Black Rock Forest Consortium

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SECOND BLACK ROCK FOREST RESEARCH SYMPOSIUM

June 2001

TALK TITLES AND ABSTRACTS

BLACK ROCK FOREST CONSORTIUM
129 Continental Road - Cornwall, New York 12518

Second Black Rock Forest Research Symposium
June 2001

Talk Titles and Presenters

Session I: Earth and Environmental Science

Mark Wiljanen, SUNY New Paltz, "Development of a GIS for the Black Rock Forest".

Jim Simpson, Lamont-Doherty Earth Observatory (LDEO), Columbia University, "Chloride, sulfate and nitrate budgets of Cascade Brook watershed, BRF".

Marc Stieglitz, LDEO, "Stormflow and a more responsive water table in a TOPMODEL-based hydrology model: Simulations at the Cascade Brook catchment".

Joseph Liddicoat, Barnard College, "Dating Sutherland Pond sediment using paleomagnetic secular variation".

Session II: Long-term Studies

Dorothy Peteet, LDEO, "Paleoecology and long-term carbon storage in BRF wetlands".

*William Schuster***,** Black Rock Forest, "Changes in tree biomass and carbon content over seven decades (1930 - 2000) in an aggrading deciduous forest".

Gerry Moore, Brooklyn Botanic Garden, "An inventory of the *Carex* (Cyperaceae) flora at Black Rock Forest with investigations on the dispersal mechanisms of their diaspores (fruits)".

Session III: Population Ecology and Behavior

Matt Gompper, Center for Environmental Research and Conservation at Columbia University (CERC), "The population biology an expanding coyote population".

Amber Wright, CERC, "Sociality of seasonal den use in the raccoon, *Procyon lotor*".

Goncalo Ferraz, CERC, "Do birds of a feather flock together? An experimental study of mixed-species flock formation".

Session IV: Community Studies

Vladamir Ovtsharenko, American Museum of Natural History, "The results of three years of study of the spiders of Black Rock Forest".

James Danoff-Burg, CERC, "Does the hemlock wooly adelgid kill hemlock trees?" (Poster)

Session V: Bridging Research and Education

Isabel Ashton, Black Rock Forest (for *Dallas Abbott*, Lamont Doherty Earth Observatory of Columbia University), "Ground source geothermal heating and cooling: A proven "alternative" energy technology".

Kim Kastens, LDEO, "Development of student investigations based on data from the BRF environmental sensors"

Nicole Buzzeto, Teachers College, "Technology to enhance research and knowledge acquisition at Black Rock Forest".

Session VI: Ecophysiology and Ecosystem Studies

Kevin Griffin, LDEO, "Loss of carbon from an ecosystem: Components of respiration at BRF".
Matthew H. Turnbull, University of Canterbury, New Zealand, "Uptake of carbon in tree stands – Species differences in photosynthesis at BRF".
Kim Brown, LDEO, "Soil characterization and soil respiration in Cascade Brook".
Victor Engel, LDEO, "Canopy hydraulic characteristics and catchment hydrology: observations and modeling."
Jim Lewis, Fordham University, "Change in productivity across a gradient of hemlock decline after 15 years in the Black Rock Forest".
Greg Turner, Fordham University, "Influence of ectomycorrhizal community structure, light, and nitrogen on oak survival and growth in hemlock versus hardwood stands".
Jenn Nagel, LDEO, "Construction cost and invasive potential: Comparing *Lythrum salicaria* (Lythraceae) with co-occurring native species along pond banks".
Jeff Shaman, LDEO, "Prediction of mosquito abundance with a land surface hydrology model".

Development of a GIS for the Black Rock Forest.

M. Wiljanen

The geographic information system (GIS) at the Black Rock Forest has been implemented on ArcView (v 3.2) software with the Spatial Analyst, 3-D Analyst, and Image Analysis extensions. Much of the development of the Forest's GIS has stemmed from the Forest's recent acquisition of high resolution, full color aerial photography of its 1530 hectare expanse. The aerial photography was delivered with 17 tiles of digital orthophotography, 17 corresponding digital elevation models (DEM), and 2-meter contours for each of the tiles. The digital orthophotography tiles were mosaiced to form a single, continuous image covering the entire forest. The digital elevation models were similarly mosaiced and then symbolized with hypsometric tints and shaded relief to highlight the roughness of the terrain. A triangulated irregular network (TIN) was developed from the mosaiced DEM and then projected as a three-dimensional model of the Black Rock Forest. The digital orthophotography was draped over the three dimensional model to create very effective visualizations of the forest topography and vegetation. Current work is focusing on the establishment of a highly accurate global positioning system (GPS) base station for the precise mapping of forest features and research sites. Potential applications of the Forest's GIS include educational outreach and research projects focused on watershed analysis and biohabitats.

