THIRD BLACK ROCK FOREST

RESEARCH SYMPOSIUM

June 23, 2003

PROCEEDINGS

BLACK ROCK FOREST CONSORTIUM
129 Continental Road - Cornwall, NY 12518
845-534-4517

Proceedings
Third Black Rock Forest Research Symposium
June 23, 2003

Talk Titles and Presenters

Session I: Long-term Studies

William Schuster, Black Rock Forest, "Past and potential future change in tree species dominance in the Black Rock Forest".

William E. Wright, Columbia University/Tree Ring Laboratory, "Stable oxygen isotopes and needle maturation of *Pinus strobus*".

Joseph Liddicoat, Barnard College, "Paleomagnetic dating of Sutherland Pond sediments in Black Rock Forest and early Holocene paleoclimate in the Hudson Highlands".

Dorothy Peteet, Columbia University/Lamont-Doherty Earth Observatory (LDEO), *Dee Pederson* Columbia University/LDEO, *T. Maenza-Gmelch*, New York University, *D. Kurdyla*, *P. Higginson*, and NASA/GISS ICP teachers and students, "Soil carbon storage – uplands vs. lowlands".

Session II: Forest Processes

Will Bowman, Columbia University/Center for Environmental Research and Conservation (CERC), "Quantifying stem respiration in the forest carbon cycle".

Kevin Griffin, Columbia University/LDEO, *J.D. Lewis*, Fordham University/Calder Center, *David Tissue*, Texas Tech University, *Matthew Turnbull*, University of Canterbury, New Zealand and *William Schuster*, Black Rock Forest, "Age-related impacts on tree growth".

Matthew Turnbull, University of Canterbury, New Zealand, *Kevin L. Griffin,* Columbia Unviersity/LDEO, *David T. Tissue,* Texas Tech University, *S. J. Richardson,* Landcare Research, New Zealand, *D.A. Peltzer,* Landcare Research, New Zealand, *William S.F. Schuster,* Black Rock Forest, *and David Whitehead,* Landcare Research, New Zealand, "Environmental factors influencing canopy respiration – implications for predicting forest carbon exchange".

David Whitehead, Landcare Research, New Zealand, *Kevin L. Griffin* Columbia University/LDEO, *Matthew Turnbull,* University of Canterbury, New Zealand, *David Tissue*,* Texas Tech University, *Victor C. Engel,* Duke University, *Kim J. Brown,* Ohio University, *William Schuster,* Black Rock Forest, *and A.S. Walcroft*, Landcare Research, New Zealand, "Response of total night-time respiration to differences in total daily photosynthesis in a canopy of *Quercus rubra* L." *presenter

Session III: Animal Population Studies

Dave Karrmann, American Museum of Natural History, "Structure and dynamics of a *Chrysemys picta* metapopulation (integrating research & education)".

Elizabeth Nichols, James Danoff-Burg, Columbia University/CERC, and *Fred Koontz,* Wildlife Trust, "Diversity and abundance of dung beetles in fragmented forest along an urban to rural gradient in the New York Bioscape".

Fred Koontz, Wildlife Trust, *Andres Gomez*, Columbia University/CERC *William Schuster, John Brady,* Black Rock Forest, *William Lynn*, Center for Humans and Nature, and *Scott Newman*, Wildlife Trust, "Coyotes of the Hudson River Highlands and the New York Bioscape initiative".

John Brady, Black Rock Forest, "A 19-year study of the whitetail deer in Black Rock Forest".

Talk Titles and Presenters of the Third Black Rock Forest Symposium continued....

Session IV: Community Studies

J.D. Lewis, Fordham University/Calder Center, "Tree and stand level responses to eastern hemlock decline".

Jerome Rozen and Valerie Giles, American Museum of Natural History, "The how, when, and whys of the bee survey of Black Rock Forest".

John Mickelson, Columbia University/Center for International Earth Science Information Network (CIESIN), *Fred Koontz,* Wildlife Trust, and *William Schuster,* Black Rock Forest, "Delineating ecological land units using multi-temporal Landsat imagery".

James Danoff-Burg, Columbia University/CERC, *Ed Goodell*, New York-New Jersey Trail Conference, *Jean Rothe,* Columbia University/CERC, and *Edwin McGowan,* New York-New Jersey Trail Conference, "Trail impacts on the birds and the bee(tle)s".

Aaron Kimple, Bard College/Black Rock Forest, and *William Schuster*, Black Rock Forest, "Impact of hemlock wooly adelgid on eastern hemlock stands in the Black Rock Forest".

Past and potential future change in tree species dominance in the Black Rock Forest

W. Schuster

There is evidence that we may now be entering a period of rapid change in much of the eastern deciduous forest. The nature of the dominant producers in any ecosystem, their health, and their productivity, dramatically impact the other organisms in the system. And if the trees that dominate eastern forests are changing, then most ecosystem processes and populations of organisms are not likely to be at equilibrium, but are probably changing as well.

