteolysis activity profile, soils were incubated at five different temperatures with and without added protein; amino acid production was then assayed. Amino acid production was consistently higher in organic soil than in the mineral soil, and increased with temperature in both soil types. The samples with added protein were also uniformly higher in amino acid production than the samples with only ambient protein levels (Figure 1). Although both temperature and substrate availability limited amino acid production, substrate availability had a more pronounced effect.

The concentrations of amino acid N, ammonium and nitrate were assayed using three methods: water extracts, 2M potassium chloride (KCl) extracts, and soil solution collected with tension lysimeters. In all three assays, the organic soils had the highest concentrations of all forms of N. The 2M KCl extracts had an order of magnitude higher concentration of all forms of N than the water extracts and lysimeter samples. Inorganic N concentrations in the lysimeter samples were at or below the detection limit. This suggests that KCl extracts may overestimate the availability of N in forest soils; however, it is also possible that water extracts and lysimeter sampling underestimate N availability.

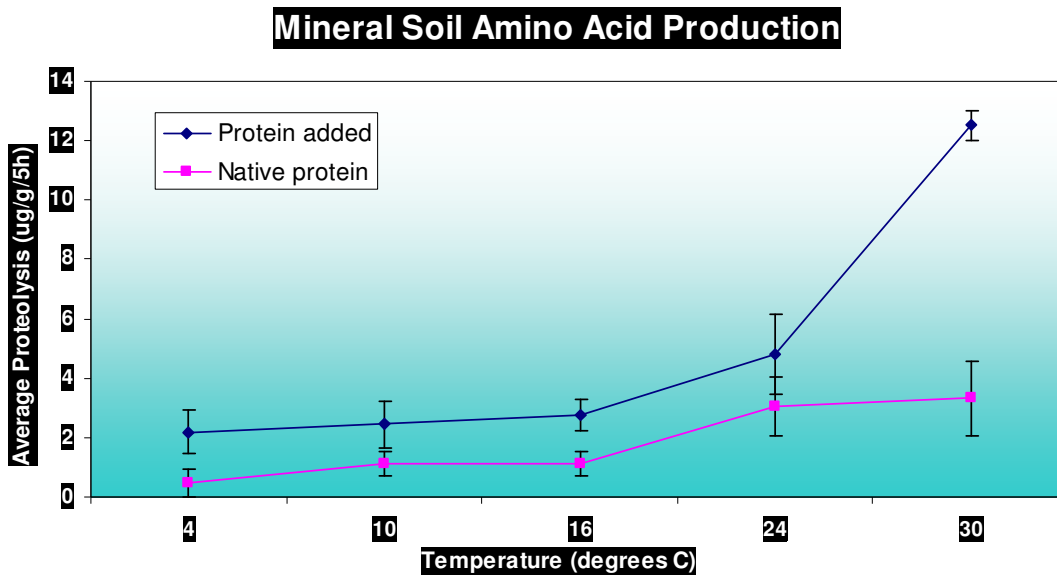


Figure 1.

A Look Ahead: Projections for the Future Composition of the Blue Hills Foundation Forests

Jonathan Cale

The Blue Hills Foundation holdings currently include roughly 5200 acres of land in Strafford, NH. This largely contiguous landscape is a mosaic of open fields, wetlands, and forest cover types, with the latter covering most of the property. In 1998 The Nature Conservancy identified eight forest community types. Among the area surveyed, three cover types were most prevalent, these being: beech-hemlock-oak-pine (BHOP), mixed pine (MP), and beech-hemlock-oak-pine beech-oak variant (BHOP-BO). Projections for the future composition of these cover types was generated using overstory and sapling data collected during the summer 2008 field season. Overstory replacement probabilities were determined by comparing the species and abundance of saplings appearing under each overstory species. Using these with the previously mentioned sapling abundance data, the composition of the overstory for the next generation was calculated. A series of these calculations was done until a stable overstory configuration was visible. Projections for the BHOP forest showed an initially gradual decline in hemlock and beech presence as that of red maple rose steadily over four generations before leveling out. The mixed pine forests showed an initial decline in balsam fir and red maple as white pine rose sharply over three generations before reaching a stable state. Forests designated as BHOP-BO showed a rise in the presence of beech and white pine as hemlock declined over five generations. One would expect the presence of less shade tolerant species to decline as the abundance of shade tolerant species increased. However, these results project the opposite and seem to assume a continuation of current silvicultural regimes.



Soil Salinity in a Temperate Forest Ecosystem Impacts Ant Foraging Behavior

Charlotte Chang

Although sodium is one of the 25 essential elements for life, it is rarely found in nature. Compared to other micronutrients, sodium loss via excretion is more pronounced because animals typically lack sodium reserves. We tested two hypotheses regarding sodium limitation in ants: 1) ants are more sodium-limited farther from an anthropogenic supply of sodium, namely, road-salting, and 2) higher temperatures elevate rates of activity and excretion, precipitating an increase in sodium intake. We studied eight sites distanced 1, 10, 100, and 1000m from Massachusetts Route 32. We collected ants foraging in vials containing one of the following solutions: distilled water, aqueous sodium chloride (0.1, 0.5, or 1.0% w/w), and aqueous sucrose (1.0, 5.0, or 10.0% w/w). As the distance from Rt. 32 increased, ants foraged for more sodium and exhibited greater preference for higher concentrations of sodium ($p < 0.05$). In contrast, ants uniformly selected for higher concentrations of sucrose at all sites. Additionally, the species *Tapinoma sessile* significantly increased its usage of sodium relative to sucrose at sites farther from Rt. 32 ($p < 0.05$), indicating that sodium facilitates sucrose metabolism. Community composition did not obviously shift toward species with higher sodium affinity along the sodium gradient, suggesting that ants selectively forage for sodium, and are thus sodium-limited. There was insufficient evidence to examine if warmer temperatures augment sodium use. Therefore, comparisons between regions with different mean temperatures may yield clearer patterns on the impact of temperature on sodium foraging.