Chloride, sulfate and nitrate budgets of Cascade Brook watershed, BRF.

H. J. Simpson, J. Nichols, W. S. F. Schuster, S. Chillrud

Dissolved ions transported by Cascade Brook integrate a number of critical watershed processes relevant to delivery from the atmosphere to the forest of materials via wet and dry deposition, followed by uptake and transformations within the ecosystem. Daily discharges of water, derived from hourly stage measurements at a weir, show dramatic short-term variability, reflecting the steep topography and thin soils in most of the basin. Dissolved silicate in Cascade Brook, derived from chemical weathering, has moderate seasonal variation, with lowest values during the spring and highest values during summer and fall. Chloride and sulfate in the stream both are appreciably higher than mean precipitation concentrations and show some seasonal variation, with higher values during colder months. There appears to be appreciable lowering of stream sulfate during warm, low discharge months, probably from SO_4 reduction in saturated soils of the wetlands near the central part of the basin. Nitrate concentrations in Cascade Brook are much lower than in precipitation throughout the year, consistent with a very large fraction of the atmospheric influx being taken up by the ecosystem.

Mean calendar month precipitation dissolved ion concentrations from the NADP network station at West Point, located about 5 km SW of Cascade Brook, have a warm season maximum for H^+, SO_4, NO_3 and NH_4, and a cold season maximum for Na and Cl. Mean chloride concentrations in Cascade Brook are about a factor of five greater than in precipitation. Chloride input from wet deposition, as measured at West Point, appears to be appreciably less than half of Cascade Brook chloride discharge, indicating that a substantial additional source of chloride is required. We interpret the inferred additional chloride influx to be derived from dry deposition to the forest, including both gas phase reactions and aerosol impaction, together accounting for about 60% of the total supply from the atmosphere. Similar large proportions of dry deposition influx are very likely for sulfate and nitrate. Thus dry deposition of a

number of chemical species, although difficult to quantify, is a major component of atmospheric inputs to BRF.

Carbon storage in BRF over the past seven decades, based on above ground carbon estimates from long-term plots, is of the order of 95 g carbon/m^2/yr. Order of magnitude calculation of potential carbon storage in the forest, assuming all wet deposition nitrate is converted to terrestrial biomass (mostly wood) is about 77 g carbon/m^2/yr, comparable to that derived form the long-term plot data. Although grossly oversimplified, these observations are consistent with the general conclusion that a substantial fraction of fixed nitrogen influxes to BRF have been retained within the ecosystem as terrestrial biomass over the past century.

Stormflow and a more responsive water table in a TOPMODEL-based hydrology model: Simulations at the Cascade Brook catchment.

M. Stieglitz

No abstract available

Dating Sutherland Pond sediment using paleomagnetic secular variation.

J. C. Liddicoat, K. Jennings, T. Maenza-Gmelch

Paleomagnetic inclination and relative declination in the lower 2 m of a 10.7 m core from Sutherland Pond record long-term change (secular variation) of the earth's magnetic field following retreat of the Laurentide ice sheet. The paleomagnetic directions are correlated with dated secular variation in cored Lake Ontario sediment and other lacustrine sediment in eastern North America to place an age of about 13,000 y BP on the origin of the pond. The chronology is in accord with previous estimates for termination of glaciation in the Hudson Highlands, and suggests that less than 500 years elapsed between the removal of the Laurentide ice sheet and full resurgence of temperate vegetation.

Paleoecology and long-term carbon storage in Black Rock Forest, NY.

D. Peteet, D. Kurdyla, T. Maenza-Gmelch

Sutherland Bog apparently formed about 12,500 years ago, the same time as Sutherland Pond and regional deglaciation. Sutherland Bog late-glacial and early Holocene LOI and carbon content is higher than Sutherland Pond (80-60% vs. 40-50%) but the carbon accumulation rate is lower because the bog is only half as deep as the pond (3.5 m vs. 8 m.). Glycerin Hollow wetland riparian sites, all between 0.5 and 1.2 m deep, record LOI from about 25% at the surface to about 5% at the base, substantially less than Sutherland Bog.

High-resolution (2cc) analysis of the 3.5 m bog section indicates three major macrofossil zones. The first (Sub-1) is indicative of a shallow pond characterized by aquatics and white spruce (*Picea glauca*). The subsequent overlying zone (Sub-2) remained a pond environment with more diversity of aquatics. White pine (*Pinus strobus*) dominates in this zone, but pitch pine (*Pinus rigida*) is also found in the uppermost sediments. Paper birch (*Betula papyrifera*) and moist emergents such as buttonbush are also present. The uppermost zone (Sub-3) features a bog environment, with *Chamaedaphne*, various sedges, and *Sphagnum*. Highest amounts of charcoal are present in zone Sub-2, the mid-Holocene. This is consistent with highest charcoal accumulation rates 4000-6000 years ago in Sutherland Pond. Sutherland Bog carbon content (g/cc) is very similar to a bog record from Mer Bleue, Quebec, with fluctuations throughout the core from 0.05 at the base to maximum amounts of 1.0 g/cc. Sharp declines are noted in both cores at the surface.