Palynological studies in the Black Rock Forest and elsewhere by NYU biologist Terryanne Maenza-Gmelch and colleagues show that conifers first dominated these forests some 12,000 years ago, but were then replaced by oak trees and other hardwoods. Another rapid, dramatic change to the forest dominants occurred between about 1700 and 1850, when most of the eastern deciduous forest was cleared to establish settlements and agriculture. Many of these cleared lands were abandoned and forests regrew, but ecosystem health undoubtedly suffered. The loss of the American chestnut, starting in 1904, caused further substantial changes to these systems; chestnut composed at the time as much as 25% of the forest biomass in this region. By 1915 the chestnut blight had eliminated American chestnut in the area of the Black Rock Forest.

During the 1930s, Hal Tryon, Black Rock's first forest director, installed a series of long term plots and conducted forest inventories and botanical surveys that have been repeated up to the present. They document how tree density has decreased through mortality, and how basal area has increased from 5 - 20 square meters per hectare to 25 - 35 square meters per hectare over that time. Two significant downturns in biomass accretion identify important controlling factors: they coincide with the severe regional drought of the 1960s and defoliations by the introduced gypsy moth in the 1980s. Red oak has grown faster over the past 70 years in comparison to all other species and has played a dominant role in carbon storage at the forest level.

The makeup of the forest canopy has not changed much over this time period, as oaks have maintained about 2/3 of the canopy composition. Red and sugar maple have not increased in the canopy. In 1930 there was an equitable distribution of species in the forest understory. There were numerous red, chestnut, and white oak seedlings, along with red maple, sugar maple, and black birch. However, oaks have failed to regenerate and red maple now dominates the understory with the next most common species being black birch. Later successional forest understory trees such as shadbush and striped maple have also increased significantly.

Extensive botanical surveys by Hugh Raup in the 1930s and Kerry Barringer and Steve Clemants from the Brooklyn Botanic Garden in recent years have documented that the tree species that have disappeared completely from the forest are mainly northern relict tree species like paper birch and black spruce. The new species that have invaded are mostly southern species extending their distributions to the north, as well as some invasive, alien tree species.

I project that changes now occurring may alter species dominance over time and thus much of the rest of the forest ecosystem. A series of drought years culminating in 2002 caused slow growth, tree mortality, and led to numerous fires, some of which were hot enough to kill canopy trees. The death of canopy hemlock trees, following their infestation by the hemlock wooly adelgid, has initiated a cascading series of impacts in

hemlock-dominated portions of regional forests, including significant losses of species dependent on conifers.

Mortality in the oak canopy began increasing in 1999. The rate normally averages 1% per year but for the past four years has averaged 3% per year, which would trigger a rapid rate of canopy turnover if sustained. Eastern oak trees now face substantial challenges, some caused by invasions of non-native species such as oak wilt, oak dieback, and bacterial leaf scorch. If sudden oak death escapes the west coast quarantine zone and arrives here, mortality rates could soar.

Damage from an ice storm in November 2002 may now accelerate changes in forest canopy composition. We are beginning to establish new long-term plots in these areas to study the changes that are occurring and welcome others to collaborate on this project.

Stable oxygen isotopes and needle maturation of *Pinus strobus*

W.E. Wright

An ongoing project in Black Rock Forest is using needles from *Pinus strobus* (eastern white pine) to evaluate the potential of using stable oxygen isotope ratio ($\delta^{18}O$) time series in needle cellulose as proxies for needle cell maturation timing and high-resolution local environmental information. The time between the initiation of plant cells and the deposition of cellulose in the cell walls is the period of cell enlargement, so any difference between the time when needle extension measurements were made and the time of highest correlation between needle cellulose $\delta^{18}O$ time series and meteorological data may be interpretable as a proxy for the cell enlargement phase. The size of the window of significant correlation between the meteorological data and the stable isotope time series may be interpretable as a proxy for the duration of secondary cell wall formation, a process that is poorly understood and difficult to determine using standard techniques. The understanding of the timing of cell enlargement and secondary cell wall formation is also critical to climatological interpretation of high-resolution determinations of the stable isotope ratios in plant materials. In addition, comparisons of the stable-isotope time series from the needles and local meteorological data may reveal a source of high-resolution paleo-environmental data.