Environmental and Historical Variables Controlling Community Composition in Southern New Hampshire Blue Hills

Joy Cookingham

The forests of New England have developed in response to heterogeneous environmental conditions and a range of historical land use practices. Like much of New England, the forests of Southeastern New Hampshire have experienced intensive agricultural activities and subsequent abandonment in the late 1800s. In Strafford County 3,000 acres of contiguous conservation land was surveyed to research the influence of historical and environmental variables on the community composition. Historical land use variables examined include cultivation, pasture, and continuous woodlot. Modern land management practices examined include timber logging and timber stand improvement. Environmental variables examined were soil drainage, organic layer depth, slope, aspect, solar radiation, rock cover, and surficial geology. Bray-Curtis ordinations were used to indicate plant communities and key variables influencing observed patterns. Three dominant cover types were indicated: Beech-Hemlock-Red Maple; White Pine-Red Pine; Northern Hardwoods (Beech-Red Maple-Sugar Maple-Birch). Community composition was most influenced by surficial geology and modern management practices. The White Pine-Red Pine community was most influenced by surficial geology, as this community was highly abundant on soils of sand and gravel. The Northern Hardwood community was influenced by land use history to a greater extent than the White Pine-Red Pine community. Other environmental variables were not found to be of influence on community composition. The homogenous management activities across the study area have likely masked the influence of environmental and historical variables influencing community composition.



Influence of Wetlands on Stream Chemistry and Macroinvertebrate Communities along a River Continuum

Israel DelToro

The River Continuum Concept (RCC) predicts changes in organic carbon dynamics and macroinvertebrate community structure along streams draining forested watersheds, but does not explicitly consider the role of stream wetlands or impoundments. We examined the chemistry and macroinvertebrate communities upstream and downstream of wetlands along the East Branch of the Swift River in North Central Massachusetts (a major tributary to the Quabbin Reservoir). We hypothesized that wetlands cause changes in biogeochemical and hydrogeomorphic stream attributes and consequently affect macroinvertebrate community structure regardless of stream order or size. Macroinvertebrates were quantitatively sampled before and after three major wetlands (ranging in size from 330m² to 1380 m²), identified to genus and sorted into functional feeding groups. Water chemistry grab samples were collected at each site and analyzed for biochemical oxygen demand and nutrients. Our results show that wetlands along this river continuum significantly reduce diversity ($p < 0.05$) and homogenize functional feeding groups. However macroinvertebrates in second order intermediate reaches show approximately the same structure as predicted by the RCC. These findings can help explain variation in macroinvertebrate communities along stream ecosystems with wetlands or impoundments. Additionally these findings can be used to better understand how landscape changes may alter macroinvertebrate communities, food webs, organic matter dynamics and water quality. Future research should emphasize the importance of wetlands and impoundments on stream continuums and their impacts on macroinvertebrate community structure.



Calcium Deficiency and Whole Plant Water Relations in Sugar Maple (*Acer saccharum* Marsh.)

Lee Dietterich

Calcium (Ca) is disappearing from forests in the northeastern United States and eastern Canada as a result of several anthropogenic causes. The depletion of Ca, a biologically essential element, is considered a causal factor in sugar maple decline and the diminishing health in general of many forests in this region. However, little is known about the physiological mechanisms by which decreased Ca availability affects forest growth and productivity. We tested the hypothesis that Ca depletion compromises the structure and function of plant conductive tissue, in particular stem xylem, pit membranes, and leaf conduits. We measured stem and leaf structure, hydraulic conductance, cavitation resistance, and leaf turgor loss point on samples of sugar maple (*Acer saccharum* Marsh.) grown in a long-term forest Ca manipulation experiment. Preliminary visual observations suggested that Ca manipulation significantly affects forest health and productivity. However, we found no significant difference in any of the physiological properties that we measured between samples subjected to different Ca levels. This could indicate that Ca availability does not affect these properties, or that our sample size was too small to resolve the differences. Alternatively, because our sampling focused on healthy trees in order to identify potential causes of sugar maple decline, it is possible that the effects of differential Ca availability have a longer latency period and a more sudden onset than we expected. Future experiments might continue to monitor healthy maples but also examine declining trees to relate symptoms of decline to symptoms of Ca deficiency.



It's the Network: How Personal Connections Shape Decisions about Private Forest Use

Angelica Erazo Oliveras

Forested landscapes in Massachusetts are commonly divided and owned by different individuals. The decisions of these landowners play an important role in the future of the land. Decisions like harvesting timber, conservation restrictions or development of the land can determine landscape patterns and change the quality of the land. We expect the relationships that landowners have with neighbors, friends, family, professionals, etc., will influence their decisions and their satisfaction. Personal interviews were used to determine the social network of landowners in the North Quabbin region that have decided to make a conservation restriction on their land (n=18). Using linear regressions we found that relationships between landowners and their close contacts were strongly related to their satisfaction. The more close contacts landowners have, the more satisfied they felt about their decisions. Also landowners who had contact with only professionals were more satisfied than those who had contact with professionals and non professionals. The subject's social network is an essential key at the moment of the decision making because the more informed landowners are the more pleased they'll be. The results show the importance of information sources like professionals, workshops and books to landowners. In the future, this project may improve information accessibility and professional assistance for landowners.