Accelerator mass spectrometry (AMS) C-14 dates will define the sedimentation rates throughout all cores, and from these rates the carbon accumulation rates over time will be calculated.

Changes in tree biomass over seven decades (1929 - 2000) in an aggrading deciduous forest.

W. S. F. Schuster, K. J. Brown, M. H. Turnbull, D. Whitehead, D. T. Tissue, K. L. Griffin.

Forests are major components of global carbon flux as well as storage. As humans have perturbed the global carbon cycle through fossil fuel burning and deforestation, regrowing (aggrading) forests have absorbed much of this carbon, and temperate deciduous forests are thought to be playing a major role in this sequestration. Yet actual storage rates, changes in those rates over time, and the factors that control those rates are poorly known. We used historical data from forest-wide surveys in 1929 and 1985, and a data from a subset of these plots remeasured in 1999, to estimate forest-wide aboveground biomass increase over this time period using allometric equations relating tree size to aboveground biomass (these data can be directly related to carbon storage as the carbon content of eastern hardwoods is almost exactly 50% of dry weight). Forest-wide biomass increased from about 80,000 kg/ha in 1929 to 140,000 kg/ha in 1985. A subset of these plots averaged 180,000 kg/ha in 1999, but these may be biased toward high biomass since they included many plots in high-biomass eastern hemlock stands.

A series of long-term plots initiated in 1930 and remeasured since at roughly five year intervals document periods of rapid biomass accumulation interrupted by shorter periods of stasis or biomass loss. These plots now average 220,000 kg/ha in aboveground biomass. In general, these stands at age 90 – 120 years are increasing in biomass at about 2 kg/ha per year, nearly 90% of the estimated rate during their first 50 years of growth. Red oak has been the major arboreal sink for carbon in the Black Rock Forest, increasing in biomass at twice the rate of other common species. Rates appear to be controlled by major climatic effects (especially drought) and outbreaks of herbivorous insects. Our lack of knowledge about underground carbon seriously hampers our understanding of carbon accounting across the ecosystem.

An inventory of the *Carex* (Cyperaceae) flora at Black Rock Forest with investigations on the dispersal mechanisms of their diaspores (fruits).

G. Moore, K. Barringer, S. Clemants

Black Rock Forest has a diverse *Carex* flora. *Carex* is the most speciose genus at BRF with 52 species having been reported by BBG staff during previous inventory work. This represents 23% of all the species of *Carex* known to occur in the northeastern United States and adjacent Canada (i.e., the range included in the 2nd edition of the Gleason & Cronquist manual).

Since most sedges are anemophilous (the perianth tissue playing no role in insect attraction or pollination), it has long been hypothesized as to what functional role the perianth tissue may have. Unlike many other anemophilous families (e.g., Poaceae), the Cyperaceae do have perianth tissue (usually bracts or bristles) and it usually persists on the fruit. This structure of fruit plus accessory perianth tissue is oftentimes referred to as a *diaspore*. In *Carex*, the fruit (achene) is enclosed by a scale-like bract called a *perigynium*. Since the perianth tissue persists on the fruits of sedges it has been suggested that the perianth tissue may play a role in fruit dispersal (e.g., epizoochory, endozoochory, hydrochory, myrmecochory).

BBG staff are currently conducting research at BRF to: 1) inventory the sedge flora of BRF and 2) study the diaspores of the sedges at BRF and hypothesize how the perianth tissue may assist in fruit dispersal. This research will involve undergraduate and graduate student interns at BBG and will include laboratory and field-based studies.

The biology of an expanding coyote population.

M. Gompper

The geographical range of the coyote has expanded dramatically over the past century. Previously restricted to the Great Plains, the species can now be found throughout most of North America, and represents perhaps the largest natural range expansion in recent history. Coyotes are now common throughout the northeastern United States. As part of a broader study examining the biology of this predator in the Northeast, we have been examining causes for the range expansion and the population biology of the species in Black Rock Forest in lower New York. GIS-based analyses show that coyotes entered New York in the 1940s, and have spread steadily since, entering Orange and Rockland counties between the late 1960s and early 1980s. Coyotes spread first through abandoned farmland and early second growth forests, spreading later into older forests such as that making up Black Rock Forest.