Paleomagnetic dating of Sutherland Pond sediments in Black Rock Forest and early Holocene paleoclimate in the Hudson Highlands

J.C. Liddicoat and K. Jennings

The path of the virtual geomagnetic poles (VGPs) for BRF-1 to a depth of 882 cm indicates the core there is no older than 13,000 BP (give or take a couple of hundred years, depending on assumptions about the orientation of BRF-1 and the Lake Ontario core for which the poles were calculated and matched). The VGPs for BRF-1 and Lake Ontario also match reasonably well with VGPs for Mono Lake, California, where there are Carbon-14 dates of 12,800+-60 yrs, 13,050+-80 yrs, and 13,700+-500 yrs BP. A comparison of declination for the three localities and several localities in the northeastern U.S. (Genesee Valley, Finger Lakes region, Lake Hitchcock, and the Mohawk Valley) also suggests an age of about 13,000 BP for the silt between 850 and 930 cm in BRF-1.

Soil Carbon: uplands vs. lowlands

D. Peteet, D. Pederson, T. Maenza-Gmelch, D. Kurdyla, P. Higginson, and NASA/GISS ICP teachers and students (K. Sauer, D. Overly, P. Cushing, J. Achampong, K. Ahkter, M. Ali, J. Alvarez, A. Anwar, N. Ewert, T. Penafort, S. Santacruz, T. Smith).

Storage of organic terrestrial carbon has become a topic of great interest and debate in the wake of increasing levels of atmospheric carbon dioxide. Conflicting estimates have been made of the amounts of carbon stored in forest ecosystems, and the relative amounts of carbon stored above and below-ground. Cascade Brook watershed, Black Rock Forest, NY is a particularly valuable site to test the amount of soil carbon because the soils are shallow and the watershed is closed, effectively meaning that the carbon sequestration should reflect the vegetational component of the watershed. Our previous research in Black Rock has focused on assessing the carbon storage at the millenial scale in wetlands, as climate changed. As part of the 2002 NASA/GISS Institute of Climate and Planets (ICP) summer program we compared the amounts of carbon stored above and below ground in uplands and lowlands. A third component of our research is a detailed ongoing program to measure the amount of soil carbon storage throughout the Cascade Brook watershed.

Our ongoing results suggest that the wetlands sequester carbon back to the time of deglaciation, about 15,000 calendar years ago. When the climate was colder and wetter, and *Picea* forest dominated, carbon was stored at a higher rate in the wetlands. When the forest became dominated by *Quercus*, carbon sequestration declined substantially. Surprising above-ground and below-ground results from an upland vs. lowland site suggest that the uplands today store slightly more carbon than the lowlands, and this is due to the dominance of *Quercus* in the uplands, and the significance of the duff layer on the ground. Upland below-ground carbon is significantly greater than that of the lowlands, probably due to the slow decomposition rate of the oak leaves in the duff layer relative to other species.

Quantifying stem respiration in stands of red oak (*Quercus rubra*) at Black Rock Forest

W.P. Bowman and K.L. Griffin

Measurements of CO_2 efflux from woody stems were collected from *Quercus rubra* in three stands (30, 70, 90+ years) in Black Rock Forest. An automated, multi-chambered system was utilized to make continuous measurements on the stems of nine trees per stand for up to 96 hours at various times during the growing seasons of 2001 and 2002. Temperature-normalized CO_2 efflux rates from stems ranged from 1.05 $\mu mol\ s^{-1}$ to 3.26 $\mu mol\ s^{-1}$ (per m^2 of stem surface area) and from 47 $\mu mol\ s^{-1}$ to 303 $\mu mol\ s^{-1}$ (per m^3 of sapwood volume). CO_2 efflux rates were largely predictable from sapwood temperature. CO_2 efflux, when expressed per unit sapwood volume, was found to be positively correlated with the reciprocal of stem diameter indicating that the source of this CO_2 is located close to the stem surface, such as the cambium and the thin-layer of living sapwood. In addition, area- and volume-based respiration rates decreased with increasing tree size. This is most likely due to decreased growth respiration in larger trees and, possibly, a decrease in maintenance respiration (per unit sapwood) in the large trees. Also, temperature-normalized respiration rates were found to decline later in the growing

season, particularly in younger trees, due to decreased respiration related to tree growth.

Age-related impacts on tree growth

K. Griffin, J.D. Lewis, D.T. Tissue, M.H. Turnbull, and W.S.F. Schuster

Age-related decline in forest growth is a well-known but scarcely studied paradigm in forest ecology. Clearly a mechanistic understanding of the patterns of growth associated with tree aging is fundamental to assessing the role of forests as carbon sinks, constructing mechanistic models of forest growth, predicting the response of forests to a changing climate as well as to a basic understanding of forest form and function. Recent improvements in the techniques and methodologies used to study large, long-lived trees, coupled with an evolving theoretical framework, have to some degree revitalized this subject and several advances have been made. Gower et al. (1997) summarize the status of the field by defining three hypotheses for age-related decline in aboveground net primary production associated with stand age:

1. Photosynthesis-respiration imbalance
2. Decreased nutrient supply (increased nutrient limitation)
3. Increased hydraulic resistance

In addition, Ryan et al. (1996) and Bond (2000) suggest that genetic changes associated with meristem age may also further constrain growth in trees as they age. Although this theoretical framework has helped to focus attention on this important issue and has stimulated several recent studies, to date, this research has not provided a clear mechanistic understanding of the observed phenomenon.