Dispersal of Yeasts in the *Sarracenia purpurea* Metacommunity

Katherine Farley

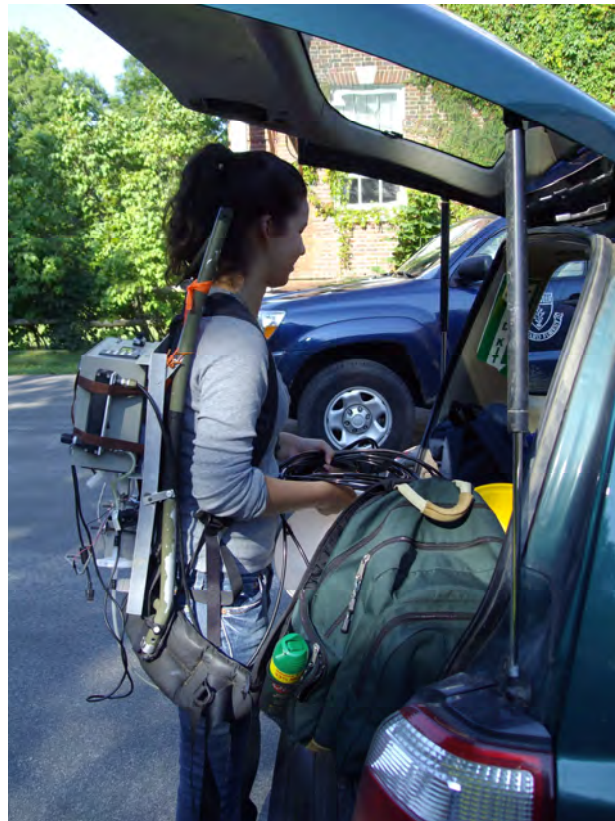
Sarracenia purpurea, the northern pitcher plant, is composed of pitcher-shaped leaves that contain microbial communities. These leaves are separated by distance but linked by dispersal, forming a microbial metacommunity. In studying the yeast metacommunity in pitcher plants, our goal was to determine how far, if at all, yeasts living in pitcher plants can disperse to colonize other pitchers. We inoculated pitcher plants in the center of a greenhouse with a yeast that forms pink colonies. We then tested pitchers located from 1 to 4 meters from the inoculated plants using a microbial culture assay. We set aside samples with pink colonies after five days and made subcultures of the pink colonies for later testing. Pink colonies appeared in pitchers adjacent to the inoculation sites and in pitchers 4 meters away, as well as in all intermediate groups of plants. This suggests that yeasts can disperse up to 4 meters away from the inoculation site, but we do not yet know the means of dispersal or the maximum distance of dispersal. Further analysis of the pink subcultures is needed to determine whether pink colonies are indeed the yeast we used in the original inoculations. Future experiments may determine the means of dispersal and the maximum distance the yeasts can travel.



Forest Canopy Loss Affects the Competition Dynamics of Carabid Beetles (Carabidae)

Alyssa Hernandez

Forest canopy loss has been shown to greatly affect the diversity of the smaller invertebrates in the forest understory. In this experiment, beetle abundance was analyzed in order to uncover any notable changes in forest habitats. A total of eight plots were examined within the Hemlock Removal Experiment (hardwood control, hemlock control, girdled and logged plots). Random pitfall samples placed in each plot and supplemental hand sampling served as a means for collecting specimens on a monthly basis. Our results show a higher than expected abundance of carabid beetles (Carabidae) from the genus *Pterostichus* represented within the hardwood, hemlock and girdled plots. However, *Pterostichus* was almost completely absent from the logged plots. Instead, in the logged sample, we found the carabid, *Cicindela sexguttata*, which seemed to be exclusive to this environment. In the absence of canopy cover and increased ambient temperature of the logged plots, the highly ectothermic *Cicindela sexguttata* may be more prevalent because the high temperatures within this area maximize its ability to catch prey. If this is true, its competition advantage is increased significantly and it can eliminate other competitors, perhaps explaining the decrease in abundance of *Pterostichus*. This same theory could be applied in explaining the lack of *Cicindela sexguttata* in the other plots. The lack of sunlight causes it to lose its competitive advantage. Although more data is needed to firmly test this hypothesis, these initial observations show a distinct correlation that gives certain insight into carabid beetle (Carabidae) dynamics.



Canopy Type Affects Habitat Preference in Web-Building and Hunting Spiders

Samantha Hilerio

Varying canopy structures supply a wide range of resources for forest arthropods, even those on the forest floor. In this experiment, habitat preference was investigated with observed differences in abundance between web-building and hunting spiders, using pitfall traps and hand collection to gather the specimens from four different canopy treatments (hemlock, hardwood, girdled, and logged) in the Hemlock Removal Experiment. Across all treatments there were more hunting spiders collected than web-building spiders ($p < 0.05$), and in the logged plots (the thinnest canopies) hunting spiders tended to be more abundant ($p = 0.09$). The hemlock and hardwood plots had a statistically equal relative abundance of both types of spiders, and the girdled plot showed a trend toward more hunting spiders. These results suggest that a thinner canopy may create an environment more favorable to hunting spiders. This may be because the sunlight of an open canopy creates, over time, more undergrowth to hunt in, unlike the barren floor of the hemlock forest. These results have interesting implications for competition dynamics between hunting and web-building spiders, particularly during a stand's transition from open to closed canopy. More data are needed before we can thoroughly address questions of competition, but this study may serve as a basis for future studies as we gain more knowledge about how canopy structure affects the arachnids in central Massachusetts.



Is Glossy Buckthorn (*Frangula alnus*) Allelopathic to Native New England Wetland Margin Vegetation?

