

Award 1633026 - Annual Project Report

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Accomplishments

* What are the major goals of the project?

The overall goal of Long-Term Ecological Research at Hubbard Brook Experimental Forest (HBR-LTER) is to advance the understanding of the response of northern forest ecosystems to natural and anthropogenic disturbances. The HBR serves as a hub for ongoing forest ecosystem research in the northeastern region where a suite of natural and anthropogenic disturbance agents is causing an unprecedented pace of change in ecosystem structure and function. We conduct an integrated suite of long-term monitoring, experimental manipulations, modeling and quantitative analysis, and public outreach and education activities. The HBR-LTER is providing both fundamental insights about forest ecosystem dynamics and applications to help guide policy and management responses concerning human-accelerated environmental change. In our current LTER funding cycle we are evaluating landscape scale patterns and processes. New studies have been initiated to improve theoretical understanding of the dependence and interconnections of ecological, hydrologic, and biogeochemical phenomena within and across various landscape scales.

Long-term collection of precipitation and surface water for complete chemical characterization has been maintained continuously since the 1960s. Our biogeochemical monitoring program is designed to provide baseline measurements from which human-induced deviations can be resolved. Similarly, we quantify the hydrologic budget of a suite of small watersheds that allows us to detect global change effects on hydrologic fluxes with extremely high sensitivity. We also maintain a comprehensive, long-term monitoring program on forest vegetation composition, biomass, productivity and chemistry and the population trends of a suite of heterotrophic organisms, focused on passerine birds and their food web. These surveys indicate local and global phenomena shaping trends and a baseline for development of deeper theoretical understanding of ecological interactions.

Our most prominent ongoing watershed-scale experiments quantify ecosystem recovery from forest harvests and ecosystem responses to restoration of pristine conditions of soil base saturation. A variety of plot-scale experiments and manipulations also provides additional process-based understanding of ecosystem function in northern hardwood forest ecosystems. We synthesize the work at Hubbard Brook using simulation models, model-data fusion and uncertainty analysis to improve understanding of ecosystem dynamics at various spatial and temporal scales. Our dynamic hydrochemical models are useful tools for understanding and predicting the interactive effects of climate change, atmospheric CO₂, and atmospheric deposition on the hydrology and water quality of forested watersheds. Evaluation of uncertainty in ecosystem dynamics has been limited by the complexity of ecosystem data sets and processes, but new computational tools provide the means to improve this situation. A major ongoing activity in the HBR-LTER project has been to advance error analysis in biogeochemical budgets.

The HBR LTER project has an active program of outreach and education activities, mostly coordinated through the Hubbard Brook Research Foundation, a non-profit group that supports research at Hubbard Brook through outreach, education and maintenance of research facilities. Long-term research should play a crucial role in addressing grand challenges in environmental stewardship at local and national scales. The HBR LTER takes this responsibility very seriously. We attempt to inform policy decisions through our Science Links program and our collaboration in the Science-Policy Exchange, a consortium of academic institutions and LTER sites dedicated to using scientific information in the policy process. The project also seeks to provide high-quality programs for the training and development of scientists and educators.

* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities: **LONG-TERM MONITORING:** We continued routine, weekly collections and analysis of precipitation and stream water from gauged watersheds at Hubbard Brook (HBR) and from the gauged outlet at nearby Mirror Lake. We sample ungauged W101 on a monthly basis. During periods of elevated flow automated ISCO samplers are used for more intensive sampling on W1, W6, W9, and the main Hubbard Brook. Samples are analyzed for concentrations of Ca²⁺, 4+Mg²⁺, K⁺, Na⁺, NH₄⁺, pH, SO₄²⁻, NO₃⁻, Cl⁻, PO₄³⁻, dissolved Si, monomeric aluminum, total dissolved nitrogen (TDN), dissolved organic carbon (DOC), pH, acid-neutralizing capacity (ANC), dissolved inorganic carbon (DIC), and specific conductance. We collect year-round, hourly water temperature data from all 9 gauged watersheds and from Mirror lake (from a centrally-located buoy, at 0.10-m depth), using programmable micro-thermistors.