Nearly all of the studies of age-related decline have focused on coniferous species, primarily from the western US where old growth forests are more common. Studies on deciduous species dominating the forests of the northeast are conspicuously absent. In this presentation, we discuss the present understanding of the hypotheses and outline current studies in Black Rock Forest to address this important aspect of forest form and function. Specifically, we propose a detailed look at the photosynthetic biochemistry and physiology of red oak (*Quercus rubra*), the dominant forest tree species of Black Rock Forest.

We propose to work in five sites representing five distinct age classes (35, 70, 95, 110 and 130+ years). At each site, twelve canopy dominant red oak trees will be selected for sampling. The measurements will be made on detached branches from the upper sun-lit canopy. The focus of this experiment will be to quantify the physiological capacity for carbon fixation, basic foliar respiration rates, leaf chemical and physical properties, and site leaf area index and standing biomass.

We propose to test the following 6 null hypotheses:

H_1: The capacity to fix carbon is independent of tree (stand) age.

H_2: The ratio of Photosynthesis to Respiration (foliar) is independent of tree (stand) age.

H_3: The ratio of total carbon fixed to carbon lost (above ground) is independent of tree (stand) age.

H_4: Foliar nitrogen and carbon to nitrogen ratios are independent of tree (stand) age.

H_5: Hydraulic limitations to carbon gain are independent of tree (stand) age.

H_6: Gene expression related to the main carbon fixing protein (Rubisco) of photosynthesis is independent of tree (stand) age.

Environmental factors influencing canopy respiration – implications for predicting forest carbon exchange

M.H. Turnbull, K.L. Griffin, D.T. Tissue, S.J. Richardson, D.A. Peltzer, W.S.F. Schuster, and D. Whitehead

We measured the response of dark respiration (R_d) to temperature and leaf characteristics in the canopies of tree species over a range of scales (through the canopies of tree species from three distinct stands – an oak-dominated deciduous forest in north-eastern USA, a plantation of cottonwood and a conifer-dominated temperate rainforest in New Zealand; in sites of differing water availability within a single catchment; in successional temperate rainforest communities in New Zealand along a soil-age chronosequence [six sites from 6 to 120,000 years]). These were chosen to examine the extent to which canopy level changes in dark respiration can be applied across forest biomes and the appropriateness of scaling rules to calculations of whole-canopy carbon efflux. The response of respiration to temperature in the dominant tree species in these communities differed significantly with depth in the canopy, between sites and along the long-term soil sequence. This involved changes in both R_d at a reference temperature (R_{10}) and the extent to which R_d increased with temperature (described by the energy of activation, E_o or the change in R_d over a 10 °C range, Q_{10}). Within tree canopies, E_o ranged from 25 kJ mol^{-1} K^{-1} in lower-canopy leaves to 53.8 kJ mol^{-1} K^{-1} in upper-canopy leaves in the deciduous forest and from 24 to 37 kJ mol^{-1} K^{-1} in the temperate rainforest site. Trees also differed significantly in their response to temperature at sites of low and high water availability. Along the 120,000 yr soil chronosequence, site-averaged E_o ranged from 44.4 kJ mol^{-1} K^{-1} at the 60 year-old site to 26.0 kJ mol^{-1} K^{-1} at the oldest, most nutrient poor site. We concluded that canopy position, site and landscape level differences in leaf respiratory characteristics should be considered in modeling efforts attempting to estimate whole-canopy respiration over large scales.

Response of total night-time respiration to differences in total daily photosynthesis in a canopy of *Quercus rubra* L.

D. Whitehead, K.L. Griffin, M.H. Turnbull, D.T. Tissue*, V.C. Engel, K.J. Brown, W.S.F. Schuster, and A.S. Walcroft

*Presenter

Measurements of photosynthesis and respiration were made on leaves in summer in a *Quercus rubra* L. canopy at approximately hourly intervals throughout five days and nights. Leaves were selected in the upper canopy in fully sunlit conditions (upper) and in the lower canopy (lower). In addition, leaves in the upper canopy were shaded (upper shaded) to decrease photosynthesis rates. The data were used to test the hypothesis that total night-time respiration is dependent on total photosynthesis during the previous day and that the response is mediated through changes in storage in carbohydrate pools. Measurements were made on clear sunny days with similar solar irradiance and air temperature, except for the last day when temperature, especially at night, was lower than that for the previous days. Maximum rates of photosynthesis in the upper leaves (18.7 μmol m^{-2} s^{-1}) were approximately four times higher than those in the lower leaves (4.3 μmol m^{-2} s^{-1}) and maximum photosynthesis rates in the upper shaded leaves (8.0 μmol m^{-2} s^{-1}) were about half those in the upper leaves. There was a strong