Amy Mays

Glossy buckthorn, an exotic shrub from Eurasia, invades upland and mesic sites in New England, forming dense canopies that diminish species richness and reduce the growth and survival of native tree saplings. To test for allelopathy as one mechanism by which buckthorn deleteriously impacts indigenous plant communities, we experimentally propagated three species of native wetland margin shrub - speckled alder (*Alnus incana ssp. rugosa*), meadowsweet (*Spiraea latifolia*) and arrowwood viburnum (*Viburnum dentatum* - in buckthorn root and leaf mulch as well as in mulch from the native shrub silky dogwood (*Cornus amomum*). After seven weeks, alder grown in buckthorn root mulch had significantly smaller basal diameter than alder grown in buckthorn leaf or dogwood root or leaf mulch. Therefore, buckthorn's potential allelopathy to alder may occur primarily through root exudation as opposed to passive leaf drop. Meadowsweet and viburnum, in contrast, showed complex responses to the different mulch treatments, indicating that buckthorn's effects on native wetland margin shrubs may be highly species-specific, thus altering the composition of plant communities as invasion proceeds.



Measuring Niche Overlap between Spiders and the Northern Pitcher Plant (*Sarracenia purpurea*) in Tom Swamp

Jonathan Mejia

Spiders and northern pitcher plants (*Sarracenia purpurea*) are both predators on invertebrates in Tom Swamp, located in central Massachusetts. Measuring the food preferences for these predators would help in understanding the amount of niche overlap and competition between them. The theory of niche partitioning predicts that for these predators to coexist in the same environment, they should be selectively preying on different types of invertebrates. Plots were set up where spiders were removed, or pitcher plants were plugged, and pitfall traps were used to sample invertebrate diversity in these plots. Initial observations suggest that spiders selectively prey on Hemipterans, which may indicate niche partitioning. However Odonate prey captures tend to indicate more complex interactions. Because some *S. purpurea* were found to prey on spiders and there were higher than expected densities of spiders in plots where pitchers were removed, there may be evidence for intraguild predation.



Increases in Soil Salinity as a Result of the De-Icing of Roads with Salt

Adrian Mood

During the winter, large amounts of snow and ice cover roads and stand between humans and their destinations. In order to allow people to travel safely during winter months where snow and ice cover nearly everything in sight, roads are usually de-iced with salt and plowed. However, the introduction of large amounts of salt to the environment may have negative effects on both the soil and vegetation. By using soil saturation and vacuum filtration, it is possible to isolate salt from a soil sample. The concentrations of the salt present as well as the pH are easily measured using an electrical conductivity meter and a pH meter. Soils nearby the Quabbin Reservoir are protected and not allowed to be salted and were chosen as a control. These protected soils' salt content was then compared to those of state maintained and town roads. I expected state-maintained roads to have significantly higher salt concentrations and pH because the state of Massachusetts uses 240 lbs. of salt per lane mile of highway and also because these roads have much larger traffic volumes. I found that the use of road salt as a de-icer has significantly increased the salinity of soils along state-maintained roads, yet it has not increased alongside town maintained roads. In addition, I found that increased soil salinity led to more acidic soil rather than the more basic soil I expected. However, both state-maintained and town roads' soil pH reached levels that were hazardous for vegetation.



Investigating Water Table Levels Affected by Topography and Clearcut Forest Harvest

Jhessye Moore-Thomas

Studies pertaining to the movement, quality, and distribution of water are vastly important to peoples' understanding of groundwater management. Walter Lyford, a soil scientist at the Harvard Forest, bored many groundwater wells (L Wells) in the early 1970s. The L Wells are arrayed along a topographic gradient (~11m change in elevation across 250m), from the headwaters of a stream to an upland area on the Prospect Hill Tract. Three of the wells are within or down-slope from a clear-cut harvest completed in May 2008. I monitored the L Wells to study water table fluctuations throughout the summer 2008 period. Two main research objectives included examining how the water table level is affected by a topographic gradient and how the water table responds to the forest harvest. I expected more variance in water table levels in response to precipitation events in the low to midland areas (5 wells) versus the upland (3 wells). Direct water depth measurements were taken and then the actual water table was calculated. The low and midland wells' water table increased dramatically over the summer period. Large summer storms and an overall wet July (observed from precipitation records from the Fisher Meterological Station) also resulted in a large, though temporary, groundwater recharge in the upland forested wells. The forest harvest may affect the residence time of the water table after a large precipitation event, but further studies are needed to clarify changes in evapotranspiration in the clear-cut harvest area.



Hydraulic Mechanisms Controlling Leaf Senescence in Sugar Maple (*Acer saccharum* Marsh.) and Red Oak (*Quercus rubra*)