ECOSYSTEM SERVICES: In 2016, we finalized an analysis of the effects of harvesting forest biomass on water and climate regulation ecosystem services based on long-term data from HBR and two other sites. Demand for woody biomass fuels is increasing amidst concerns about global energy security and climate change, but there may be negative implications of increased harvesting for forest ecosystem functions and their benefits to society (ecosystem services). Using new methods for assessing ecosystem services based on long-term experimental research, post-harvest changes in ten potential benefits were assessed for ten first-order northern hardwood forest watersheds at HBR and two other long-term experimental research sites in northeastern North America.

We conducted an analysis of costs, health and ecosystem co-benefits for a U.S. power plant carbon (C) standard (known as the Clean Power Plan) that has been finalized by the Environmental Protection Agency (EPA). Reducing carbon dioxide (CO₂) emissions from power plants can have important “cobenefits” for public and ecosystem health by reducing emissions of air pollutants. We examined the costs and health co-benefits, in monetary terms, for a policy that resembles the Clean Power Plan and then examined the spatial distribution of the co-benefits and costs, and the implications of a range of cost assumptions in the implementation year of 2020.

CARBON FLUX STUDIES: Our model of deciduous forest phenology, calibrated to PhenoCam data from across the eastern USA (including HBR), was used to predict spring onset in Northern Hemisphere deciduous forests under future climate scenarios. By embedding the phenological model in CLM, the Community Land Model, we investigated how future shifts in phenology would influence biogeochemical cycling.

CLIMATE CHANGE STUDIES: HBR is located at the headwater regions of the Merrimack Watershed, the fourth largest basin in New England, USA. The Merrimack watershed is mostly forested (67%) with some developed regions (16%). We assessed the scale-dependency of streamflow response to climate variation, river regulation, and development for dry, average, and wet years using long-term precipitation and discharge records for HBR and the Merrimack River.

Assessments of future climate change impacts on ecosystems typically rely on multiple climate model projections, but often utilize only one downscaling approach trained on one set of observations. Here, we explored the extent to which modeled biogeochemical responses to changing climate are affected by the selection of the climate downscaling method and training observations used at the montane landscape at HBR. We evaluated three downscaling methods and trained outputs from four atmosphere–ocean general circulation models (AOGCMs) driven by higher and lower future emissions scenarios on two sets of observations to generate high-resolution climate input for the forest biogeochemical model PnET-BGC.

We also used a suite of models to analyze ecohydrological responses to climate change in seven diverse, forested watersheds in the northeastern United States, including HBR. We evaluated responses of evapotranspiration, soil moisture, seasonal and annual streamflow, and water stress to projections of future climate. We used output from four AOGCMs, coupled with two Representative Concentration Pathways (RCP 8.5 and 4.5). The coarse resolution AOGCMs outputs were statistically downscaled using an asynchronous regional regression model to provide finer resolution future climate projections as inputs to the deterministic dynamic ecosystem model PnET-BGC.

DISTURBANCE STUDIES: We quantified damage by a microburst windstorm that affected HBR in June 2013. These storms may be important in regulating the structure, dynamics and composition of northeastern U.S. forests, but few studies of damage patterns from microburst storms have been reported.

BIODIVERSITY STUDIES: In a collaborative effort with the Harvard Forest LTER and other investigators, we reviewed the scientific information on the ecological and economic impacts of non-native forest pests in the U.S., and policy options for reducing future invasions.

Ongoing studies of forest birds this year focused on the ability of intact forest to promote stable population trends of songbirds at HBR. Recent work suggests current and future broad-scale declines across forest bird species. However, drawing firm conclusions from such trends can be complicated due to spatial biases in sampling, differential trends across spatial scales, and biases caused by imperfect detection. We estimated population trends from 1999-2012 for 38 forest bird species that were sampled systematically across an undisturbed forested watershed at HBR and compared these trends to those estimated at regional and local scales to address three questions: (1) Are any species consistently declining across each of these scales? (2) Are life history or ecological traits predictive of putative declines? (3) To what extent does imperfect detection obscure long-term trends? We derived regional trends from the Breeding Bird Survey (BBS) and local trends from a 10-ha plot within HBEF.