Using a fecal DNA approach we have been examining the sex ratio of the coyote population in Black Rock. While expectations were that the population would be male biased, in fact, the opposite pattern was found. Based on genotyping of approximately 50 fecal samples, the population was found to be strongly female biased. Causes of this bias are unclear, but may indicate that the population started as male biased, and rapidly moved towards a 1:1 sex ratio, but overshot this equilibrium point. If this hypothesis is valid, the sex ratio should shift back towards a 1:1 ratio over the next decade.

Sociality of seasonal den use in the raccoon, *Procyon lotor*.

A. Wright, R. Goodman, M. Gompper

Raccoons, *Procyon lotor*, are traditionally considered asocial, however they have been shown to exhibit flexibility in social structure. Group formation and communal denning have been anecdotally reported, often in relation to the utilization of clumped resources. We radiotracked 24 raccoons between the 1999-2000 winter and the present in Black Rock Forest, NY. All animals were communally denning throughout the 1999-2000 winter in a limited number of dens that were used repeatedly. The composition of communally denning groups was fluid, with individuals moving between dens independent of one another. In contrast, from spring through fall all raccoon dens involved solitary individuals that rarely used dens for multiple nights. We hypothesize that this seasonal social tolerance is a thermoregulatory strategy, which may explain why rabies spreads faster north.

Do birds of a feather flock together? An experimental study of mixed-species flock formation.

G. Ferraz

No abstract available

The results of three years of study of the spiders of Black Rock Forest.

V. Ovtsharenko, K. Catley, A. Tanasevitch

Over the past three years, our project "Biodiversity of spiders of BRF" has been very successful, documenting 270 species of spiders in the forest. We created a new website called "Interactive Identification Keys of BRF Spiders Genera"; keys include all 115 spider genera at BRF and are now published on the American Museum of Natural History website (http://research.amnh.org/entomology/blackrock) It is apparently the first Interactive Identification Key of Spider Genera in this country. These keys will be tested on the distance-learning course of AMNH "The Study of Spiders" during the spring.

The website "Identification Keys of BRF Spider Families" was changed to a new and more convenient design, (http://www.andtan.newmail.ru/project/key.htm) and will soon be transferred to the AMNH website (http://research.amnh.org/entomology/blackrock)

We have had tremendous success with our DNA research; all North American material for this research was collected, sorted, identified and specially preserved in BRF. A BRF spider DNA progress report has been submitted.

Does the hemlock woolly adelgid kill hemlock trees?

J. Danoff-Burg

Death of eastern hemlock trees (*Tsuga canadensis*) has been hypothesized to result from defoliation by the hemlock wooly adelgid (HWA; *Adelges tsugae*), but the evidence is mostly correlational. I tested three alternate hypotheses: H1) HWA is the sole cause of mortality, H2) HWA is one of a few species that cooperate to kill hemlocks by overfeeding, H3) HWA only facilitates death of hemlock trees by allowing real vectors of mortality to invade. I established a 2300 m transect along Black Rock Brook and estimated crown vigor in the field, then collected branch samples from 153 trees for analysis of leaf loss, new growth, HWA abundance, and scale insect abundance.

Hypothesis 3 was best supported: HWA seems to only facilitate tree death by allowing the true killers (probably scales) to colonize trees. HWA abundance and crown vigor were not correlated. HWA was least abundant on trees that were the most defoliated. HWA abundance peaked relatively early in the defoliation process. Scale abundance and crown vigor seem to correlate. Scales were most densely abundant on branches that were most defoliated and were abundant later in the defoliation process than was HWA.

The leaf loss and new growth variables correlate well with the Crown Vigor Index that is typically used by foresters as a heuristic. These variables are reliable estimates of tree health and can be more rigorous than the commonly used Crown Vigor.

HWA seems to not completely defoliate hemlock trees. It arrives earlier in the defoliation process than scales, and can cope with plant secondary chemicals better than scales. After their populations explode, HWA depletes photosynthate sugars until the HWA prefer to leave for other, healthier trees.

Scales seem to be the insects that defoliate the trees, apparently arriving after HWA has weakened the tree. Healthy trees can repel scales. Scales feed until total tree defoliation. The process of defoliation is one of degradative succession. HWA arrives, feeds and alters the resource (tree) until it is no longer acceptable.

Scales can consequently arrive, feed and completely defoliate tree.

Thus control strategies need to also focus on control of scales. Those control efforts that kill all insects might be most effective. However these are also very expensive and ecologically destructive.

Biological control may be insufficient, even if it is completely successful at controlling HWA with ladybird beetles. Scales may eventually evolve to cope with secondary chemicals, not needing the HWA to weaken the tree before they can invade. These implications may be appropriate elsewhere in the New York, New Jersey and Pennsylvania areas.