James Onstad

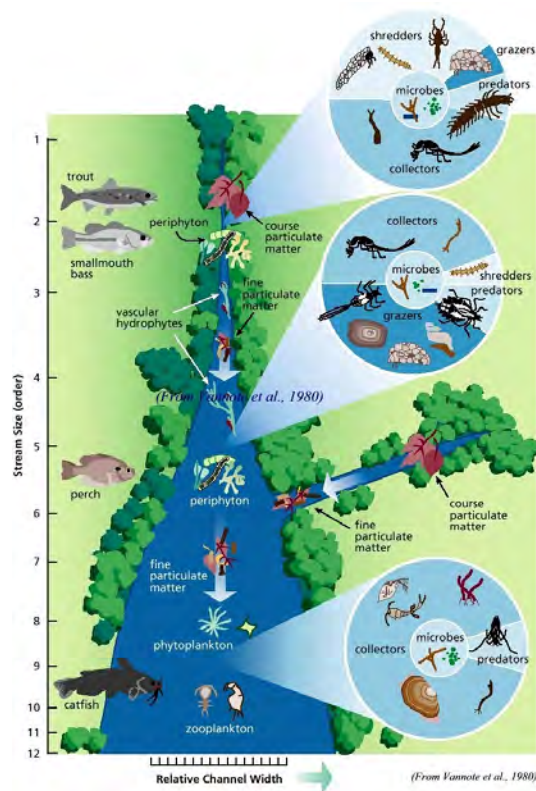
It remains poorly understood which physiological, environmental and endogenous factors contribute to the onset of leaf senescence. Understanding how senescence is triggered in leaves is crucial to incorporating leaf fall into ecosystem models and carbon flux scenarios. Recent research suggests that a decline in the conductance of the liquid phase of water through leaves (K_{leaf} ; $\text{mmol m}^{-2} \text{s}^{-1} \text{Mpa}^{-1}$) is correlated to leaf senescence. It has been hypothesized that a decline in K_{leaf} triggers leaf senescence by reducing the delivery of xylem-transported compounds such as nitrogen and cytokinins to the leaf. We tested the hypothesis that a decline in K_{leaf} acts causally to trigger leaf senescence. Our measurements of K_{leaf} and leaf chlorophyll concentrations in sugar maple (*Acer saccharum* Marsh.) and red oak (*Quercus rubra*) during the spring and summer of 2008 suggest that a decline in K_{leaf} precedes leaf senescence. Using humidity chambers to lower K_{leaf} without altering photosynthetic radiation we were able to significantly decrease the concentration of chlorophyll in Red Oak leaves ($p < 0.05$). These preliminary results provide evidence that K_{leaf} acts as a determiner of leaf senescence. An attempt was made to determine the role that petiole and lamina conductance play in decreasing K_{leaf} . Our data indicate that lamina conductance plays the determining role in K_{leaf} variability, but we recommend that more effective techniques need to be developed in order to examine the respective role that petiole and lamina conductance play in altering K_{leaf} . Finally, an investigation into the effect of K_{leaf} on the delivery of compounds known to regulate senescence should be carried out on these two species.



Chemical Analyses Suggest Impacts of Alteration in Central Massachusetts Headwaters

Mathew Quattrocelli

Stream ecosystems can be strongly influenced by alterations to the surrounding watershed. Presently, the unmapped headwaters of Massachusetts streams, a critical element of healthy stream function under the river continuum theory, receive no formal protection from development. To augment ongoing studies on physical characteristics of headwaters we conducted a pilot study of water chemistry in headwaters of central MA. Our intent was to establish a chemical “fingerprint” of healthy headwater streams. The concentrations of nitrogen, phosphate, sulfate, total iron, and color were measured using a spectrophotometer along a continuum that extended from 400m into the mapped reach to the terminus of the headwater. Three completely undeveloped streams in the Quabbin watershed were compared to three urbanized streams in Gardner, MA to demonstrate any aberrant conditions that arise with development. Our relatively small sample size showed trends such as elevated nitrogen and color levels in urban streams and also a high degree of nutrient variability both within and between streams. We interpret the elevated nitrate in urbanized streams as a likely indicator of runoff from residential lawn fertilizers, wastewater, or automobile pollution. In light of these trends we suggest further study of headwater chemistry that encompasses organic carbon and oxygen with the goal of determining a “fingerprint” of healthy headwater streams. Our proposed study coupled with ongoing studies of physical characteristics and macro-invertebrate communities should elucidate the need, if any, for the protection of headwater streams.



Hemlock Forest Vegetation Dynamics: Long-term Responses to Hemlock Woolly Adelgid

Relena Ribbons

Eastern hemlock (*Tsuga canadensis*) stands across the eastern United States are being infested by hemlock woolly adelgid (*Adelges tsugae*) and exhibiting mortality within 4-10 years of initial invasion. The purpose of our study was to investigate overstory and understory vegetation dynamics associated with chronic adelgid infestation. In 1995, forest structure, composition, health, and physical site characteristics were examined at eleven sites in central Connecticut. Permanent plots were established at each site and were re-sampled this year. Field methods included overstory diameter measurements, crown classification, *T. canadensis* mortality levels and understory vegetation identification and percent cover estimates. Overstory mortality was variable across sites, ranging from 10-98%. Three field sites originally containing 50-90% hemlock have since lost over 95% of hemlock trees. Hemlock mortality has resulted in a shift in forest structure, to forests dominated by black birch (*Betula lenta*), red maple (*Acer rubrum*) and beech (*Fagus grandifolia*) saplings. Black birch sapling density increased from 125-250 ha⁻¹ to >4,000 ha⁻¹ at some sites. In heavily damaged stands, black birch has recently recruited into the tree size category (>8cm dbh). Healthy hemlocks remain at some sites, despite 15 years of adelgid infestation. Research will continue to focus on community vegetation responses to the decline of hemlocks, in existing and future plots.



Forest Type Transition Directly Influences the Seed Bank

Cassandra Rivas

The New England forest contains a history dominated by agriculture and forest plantations which have in turn determined modern flora. The Harvard Forest is currently harvesting 80 acres of plantations in order to regenerate native species. These plantations are mainly monocultures of non-native conifers, and have lower biodiversity than most native forests. The seed bank plays an important role in forest regeneration after disturbances, such as logging, and can directly influence biodiversity. The objective of this project is to assess seed bank species composition and abundance across forest type transitions in recently harvested plantations and adjacent forests. Transects were extended from the middle of two recently logged sites (Fisher Pine and PH 25-H), to their edges, and into the adjacent forests. Soil core samples were taken every ten meters along each transect and placed in the greenhouse to evaluate the seed bank by direct germination. Overstory basal area was sampled at every plot using a Cruise Angle. In the Fisher Pine site there was apparently a smaller overall seed bank in the plantation and particularly more woody plants and graminoids in the adjacent plots. Similarly in the PH 25-H site, an evident contrast was noted between the plantation, which had higher graminoid abundance, and the hemlock-dominated west adjacent forest, which had a lower abundance of plants, but included more woody plants than the plantation. These trends highlight how plantations may affect future diversity and reinforce the legacy of land use history.