INTERACTIONS OF NITROGEN AND CARBON: To understand how nitrogen cycling varies with depth and forest stand age, we measured gross and net nitrogen (N) mineralization and nitrification rates, as well as extracellular enzyme activity to 50 cm depth across three sites varying in stand age (45 and 100 years post-harvest and old growth) at and near HBR. Enzyme activity and N cycling rates were expected to decrease with depth in response to decreasing soil C and N concentrations and increasing organic matter age.

We developed a new simulation model for forest C and N cycling based on data from HBR and elsewhere in the northeastern US. The model, called Spe-CN, is an advance because, unlike previous models, it distinguishes different

tree species and allows the user to simulate the consequences of tree species change. We used the model to predict likely changes in C and N cycling that would be caused by invasion of introduced forest pests and subsequent changes in tree species composition. We simulated decline of American beech due to beech bark disease, of eastern hemlock due to the hemlock woolly adelgid, and of red oak due to the disease called “sudden oak death”.

Specific

Objectives:

Significant

Results:

LONG-TERM MONITORING: Analysis of long-term Ca data showed that a harvested watershed had increased Ca flux in stream water after it was cut in 1983-84, that slowly declined toward pre-treatment levels thereafter. As of 2009, the difference in flux between the watersheds no longer exceeded the uncertainty in the estimates, indicating that the treatment effect was detectable for 25 years after the harvest. We evaluated individual sources of uncertainty and determined that in some cases (e.g., unusable precipitation chemistry, gaps in streamwater volume) the uncertainty could be reduced. Our results highlight the value of estimating uncertainty in studies where replication is impracticable and demonstrates how uncertainty estimates improve confidence in comparisons.

ECOSYSTEM SERVICES: Our analysis of the effects of harvesting forest biomass on water and climate regulation services showed that there are near-term tradeoffs between intensive harvest and the capacity of the forest to remediate nutrient pollution (Figure 1). In both cases, service provision began to recover along with the regeneration of forest vegetation; in the case of pollution remediation, the service recovered to pre-harvest levels within 10 years. In contrast, biomass harvesting had relatively nominal and transient impacts on other ecosystem services. Our results are sensitive to empirical definitions of societal demand, including methods for scaling societal demand to ecosystem units.

Our analysis of costs, health and ecosystem co-benefits for a U.S. Clean Power Plan were \$29 billion, and net co-benefits under our central cost case were \$12 billion. The results for our central case suggest that all but one region should experience positive net benefits within 5 years after implementation. Decreases in CO₂ emissions from fossil fuel combustion also have the potential co-benefit of reductions in emissions of oxides of N, which contribute to the formation of ground-level ozone.

CARBON FLUX STUDIES: Our model of deciduous forest phenology predicts a greater advancement of spring onset (~10 days by 2100) which then influences ecosystem services related to C and water (Figure 2). The model indicates that gross and net primary production of deciduous forests worldwide will be enhanced, together with evapotranspiration – meaning that future advances in spring onset will result in more forest productivity but drier soils and reduced runoff for downstream uses.

CLIMATE CHANGE STUDIES: Analysis of the scale-dependency of streamflow response across the Merrimack watershed showed that the effects of basin scale were limited to discharges with exceedance probability of less than 15% and greater than 60%. Annual discharge responded to increases in annual precipitation but not to river regulation or land development.

Our analysis of the effects of climate downscaling technique and observational data set on modeled ecological responses showed that the choice of downscaling approach and spatial resolution of the observations used to train the downscaling model impacted modeled soil moisture and streamflow, which in turn affected forest growth, net N mineralization, net soil nitrification, and stream chemistry. All three downscaling methods were highly sensitive to the observations used. Different sources of variability including selection of AOGCM, emissions scenario, downscaling technique, and data used for training downscaling models, result in a wide range of projected forest ecosystem responses to future climate change.

Model analysis of ecohydrological responses to climate change indicated that warmer temperatures and longer growing seasons will increase evapotranspiration across all sites, although invoking CO₂ effects on vegetation (growth enhancement and increases in water use efficiency) diminish this response. The model showed that enhanced evapotranspiration resulted in drier growing season conditions across all sites and all scenarios in the future. Our analyses suggest that dominant vegetation type and soil type are important attributes in determining future hydrological responses to climate change.