A comparison of the ground source geothermal system at Black Rock Forest with conventional heating systems at Lamont Doherty Earth Observatory.

D. Abbott, P. Modi, I. Ashton

Black Rock Forest's recently constructed a Science and Education Center that utilizes many energy saving features: a ground source heating and cooling system, passive solar design of the building, and extra insulation in walls and windows. We are specifically interested in how the ground source geothermal heating system contributes to the overall energy efficiency of the building. In particular, we address three scientific questions: 1) How well does the ground source geothermal system work in comparison to the conventional heating and cooling system at LDEO? 2) How does the ground source power usage change as a function of the daily outside temperature? and 3) How well does the ground source system at Black Rock Forest shave the peak power use of the building?

The overall monthly power usage per square foot at Black Rock Forest is much less than at LDEO. Every building at Lamont uses more power per square foot in the months of January through May than does the Science Center at Black Rock Forest (BRF). There is also a noticeable trend in BRF power usage through these months. Power usage decreases steadily from about 1.0 kWh/square foot in January to about 0.5 kWh per square foot in May.

We find that there is a linear relationship between the total daily power use (P) at BRF and the average difference between the inside and outside temperature (deltaT) such that $P = 4.1\ deltaT + 139$. As the difference between the inside and outside temperature increases more power is used to heat or cool the building. The intercept value of 139 is disturbing, in that it represents over half of the overall power usage. We believe that a more careful analysis using data on solar insolation and wind speed is needed in order to define the major variables affecting the power usage of the ground source geothermal system.

The ground source system at BRF produces very flat power usage versus time of day for the entire building. This flat power usage is most pronounced in January and becomes increasingly more peaked as the year advances to May. Nevertheless, the size of the peak in electrical power use in May is substantially smaller than the peak power use of a comparable cooling system. Because power companies pay the most for their peak power, installation of more ground source geothermal heating and cooling systems could yield substantial savings to utilities in the New York metropolitan area.

Development of student investigations based on data from the BRF environmental sensors.

K. Kastens

No abstract available

Technologies impact on the future of knowledge acquisition at Black Rock Forest

N. Buzzetto

During the fifth century B.C., ancient Athens was the center of scholarly thought and creativity. Athens attracted academicians from all over the world who stressed intellectual discourse, innovative thought, argumentation, and hypothesis. The Athenians encouraged the sharing of knowledge and the participation in collaborations among intellectuals. They brought people and ideas together understanding that collaboration, controversy, and debate can lead to new thought patterns. The Greeks believed that intellectualism should not be relegated to the wealthy elite and that knowledge like government should be democratic and equitable accessible to all who are interested in truth.

Current digital technologies led by the internet are fostering an Athenian sense of openness as they provide individuals access to infinite scholarly resources. The internet enhances knowledge acquisition in profound ways encouraging accessibility across all socio-economic, spatial, temporal and cultural barriers. The internet crosses all class boundaries creating a sense of virtual equality that is helping to bridge gaps that exist between peoples in the real world putting learners in contact with databases research sites, publications, digital libraries, intellectuals, scientists, professionals, and schools of learning.

As we look at the future of digital technologies to enhance scholarly activity at Black Rock Forest we must keep in mind the mission of the Consortium to act as a "Center for Research and Education" that serves as an "Information Network" concerned with "Ecosystem Management". The Consortium should be looking to use technology to further the Forest's mission statement by enhancing four major areas: increasing the amount and reach of publishing activities; merging the practice of scientific education with scientific practice where learners practice the same types of inquiry as actual scientists; greatly expanding communications and collaborations among scientists, educators and learners; and democratizing and simplifying access to information through participation in digital libraries/ repositories.

Loss of carbon from an ecosystem: Components of respiration at BRF.

K. L. Griffin, M. H. Turnbull, D. Whitehead, D. T. Tissue, W. S. F. Schuster, K. J. Brown

We measured responses of leaf respiration to temperature and leaf characteristics in three deciduous tree species (*Quercus rubra*, *Quercus prinus* and *Acer rubrum*) at two sites differing in water availability within a single catchment in the Black Rock Forest, New York. The response of respiration to temperature differed significantly among the species. *Acer rubrum* displayed the smallest increase in respiration with increasing temperature. Corresponding Q_{10} values ranged from 1.5 in *A. rubrum* to 2.1 in *Q. prinus.* Dark respiration at ambient air temperatures, expressed on a leaf area basis (R_{area}), did not differ significantly between species, but it was significantly lower (P<0.01) in trees at the wetter (lower) site than at the drier (upper) site (*Q. rubra*: 0.8 versus 1.1 μmol.m^{-2} s^{-1}; *Q. prinus*: 0.95 versus 1.2 μmol m^{-2}s^{-1}). In contrast, when expressed on a leaf mass basis (R_{mass}), respiration rates were significantly higher (P<0.01) in *A. rubrum* (12.5-14.6 μmol CO_2kg^{-1}s^{-1}) and *Q. prinus* (9.2-10.6 μmol CO_2kg^{-1}s^{-1}) at both the lower and upper sites. Respiration on a nitrogen basis (R_N) displayed a similar response to R_{mass}. The consistency in R_{mass} and R_N between sites indicates a strong coupling between factors