Linking the Past to the Present: Beaver Provide Suitable Wetland Habitat for Rare Plant Swamp Lousewort in Central Massachusetts

Erin Schaeffer

Swamp Lousewort, (*Pedicularis lanceolata*) is a hemiparasitic plant, once more common in New England, but now declared rare in Massachusetts with only two existent populations in the state. The purpose of this study is to consider how historical and present day interactions among beaver (*Castor canadensis*), land use and wildlife management affect available open habitat for the recruitment and survivorship of Swamp Lousewort. We analyzed historical images, maps and journals, and conducted interviews to reconstruct historical and current habitat changes for Swamp Lousewort. In the 17th century, when beaver were extirpated from the national landscape, pastures continued to provide open spaces for wetland species. Current land use of wetland habitat and high beaver density are conservation areas, compared to agricultural or residential spaces. Our field data on canopy cover measurements and counts of beaver sign show an increase in beaver density in areas of wetland habitat suitable for Swamp Lousewort. Today, Reed Canary Grass (*Phalaris arundinacea*), a grass once used to feed livestock in the 19th century, is currently an invasive species capable of forming monocultures that threaten the occurrence of native wetland species through competition exclusion. Our study suggests that beaver create and sustain suitable habitat for native wetland species at the cost of engineering prime habitat for invasive Reed Canary Grass.



Private Land, Public Landscape: How Social Networks Affect Landowners' Decisions

Emma Snellings

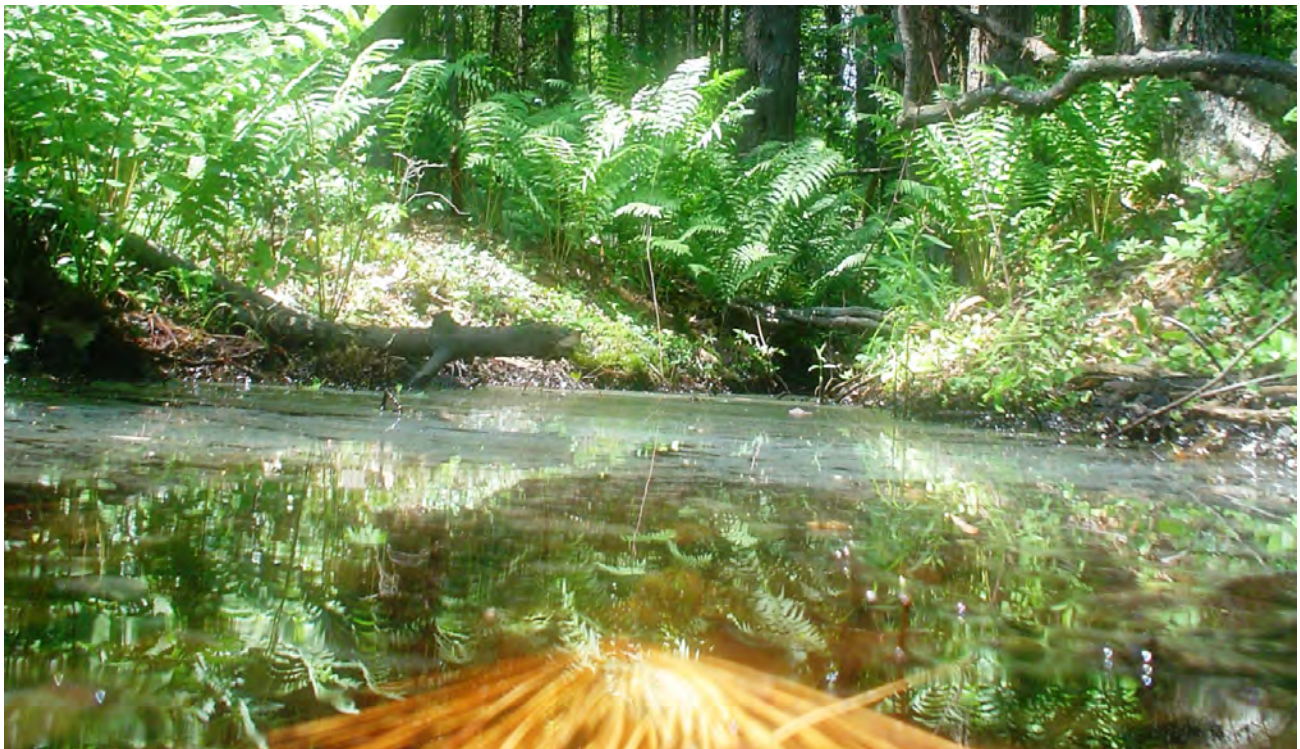
The decisions of woodland owners in Massachusetts often dictate the state of the landscape. Massachusetts, and the Northeast, is a patchwork of ownership, thus any decisions on the landscape level have many players involved. Whether to harvest timber or not on one's land is a decision every landowner must make, and is one that could be understood better. Landowners' social networks positively impact their decisions about timber harvesting and their satisfaction with those decisions. Seventeen interviews were conducted with landowners who had recently completed a timber sale. Using a linear regression, it was found that age, income level and number of people talked to before the timber sale all were significant factors in the level of satisfaction with the timber sale. It was also found that satisfaction was negatively correlated with talking to a forester, and positively correlated when the contact was a relative. Landowners' social networks seem to play an important role when it comes to decision satisfaction. However, further research is needed to see if a landowner's social network is the limiting factor in their decision making process.