linear relationship between total night-time respiration and total photosynthesis during the previous day when rates of respiration were scaled to a fixed temperature of 20^0C, removing the effects of temperature from this relationship. Measurements of specific leaf area, nitrogen and chlorophyll concentration and calculations of the maximum rate of carboxylation activity, V_{cmax}, were not significantly different between upper and upper shaded leaves five days after the shading treatment was started. There were small, but significant decreases in the rate of electron transport at saturating irradiance, J_{max} ($P<0.05$), and light use efficiency, ε ($P<0.05$), for upper shaded leaves compared with those for upper leaves. This suggests that the duration of shading in the experiment was sufficient to initiate changes in the electron transport, but not the carboxylation processes of photosynthesis. Support for the hypothesis was provided from analysis of soluble sugar and starch concentrations in leaves. Respiration rates in the upper shaded leaves were lower than those expected from a relationship between respiration and sugar concentration for fully exposed upper and lower leaves, but there was no similar difference in starch concentrations. This suggests that shading of the duration of several days did not affect sugar concentrations but reduced starch concentrations in leaves, resulting in lower rates of respiration at night. A model was used to quantify the significance of the findings on estimated canopy CO_2 exchange for the full growing season. Introducing respiration as a function of total photosynthesis on the previous day resulted in a decrease in night-time respiration by 23% compared with the value when respiration was held constant. This highlights the need for a process-based approach linking respiration to photosynthesis when modelling long-term carbon exchange in forest ecosystems.

Structure and dynamics of a *Chrysemys picta* metapopulation (integrating research & education)

D. Karrmann

The population of painted turtles (*Chrysemys picta*) in Black Rock forest is a metapopulation comprised of at least eight distinct local (sub) populations resident in discrete habitat patches separated by 200 - 800 meters. Watercourses providing obvious routes for peripatetic turtles connect some, though this generally increases linear travel distance up to 1200 meters. In other cases significant ridgelines requiring vertical displacement of up to 400 meters need to be traversed. Any comprehensive study of a population requires determining as precisely as possible what that population is. Koper and Brooks (1998) have shown that the traditional random sampling and statistical modeling techniques are only 40 – 60 percent accurate. It is suggested that an extended (3-5 year) program of rigorous mark-recapture (using a variety of capture methods: basking traps, feeding traps, dip netting), PIT tagging, and extensive data recording will be required to accomplish a thorough census of each local population, and thus the metapopulation. Completion of the census will lead to two additional lines of investigation. To determine the rate of gene flow, census data will be collated to identify individuals who have been collected from different habitat patches over time. During censusing, tissue samples (blood and or carapace notches) are being collected and stored at the frozen tissue lab at AMNH. When the sample base from each local population is sufficiently large it is expected that genetic study will provide a detailed analysis of gene flow and distribution between local populations. Morphological examination

of *C. picta* individuals to date suggests that both *C. p. picta* and *C. p. marginata* lineages of the complex are present. These subspecies are known to intergrade readily where their ranges overlap. Preliminary observations suggest that this intergradation is not evenly distributed among the local populations. A thorough morphological examination of the population is now being conducted. This includes compilation of a digital image file of each individual's carapace and plastron to document dorsal scute alignment/dis-alignment and plastral blotching. Future genetic analysis comparing markers from "pure" *C. p. marginata* and *C. p. picta* samples with those of the BRF population is expected to more definitively quantify the degree of intergradation.

As an education project, this offers the opportunity for AMNH classes to participate in actual on-going research. In addition, individual AMNH student interns become involved in a long-term research project that involves 7 months of fieldwork and year-round data manipulation and paper writing. Individual students and staff have the opportunity to develop their own related research project. Integrating a field project into the classroom stimulates the process of inquiry and encourages students to develop important cross-disciplinary skills in math, and biological, environmental, and physical sciences, as well as to develop writing and communication skills through the submission of abstracts and papers. This elevates the process from one of simple demonstration, where standard 'experiments' are reproduced from manuals or texts, to active development of original research with valid scientific implications, so that students are motivated to develop their own process of inquiry and to acquire a variety of skills that are often resisted in the traditional classroom environment. This is likely to lead to lifelong learning experiences, and the development of a sense of involvement, and achievement, in the scientific community.

Diversity and abundance of dung beetles in fragmented forest along an urban to rural gradient in the New York Bioscape

E. Nichols, J. Danoff-Burg, and F. Koontz

This study seeks to understand the impacts of urbanization on the diversity, distribution and abundance of coprophagous beetles. Urbanization results from the fragmentation of contiguous habitat into habitat islands, the interceding land between fragments (termed a matrix) gradually becoming dominated by impervious cover such as buildings or roadways. Habitat fragmentation has been shown to negatively affect terrestrial beetles by reducing species diversity, individual abundance within each species, and reducing body size. Dung beetles perform a large number of ecological services, including burying of dung and carrion, seed dispersal, control of vertebrate parasites and soil aeration. Without these services, plant diversity and regenerative ability in fragments decreases, soil nutrient levels fall, and vertebrate parasite levels rise, services which when lost have implications for both human and ecosystem health in fragmented areas.