influencing respiration and those affecting leaf characteristics. Finally, the relationships between dark respiration and A_{max} differed between sites. Trees at the upper site had higher rates of leaf respiration and lower A_{max} than trees at the lower site. This shift in the balance of carbon gain and loss clearly limits carbon acquisition by trees at sites of low water availability, particularly in the case of *A. rubrum.*

Response of leaf photosynthesis and respiration in three deciduous tree species vary with site water availability.

M. H. Turnbull, K. L. Griffin, D. Whitehead, D. T. Tissue, W. S. F. Schuster, K. J. Brown

Photosynthesis and related leaf characteristics were measured in canopies of co-occurring *Quercus rubra* (red oak)*, Quercus prinus* (chestnut oak) and *Acer rubrum* (red maple) trees. This enabled us to investigate photosynthetic characteristics of mature (20+ m tall) trees at sites of differing soil water availability within a catchment (a dryer upper site and a wetter lower site). The overall aim of this research was to determine the physiological relationships that regulate the relative contribution of species to carbon uptake in temperate deciduous forests. Leaf photosynthetic characteristics and related leaf characteristics differed significantly between species and in response to site and position in the canopy. Photosynthetic capacity (A_{max}) was significantly greater at the lower site in all canopy strata in *A. rubrum* but not in *Q. rubra* or *Q. prinus*. The greatest rates of photosynthesis (12.6 - 13.6 $\mu mol\ m^{-2}\ s^{-1}$) were measured in *Q. rubra* and *Q. prinus* at the lower site. Importantly, the relationships between A_{max} and leaf nitrogen (and by implication photosynthetic nitrogen-use efficiency, PNUE) differed in *A. rubrum* at the lower and upper sites. At the upper site, no relationship was displayed between A_{max} and leaf nitrogen, indicating that PNUE was extremely low in *A. rubrum* at the drier site. The lower photosynthetic capacity and PNUE must substantially reduce carbon acquisition capacity in *A. rubrum* under these field conditions.

Maximum stomatal conductance (g_{smax}, a measure of maximum capacity for gas exchange) differed significantly between species, with g_{smax} greatest in *Q. rubra* and *Q. prinus*. In *Q. rubra* and *Q. prinus*, g_{smax} was significantly lower at the upper site than the lower site. There was no significant response of g_{smax} to site in *A. rubrum*. Leaf carbon stable isotope signature ($\delta^{13}C$, a biological integrator of leaf gas exchange history and stomatal behavior) was significantly lower in *A. rubrum* than in either *Q. rubra* or *Q. prinus* at both sites. These findings indicate differences in stomatal behavior in *A. rubrum* that are likely to contribute to lower water use efficiency in this species (cf. *Quercus* species) at both sites.

Our results support the hypothesis that the two *Quercus* species, in contrast to *A. rubrum*, maintain photosynthetic capacity at the drier site whilst minimizing transpirational water loss. They also suggest, based primarily on physiological evidence, that the ability of *A. rubrum* to compete with other component species of these deciduous forests may be limited, particularly in sites of low moisture availability and during low rainfall years.

Soil characterization and soil respiration in Cascade Brook.

K. J. Brown

No abstract available

Canopy hydraulic characteristics and catchment hydrology: observation and modeling.