Examining the Impacts of Past Land Use on Headwater Stream Morphology

Christine Urbanowicz

Headwater streams are important interfaces between terrestrial and aquatic ecosystems. Therefore, differences in headwater stream morphology are expected to reflect differences in past and present land-use. The study of this spatial and temporal relationship has important implications in understanding stream restoration, aquatic habitat availability, and land use management. I integrated data from a field survey of streams in northern Massachusetts with spatial land use data for 1830 and 1999. PCA ordinations and Kolmogorov Smirnov analyses revealed that out of eleven morphological attributes, substrate sand frequency and bankfull depth best correlated with 1999 land use composition. Forested area was the most dominant land use type in 1999, but developed and open land better explained variability in stream morphology. Stream morphology did not correlate strongly with 1830 land use, which was predominantly open land. The correlation between land use and stream morphology may be best attributed to differences in runoff and stream competence. The trends presented in this study suggest that the legacies of recent land use are evident in small headwater streams.



Johanna Weaver

Two anthropogenic effects: added nitrogen (+N) in rainfall and increased temperature (+Heat) through increasing CO₂, are widespread in northern temperate forests but the combined impact of heat and nitrogen additions on community structure is still unknown. We tested their effects on the community structure of a brown food web (decomposer microbes and their consumers) in a New England forest. We tested two hypotheses. First, ectotherms are heat limited, so activity of arthropods will increase with +Heat. Second, decomposer populations are N-limited, and feed arthropods, hence +N should in turn increase arthropod abundance. At the Harvard Forest six replicates of four treatments (+N, +Heat, +N +Heat, Control) were applied to 3x3 m plots, beginning in the Fall of 2006. From April – July 2008 we measured activity density of four common taxa — two predators: ants and spiders, and two microbivores: collembola and mites— using two pitfall traps per plot over 48 hours. Taxa responded differently. Ants and collembola increased on +Heat plots. Acari abundance increased on +N and +Heat plots, but decreased again on +Heat +N plots. Spiders did not vary with either treatment. Thus two common taxa, a microbivore and a predator, appear to increase in local activity with warming. The lack of +N effects may reflect the lack of N-limitation of decomposers and/or increased shading of +N plots. After two years, warming appears to have a larger effect on this brown food web than nitrogen deposition.



Which Landscape Variables are Suitable Predictors for Presence of Cavity-nesting birds in Human-occupied Landscapes?

Anastasia Yarbrough

Most habitat studies for cavity-nesting birds have focused primarily on individual cavities and within a radius of approximately 25 meters of individual nesting trees. By contrast, the habitat selection literature has emphasized that birds make habitat choices at multiple spatio-temporal scales. Many recent studies have described and modeled the influence of landscape variables on habitat choice in a variety of bird species. However, few studies have considered the possibility of landscape variables contributing to choices of cavity-nesting birds. The objectives of this study are to explore associations between landscape variables and presence of nests for cavity-nesting bird species. Nest searching focused on 25 1-km plots along roads of varying traffic density roughly following an urban gradient. There are approximately 62 nests located and identified throughout the plots, varying by bird species occupancy and land cover characteristics (Figure 1). I acquired land cover, canopy cover, and impervious surface multi-resolution land cover (MRLC) data through the National Land Cover database and elevation data from MASS GIS. I analyzed and described the data using ArcGIS and simple statistics in Microsoft Excel. The primary goal of this exploratory analysis is to provide a preliminary basis to develop a predictive model of nesting densities. I expect for current and future results of this project to contribute to the quest for understanding cavity-nesting bird nesting behavior and success in dynamic human-occupied landscapes.

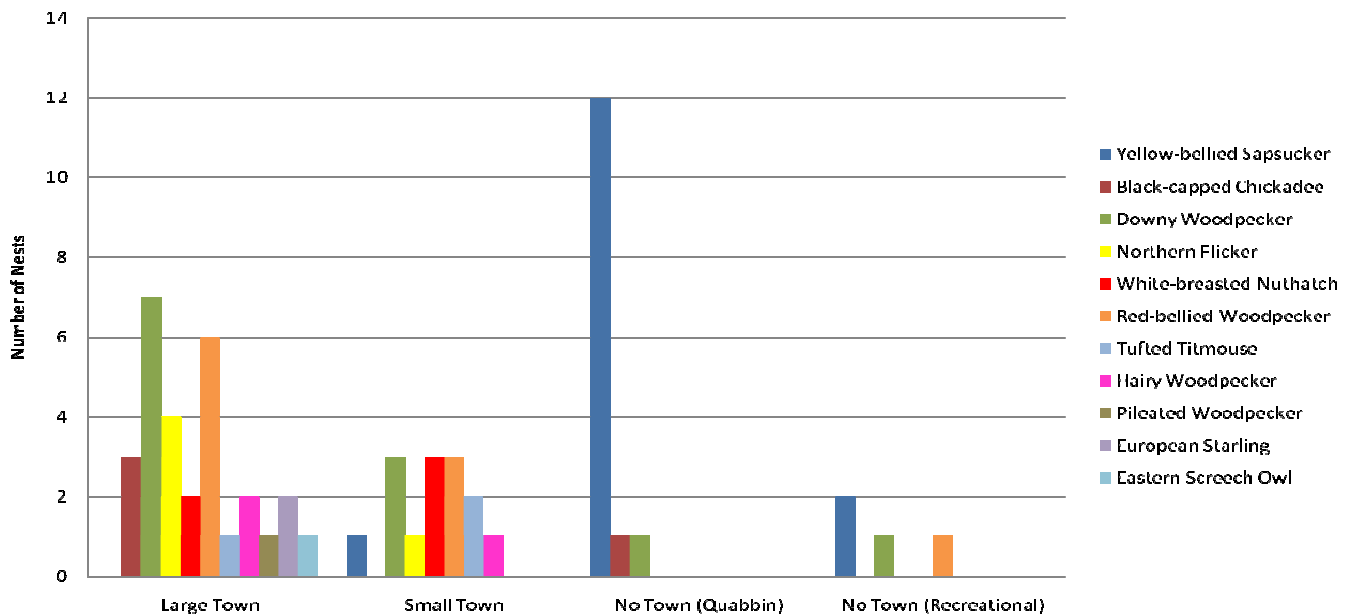


Figure 1.