Beetles will be sampled within contiguous forest and in forest fragments around which the matrix habitat is defined as forested, agricultural, low density suburban, high density suburban, and urban, chosen with aerial photography. Beetles will be sampled July-August 2003 using both flight intercept and pitfall traps. Understanding the changes wrought by urbanization on beetle community structure and concomitant function improves our understanding of how elements of the urban landscape influence the colonization and persistence of species

and has direct implications for maintenance and management of isolated parks and green areas. Improving our understanding of the impact of losing decomposers on long-term ecological health and human health is another key aim of this project, as dung beetles are postulated to be important in the reduction of vertebrate parasites and bacteria levels from fecal effluence.

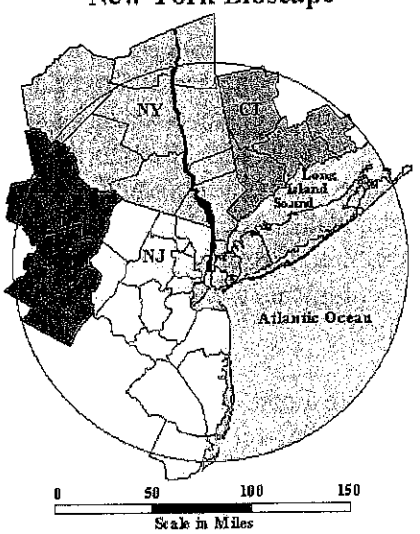
Coyotes of the Hudson River Highlands and the New York Bioscape Initiative

F. Koontz, A. Gomez, W. Schuster, J. Brady, W. Lynn, and S. Newman

Plans are underway to begin a long-term transdisciplinary study of coyotes living in Black Rock Forest and the New York Bioscape. The intent is to build on earlier work by Matthew Gompper and his colleagues, and to use the results to inform regional wildlife biologists, public health officials, and citizens with science-based coyote management recommendations. Our coyote research will focus on behavior and spatial ecology, health assessment, and their role as top predators in affecting ecological health. In addition, the team plans to investigate the attitudes and ethical values toward coyotes of people living in the New York Bioscape. The idea is that a better understanding of local human attitudes will guide our research questions, and consequently, strengthen the effectiveness of our public outreach efforts. By tracking the animals with GPS-based telemetry, the study subjects themselves will tell us how coyotes are responding to human-induced landscape modification. Health assessments will provide valuable context for separating fact from myth when evaluating concerns of sharing space with top predators like the coyote. We anticipate that the project will contribute to finding solutions to the increasing human-coyote conflict in the region. The project is one part of a larger effort: "The New York Bioscape Initiative."

The New York Bioscape Initiative, a collaborative effort of 34 scientists from 15 institutions, seeks in the New York City metropolitan region (100-mile average radius) to: assemble a transdisciplinary learning team to study ecology and health; demonstrate links between human-induced environmental change, biodiversity, and the health of all living things; bring the new discipline of Conservation Medicine to the area; help conserve biodiversity and habitats; and ultimately influence environmental policy, ecosystem management, and citizen behavior. It is also our intent to strengthen regional conservation thinking by offering a people-oriented approach that unites ecology, health, sense of place, and sustainable

New York Bioscape



living. In addition, because the New York City metropolitan region has a long, distinguished history of national environmental leadership, we recommend that it makes an ideal first major test of the "bioscape" concept.

A "bioscape" is both a way to describe a particular kind of region and a framework to study and integrate components necessary for sustainable ecological health. Geographically, a bioscape is a region bounded by a common sphere of human influence and comprised of a mosaic of areas with varying levels of human disturbance. A bioscape also serves as a human-oriented ecological unit for integrating environmental science, natural resources management, and public health policy together with local values and other activities needed to ensure sustainable ecological health. Successful bioscapes are marked by a strong local sense of place linked to an understanding of the connections between biodiversity, ecology, ecosystem function, health, and sustainability. In successful bioscapes, policies exist to protect biodiversity, maintain ecosystems, and safeguard public health. Bioscapes can vary in geographic scale (e.g. towns, metropolitan regions, states, recreational regions) and can be hierarchically nested and overlapping. The idea behind setting boundaries by a "common sphere of human influence," as opposed to natural boundaries (e.g. watersheds or ecoregions), is to increase the ease of connecting human decision-making to ecological stewardship and public health policy.