V. Engel, M. Stieglitz, K. L. Griffin, M. Williams

This work presents observations and a modeling exercise examining plant-water relations in the Cascade Brook watershed. This catchment is characterized by strong topographic control over surface hydrology and stand structure, and is dominated by xeric and mesic ecotypes of *Quercus rubra*. Soil depths are typically very thin and the severity of seasonal water stress in these trees is determined largely by position along the local topographic gradient. Water balance related ecotypic differences in *Q. rubra* were measured during the 2000 growing season at an upland and lowland site. Significant site differences in stomatal conductance sap flux density, and leaf to sapwood area ratios were revealed. However, mid-day leaf water potentials and the leaf area-specific canopy hydraulic conductance were not significantly different despite 20% higher soil moisture content, 10m higher in tree height, and a higher leaf area index at the lowland site. These results suggest a close coordination of tree morphology, stand structure, and the hydraulic conductance of the combined soil-root-leaf pathway that governs leaf-level gas exchange rates similarly across the topographic gradient. The observational data justified the development of a simulation model that incorporates upland and lowland canopy hydraulic conductance, atmospheric fluxes, and runoff generation in a consistent framework. Towards this end we linked the SPA canopy model with a 1-D soil column model and TOPMODEL hydrologic formulations. The SPA model was used to represent the canopy because of its specific inclusion of hydraulic constraints on transpiration and leaf water potential. The combined model is spatially explicit in the distribution of ecotype morphology, and calculates transpiration rates for TOPMODEL-derived saturated and unsaturated area fractions of the watershed separately. Model predictions of stomatal conductance, upland latent energy flux, stream discharge, and soil moisture content compared favorably with observations. Sensitivity analyses of canopy hydraulic parameters indicate stream discharge in this system is most sensitive to changes in the maximum leaf area index, the minimum leaf water potential, and belowground resistance. Discharge was least sensitive to changes in stem hydraulic conductivity and capacitance. Model results and observations are discussed with respect to adaptations to water stress, hydraulic controls on canopy water use, and ecosystem water use efficiency.

Change in productivity across a gradient of hemlock decline after 15 years in the Black Rock Forest.

J. D. Lewis, J. T. Mates-Muchin, W. S. F. Schuster

The loss of dominant species due to invasive parasites may significantly alter forest productivity. However, few studies have assessed how species composition, and in particular the relative importance of the target species, affects forest responses to the loss of that species. Eastern hemlock (*Tsuga canadensis*) has been declining in the eastern US over the past 15 years, associated with the spread of the hemlock woolly adelgid (*Adelges tsugae*), a non-native insect. We tested the hypothesis that eastern hemlock decline will cause a decrease in productivity in hemlock-dominated and mixed areas, but the loss of eastern hemlock will be partially offset by competitive release of coexisting species. To test this hypothesis, we set up 12 plots across a gradient of percent hemlock from 0% to 80%. In 2000, the mean basal area was 40, 30 and 25 m^{-2} ha^{-1} in hemlock, mixed and hardwood plots, respectively. Stem growth increment and annual leaf litter fall were measured to assess aboveground NPP. The percent change in stem basal area between 1985 and 2000 was 20, 23 and 40% in hemlock, mixed and hardwood stands, respectively. Repeated measures analysis showed a significant

interaction between stand type and growth rate from 1985-2000, suggesting that hemlock and mixed stands grew significantly more slowly than hardwood stands. Repeated measures ANOVA on the growth of individual species indicated that red oak (*Quercus rubra*) and chestnut oak (*Quercus prinus*) grew significantly more slowly in hemlock stands compared to mixed and hardwood stands, while growth rates of red maple (*Acer rubrum*), sugar maple (*Acer saccharum*) and black birch (*Betula lenta*) did not significantly vary between stand types. These results suggest that loss of eastern hemlock should further reduce net primary productivity in both hemlock-dominated and mixed stands, but that competitive release of coexisting species likely has not yet occurred.

Influence of ectomycorrhizal community structure, light, and nitrogen on oak survival and growth in hemlock versus hardwood stands.

G. D. Turner, J. D. Lewis

I examined the role of ectomycorrhizal fungi (ECM) on northern red oak (*Quercus rubra*) seedling survival and growth in declining eastern hemlock (*Tsuga canadensis*) and adjacent hardwood stands. ECM fungal communities often vary between hardwood and coniferous forests, and these differences may negatively affect the recruitment of hardwood species into stands dominated by conifers. We hypothesized that oak seedlings would be colonized by different fungal species in hardwood stands compared to hemlock stands, and that oak seedling growth would be greater in soils from hardwood versus hemlock stands. Soil cores were taken from hardwood and hemlock stands. Seeds were planted in the cores and grown for 20 weeks in a greenhouse with seedling growth and physiological variables monitored weekly. At 20 weeks, seedlings were harvested for determination of biomass allocation and ECM development and composition. All plants developed extensive ECM. Differences were found in ECM morphotype composition between stands indicating qualitative differences in community composition. Despite this, no significant stand effects were found for plant growth or physiology. These results suggest that ECM communities differ between stand types in this forest, but that such differences do not influence oak seedling growth under the conditions of this study. Further studies are planned to examine how environmental stressors (e.g. light and nitrogen limitation) may affect oak seedling interactions with ECM fungal communities, particularly how they influence stand-level ECM fungal community composition.

Construction cost and invasive potential: Comparing purple loosestrife with co-occurring native species along pond banks.