2008 STUDENT SUMMER PROGRAM SEMINARS AND WORKSHOPS

June 4	Seminar 1-Land-use History	David Foster
June 5	Plant ID Workshop	John O'Keefe
June 9	Seminar 2-Pitcher Plants	Aaron Ellison
June 11	Forest Service Day Workshop	Audrey Barker Plotkin
June 12	Seminar 3- Fungal Diversity	Anne Pringle
June 16	Ethics Panel Workshop	Ben Minter & Elizabeth Farnsworth
June 18	Seminar 4-Hemlock Woolly Adelgid	Dave Orwig
June 24	Seminar 5-Global Carbon Cycle	Bill Sobczak
June 27	Cambridge Museum Field Trip	
July 1 & 3	Student Presentations Workshop	
July 8	Seminar 6-Decisions -Private Landowners	Dave Kittredge
July 10	Seminar 7-Tardigrades/Water Bears	W. Randy Miller
July 14	Seminar 8-Vernal Pools	Betsy Colburn
July 16	Walk to Vernal Pools Workshop	Betsy Colburn
July 22	Graduate School Panel Workshop	Dave Kittredge Matt Fitzpatrick Sarah Butler and Synde Record
July 23	Seminar 9-Urban Ecology	Paige Warren
July 25	Career Forum Workshop	
July 29	Writing an abstract Workshop	Kristina Stinson
July 31	Scientific Presentation Workshop	David Orwig
August 14	Summer Research Symposium	

PERSONNEL AT THE HARVARD FOREST – 2008

Audrey Barker Plotkin	Site and Research Coordinator
Emery Boose	Information & Computer System Manager
Jeannette Bowlen	Accountant
Laurie Chiasson	Financial Assistant/Receptionist
Elizabeth Colburn	Aquatic ecologist
Sheila Connor	Archivist
Elaine Doughty	Research Assistant
Edythe Ellin	Director of Administration
Aaron Ellison	Senior Ecologist
David Foster	Director
Lucas Griffith	Maintenance Technician
Julian Hadley	Ecophysiologicalist
Brian Hall	Research Assistant
Linda Hampson	Staff Assistant
Mike Kaspari	Bullard Fellow
David Kittredge	Forest Policy Analyst
Grace Lacharite	Summer Admin. Intern
Oscar Lacwasan	Maintenance Technician
James Levitt	Director, Program on Conservation Innovation
Heidi Lux	Research Assistant
Ron May	Maintenance Technician
Glenn Motzkin	Plant Ecologist
John O'Keefe	Museum Coordinator
David Orwig	Forest Ecologist
Wyatt Oswald	Paleoecology Lab Coordinator
Julie Pallant	System and Web Administrator
Jennifer Popham	Summer Maintenance Crew
Fermin Rada	Bullard Fellow
Sydne Record	Graduate Student
Michael Scott	Maintenance Technician
Steve Shepardson	Summer Maintenance Crew
Pamela Snow	Environmental Educator
William Sobczak	Bullard Fellow
Kristina Stinson	Population Ecologist
Travis Stolgitis	Maintenance Technician
P. Barry Tomlinson	E.C. Jeffrey Professor of Biology, <i>Emeritus</i>
Judith Warnement	Librarian
Emily Winters	Summer Assistant Cook
John Wisnewski	Maintenance Technician
Tim Zima	Summer Cook

Harvard University Affiliates

Peter del Tredici	Arnold Arboretum
Richard T.T. Forman	Graduate School of Design
Charles H.W. Foster	JFK School of Government
N. Michelle Holbrook	Organismic & Evolutionary Biology
Paul Moorcroft	Organismic & Evolutionary Biology
William Munger	Div. Engineering & Applied Sciences
Anne Pringle	Organismic & Evolutionary Biology
Steven Wofsy	Div. Engineering & Applied Sciences

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- ILTER III: Long Term Ecological Research at Harvard Forest (#0080592)
- ILTER IV: Integrated Studies of the Drivers, Dynamics, and Consequences of Landscape Change in New England (#0620443)
- Moths, Ants, and Carnivorous Plants: the Spatial Dimension of Species Interactions (#0541680)
- REU Site: Harvard Forest Program in Forest Ecology: Multi-Scale Investigations of a Forested Ecosystem in a Changing World (#0452254)

US Department of Energy – Terrestrial Carbon Program: Detection of Long-Term trends in Carbon Accumulation by Forest in Northeastern U.S. and Determination of Causal Factors (DE-FG02-07ER64358)

Commonwealth of Massachusetts - Division of Fisheries and Wildlife:

Natural Heritage & Endangered Species Program: An Inventory of the Ants of Massachusetts

Landowner Incentive Program: Wildlife Habitat Enhancement at the Harvard Forest: Early Successional Habitat Creation and Invasive Plant Control

Private Foundations:

Conservation Research Foundation and the Nantucket Biodiversity Initiative: An Inventory of the Ants of Massachusetts

Harvard University:

- Department of Organismic and Evolutionary Biology
- HU Center for the Environment
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