Wildlife Trust formally defines a bioscape as: "a social-ecological landscape whose boundary is set by a common sphere of human influence, and it serves as an effective area for integrating environmental science, natural resources management, and public health policy together with local values and other activities needed to ensure sustainable ecological health."

A 19-year study of the whitetail deer in Black Rock Forest

J. Brady

Information concerning white-tailed deer at Black Rock Forest has been collected for over 40 years. Since 1984 over 1000 deer have been measured and inspected at the Black Rock Forest deer station (N.Y.D.E.C. certified). Data collected (sex, age, antler beam diameter, antler points, weight and heart girth) have given excellent indications of herd health annually.

Determination of herd size began in 1988 using a deer tracking census method during the winter months, monitoring deer group size, ranges and health.

Herd health and size has proven to be closely related to mast crops. Since 1995 acorn production has been measured and studied. Calculations have been made of numbers and pounds per acre by species, also determining viability and germination rates.

The presentation of this information makes researchers and students aware of the data available for future studies and projects. The next step for a successful management plan concerns the effects of deer on forest regeneration, determining forest carrying capacity, and the many questions concerning oak regeneration.

Tree and stand level responses to eastern hemlock decline

J.D. Lewis

Invasive, non-native insects and pathogens are a significant threat to native forests. Currently, forests from North Carolina to Massachusetts are experiencing striking

declines in eastern hemlock (*Tsuga canadensis*) associated with the invasion of the hemlock woolly adelgid (*Adelges tsugae*). The dramatic changes in eastern hemlock growth and mortality associated with this invasion may have far-reaching effects on forest communities because eastern hemlock is a widespread, dominant tree species. Although the impact of the invasion is likely to reflect the densities and distributions of eastern hemlock and the hemlock woolly adelgid, relatively little is known about how these factors may affect forest responses to the hemlock woolly adelgid. A series of experiments conducted in the Black Rock Brook watershed over the last four years have added new insights into these issues. At the leaf level, net photosynthetic rates declined by ~30% as the average adelgid density increased from zero to 0.5 adelgid per needle. However, net photosynthetic rates did not significantly vary as adelgid density increased from 0.5 to two adelgids per needle. At the tree-level, eastern hemlock growth was significantly negatively correlated with the extent of defoliation, an indicator of hemlock woolly adelgid densities. However, despite significant reductions in eastern hemlock growth, growth of co-occurring red oak, red maple, and sugar maple did not significantly vary with the relative dominance of eastern hemlock. In contrast, assays of the ectomycorrhizal community using red oak bait seedlings and soil cores found significant reductions in fungal abundance and diversity in hemlock-dominated relative to oak-dominated stands. Further, 92% of the variation in the growth of red oak seedlings outplanted into oak and hemlock stands could be explained by variation in fungal abundance and diversity, and stand type. These results indicate that the densities and distributions of eastern hemlock and the hemlock woolly adelgid influence the impact of the hemlock woolly adelgid on forest communities, and that the impact of the hemlock woolly adelgid can have cascading impacts on other trophic levels and on tree regeneration within affected stands.

The how, when, and whys of the bee survey of Black Rock Forest

J.G. Rozen, Jr., and V. Giles

Of all of the animal pollinators of angiosperms in terrestrial ecosystems, bees (hymenoptera: *Apoidea*) are believed to be the most important because virtually all bees feed their larvae on pollen mixed with nectar (honey) or floral oils. Through the act of foraging for these substances, female bees accidentally transport pollen from flower to flower on their hairs and body parts, thus pollinating the plants. Males also contribute in that many visit flowers to nectar, to sleep, and to search for females. Because of their ability to pollinate plants and because of their abundance and diversity, bees plan a fundamental role in maintaining and perpetuating terrestrial ecosystem. The survey of the bees of Black Rock Forest will provide baseline data on bee diversity that can be used to monitor changes in the forest and in the surrounding lands through time.

Specimens collected will be a valuable addition to the dry collection of the American Museum of Natural History since little recent material has been added from the northeastern United States. Other specimens will be incorporated in the frozen tissues collected of the same institution, i.e. the Ambrose Monell Cryo collection; they will be among the first bee specimens to be made available to the scientific community for DNA studies. A synoptic collection will also be deposited at the Black Rock Forest, for possible site use by other researchers.

Survey techniques require sampling to be carried out throughout the flowering season of the year because of flowering of different plant species through the seasons. Sampling is carried out using hand nets, pan traps, and trap nesting throughout Black Rock Forest.