J. Nagel, K. L. Griffin

Lythrum salicaria (purple loosestrife) is a nonindigenous invasive species, characterized by prolific growth and abundance in marshy and riparian habitats across North America. Given its invasive success, we hypothesized this species may require less energy and/or use energy more efficiently for biomass construction than co-occurring noninvasive plant species. We measured leaf construction cost (CC), leaf mass per unit area (LMA), and leaf organic nitrogen and carbon content of *L. salicaria* and the five most abundant co-occurring species, *Parthenocissus quinquefolia*, *Erigeron philadelphicus*, *Asclepias syriaca*, *Spiraea latifolia*, and *Solidago graminifolia*, along dammed ponds in the Black Rock Forest, Cornwall, New York, USA. *Lythrum salicaria*, which was highly abundant (2.52 individuals/m^2), exhibited significantly lower area-based leaf CC (44.47 4.24 g glucose/m^2 leaf) than relatively less abundant species,

suggesting energetics may influence its invasive success. Conversely, least abundant *S. graminifolia* (0.67 individuals/m^2) exhibited the significantly highest leaf CC per unit leaf area (141.87 39.21 g glucose/m^2). Overall, a negative correlation between species abundance and area-based leaf CC ($r^2 = 0.73$) indicated low energy requirements and/or high energy efficiency may influence relative abundance in the plant species studied. As it correlates with species abundance in this study, CC may be a useful tool for evaluating invasive potential.

Prediction of Mosquito Abundance with a Land Surface Hydrology Model.

J. Shaman, M. Stieglitz, M. Cane

Using hydrological and meteorological data collected at the Cascade Brook experimental watershed in Black Rock Forest, we are forcing a dynamic hydrology model. Model predictions of the spatial and temporal variability of surface wetness are then associated with the spatial and temporal variability of mosquito collections taken within the watershed. This technique has been applied successfully to historical data in two New Jersey locales. The controlled, experimental setting of Black Rock permits examination of several issues: 1) which mosquito species are best
predicted by modeled surface wetness; 2) what the spatial limitations of this approach are--i.e. how accurately we can locate floodwater and swampwater breeding habitats with modeled hydrology; 3) regional variability in the approach--i.e. do the Black Rock findings corroborate the New Jersey results? By predicting the location of larval habitats, public health agencies will be able to effect control measures prior to the emergence of the mosquitoes as adults, when their role as nuisance pests and transmitters of disease comes into play.

June 25, 2001
Black Rock Forest Symposium
ATTENDEES

	Name		Association
1	Isabel	Ashton	SUNY Stonybrook
2	Jim	Beemer	Nat. Res.- USMA at West Point
3	Chanda	Bennett	CERC
4	Michali	Berenstein	Barnard - Environmental Science
5	William	Bowman	CERC
6	Barbara	Brady	BRF
7	John	Brady	BRF
8	Kim	Brown	LDEO
9	Shawn	Burnell	LDEO
10	Nicole	Buzzeto	Teachers College
11	Richard	Cobb	Harvard Forest
12	Catherine	Coleman	ITAM at USMA at West Point
13	Toni	Daly	Friends Seminary
14	Maureen	Davis	USMA at West Point
15	Joe	Deschenes	ITAM at USMA at WP
16	Sally Faith	Dorfman	
17	Chris	Duerkes	Barnard - Environmental Science
18	Victor	Engel	LDEO
19	Heather	Fener	CERC
20	Goncalo	Ferraz	CERC
21	Lewis	Gilbert	Columbia Earth Institute
22	Sibyl	Golden	
23	Matthew	Gompper	CERC
24	Kevin	Griffin	LDEO
25	Kim	Kastens	LDEO
26	Jim	Lewis	Fordham University
27	Joe	Liddicoat	Barnard College
28	Wendy	Miller	West Point
29	Gerry	Moore	Brooklyn Botanic Garden
30	Matthew	Munson	BRF/AmeriCorps

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	Name		Association
31	Jenn	Nagel	LDEO
32	Vladamir	Ovtsharenko	AMNH
33	Mrs.	Ovtsharenko	AMNH
34	Dorothy	Peteet	LDEO & GISS
35	Kelly	Pew	USMA at West Point
36	Greg	Robie	Storm King School
37	William	Schiller	AMNH
38	William	Schuster	BRF
39	Jeff	Shaman	LDEO
40	Jim	Simpson	LDEO
41	Marc	Steiglitz	LDEO
42	John	Stillman	
43	Martin	Stute	Barnard
44	Andrei	Tanasevitch	AMNH
45	John	Thompson	Mohonk Preserve
46	David	Tissue	Texas University
47	Molly	Trantern	Mohonk Preserve
48	Matthew	Turnbull	Univ. of Canterbury, New Zealand
49	Greg	Turner	Fordham University
50	David	Whitehead	Landcare Research, New Zealand
51	Mark	Wiljanen	Univ. of Eastern Kentucky
52	Amber	Wright	CERC
53	Ross	Zito	Museum of the Hudson Highlands