Delineating ecological land units using multi-temporal Landsat imagery

J. Mickelson, F. Koontz, and W. Schuster

This on-going project seeks to advance our ability to resolve, map, and analyze more accurate and precise digital geospatial data and information systems representing land cover and ecological communities within Black Rock Forest (specifically, Landsat TM Scene 14/31), and eventually, the entire New York Bioscape. We seek to improve the mechanisms and protocols for establishing more detailed spatial and thematic information and data baselines than are currently available, with the intent that the resulting products will be used for effectively mapping (locations and distributions), monitoring (conditions and changes), and modeling (historic paleo-ecological patterns, underlying drivers and system influences, and projected future conditions) multivariate environmental dimensions across both spatial and temporal scales. Multi-date Landsat TM and ETM+ imagery, as well as a wide array of ancillary digital geospatial data and GPS referenced ground plots, will be used to evaluate the spectral and spatial signals that ecological communities (as defined by the National Vegetation Classification System and the New York State Natural Heritage Program) exhibit across the growing season. We hope that efforts as varied as Wildlife Trust's New York Bioscape Initiative to research projects at Black Rock Forest to the Natural Heritage Program will benefit from the methods and information generated from this project.

Progress, to date, includes building a system to utilize detailed information from over a thousand vegetation plots across New York State from a network of collaborators, as well as the establishment of an image acquisition partnership with three regional University mapping programs (Cornell, Rutgers, Syracuse), whereby our satellite purchase dollars can be potentially more than tripled. The first NY State Land Use\Land Cover (LULC) Working Group has been fostered as a consequence of the project, along with a working relationship with the major federal LULC programs in the region (EPA\USGS MRLC and NLCD, Urban Dynamics). Efforts are underway to discuss the exchange of methods, results, and associated data (e.g. ground control points) within these communities, and to assess the possibility of securing additional funding for the project through Federal government programs.

Now in its second year, the project, after initial funding by CERC (Center for Environmental Research and Conservation, headquartered at Columbia University) has received continued funding through Wildlife Trust to extend the work through 2003-2004. In upcoming months, we will integrate the vast amount of ground plot and image data collected during the first part of the work. Also, additional vegetation data will be acquired during the coming field season, filling in gaps spatially as well as compositionally (by classes) with the hope that invasive species information (e.g. purple loosestrife, *Lythrum salicaria*, and common reed, *Phragmites australis)* can be included within our final classification categories. Our intent is to produce markedly more accurate and detailed ecological land units information for Black

Rock Forest and the area covered in Scene 14/31, as well a methodological template and image processing engine that will drive the construction of the same level of detail for the entire New York Bioscape.

Effects of hiking trails on arthropod and bird community diversity

J. Danoff-Burg, E. Goodell, J. Rothe, and E. McGowan

A great deal of research in the past decade has been conducted to examine the effects of forest fragmentation on both animal and plant populations and communities. This work has focused on large-scale fragmentation that reduces forests to isolated islands of habitat. In the northeastern United States, as the cleared areas between forests regenerate, the frequency of such large-scale fragmentation may be declining (Foster 1992). Instead, as relatively undisturbed forest become managed as multiple use facilities, a potentially more insidious type of fragmentation is superimposed onto the landscape in the form of smaller scale internal fragmentation. This type of disturbance is caused by roads, power lines, and other linear disturbances cutting through a previously undisturbed forest and affects a greater overall land area than direct habitat loss (Foster 1992). We propose to answer whether and how single-path hiking trails may detrimentally impact upon native arthropod and bird fauna in the Black Rock Forest and the nearby Sterling Forest. This project proposal represents a novel collaboration between two Black Rock Forest Consortium members: Columbia University and the New York – New Jersey Trail Conference (NYNJTC).

Spatial patterns of HWA damage and impacts on tree physiology and water use in the Black Rock Forest, southern New York

A. Kimple, and W. Schuster

This study was designed to document spatial patterns in HWA damage in three hemlock stands in the Black Rock Forest, southeastern New York, 4 to 8 years after adelgid infestation, and to quantify HWA impact on hemlock operating physiology and water use. In all three stands, damage was more severe along the stream courses and less severe away from the streams. A similar negative relationship was found between damage and distance from the forest/stand exterior. The data suggest that damage from HWA to large, native eastern hemlock stands progresses through stands in linear manner over a course of several years, but these spatial differences in damage lessen over time. It is not known whether the pattern of lower damage away from stream channels is related to adelgid dispersal or to topoedaphic conditions.

Managers can expect that mortality in hemlock stands will first occur at initial areas of contact on stand exteriors, potentially allowing more time to implement control strategies in interior locations. HWA damage reduces tree sap flow and transpiration but not simply as a linear function of defoliation damage class. During the summer, heavily damaged trees exhibited only 50% of the sap flow of other trees, but trees with lighter levels of damage showed no significant reduction. During the fall, however, sapflow drops precipitously in trees with moderate or high levels of damage compared to trees with lighter damage. Stand productivity and water use appear little impacted until an intermediate threshold of damage has occurred. Enhanced soil moisture availability may first be noticed toward the end of the growing season. Once trees reach heavily damaged status, water uptake and transpiration are severely reduced throughout the growing season, leaving substantially more water available for evaporation, runoff, and/or use by other plant species.