DISTURBANCE STUDIES: In a 600 ha area impacted by a microburst windstorm that affected HBR in June 2013, 4.6% of the canopy was removed. Although most disturbances were small (< 200 m²), much (22%) of the area damaged by the storm was associated with one 5.2 ha gap (“epicenter”) within which 75% of the trees suffered severe damage (Figure 3). Intermediate windstorms like this one may have played a significant role in determining the pattern, structure and composition of these humid temperate forests, maintaining populations of intolerant and mid-tolerant species, but additional data on the spatial extent of damage caused by microburst storms is needed.

BIODIVERSITY STUDIES: Our review of the scientific information on the ecological and economic impacts of non-native

forest pests in the U.S. found that nonnative insects have accumulated in United States forests at a rate of approximately 2.5 per yr over the last 150 yr. Introduced insects and diseases occur in forests and cities throughout the United States, and the problem is particularly severe in the Northeast and Upper Midwest. Nonnative forest pests have severe ecological impacts, and are the only disturbance agent that has effectively eliminated entire tree species or genera from United States forests within decades. The economic damage from nonnative pests is not yet fully known, but is likely in the billions of dollars per year, with the majority of this economic burden borne by municipalities and residential property owners.

Analysis of population trends from 1999-2012 for 38 forest bird species showed that abundance trends of most forest bird species at HBR were relatively stable over the period observed; we detected statistically significant declines in only 7 of 38 species (18.4%). The relatively stable breeding habitat at HBR appears to translate into mostly stable bird populations over the 14 years observed. This contrasts with trends between 1969 and 1998 showing consistent declines across many species (~50%), and is therefore cause for cautious optimism.

INTERACTIONS OF NITROGEN AND CARBON: Analysis of how N cycling varies with depth and forest stand age found that N- and C- degrading enzyme activity correlated with gross N mineralization rates, but not net N mineralization rate, directly linking microbial activity to the release of N from soil organic matter. We found that N cycling rates per g dry soil and g N decreased between the forest floor and mineral soil, but decomposition enzyme activity remained constant relative to decreasing organic matter concentrations with depth. On an areal basis, N cycling in the mineral soil was much larger than flux in the organic horizon due to the large mass of the mineral soil. We found few differences in activity rates across the three sites that differed in age, though net nitrification was significantly higher at the old growth site and enzyme activities were often lower at the 100 year old stand as compared the other two sites. Although N cycling decreased with depth, N turnover remained relatively high throughout the soil profile, highlighting the availability of N in old SOM and the likely importance of deep soil in supplying N to plants and microbes.

Simulated declines of American beech, eastern hemlock, and red oak due to pests and pathogens with the Spe-CN model showed that the responses of productivity, C storage, and N leaching depend on the identity of the declining species and the species that replace it, and that these responses are predictable given species-specific information. Predictions of future C and N cycling in these forests will need to account for likely changes in tree species composition.

Key outcomes
or Other
achievements:

HBR INFORMATION MANAGEMENT

The Information Management System at HBR addresses several major goals; (1) maintaining a catalog of HBR data, with an emphasis on high quality data/documentation and data preservation (2) enabling data discovery/access to serve the HBR, LTER, and broader scientific communities (3) development and maintenance of a website to share information on site history, current research, publications, photos, educational materials, etc. (4) maintaining a physical sample archive. The primary role of the HBR Information Manager is to support the HBR information management system (IM) and to provide expertise in data documentation, archiving and retrieval, for on and off-site scientists conducting research projects and data syntheses.

Data catalog - The HBR data catalog is available on the HBR website as well through the LTER data portal.

The data catalog contains 142 data packages ranging from single year studies to longterm data collections, with more than 20 data packages containing data collected for more than 50 years, and another 30 covering a timespan of more than 20 years. Ongoing data package development addresses time-series additions to our core data sets and the incorporated of new data sets. We have also restructured a number of data sets to better serve the user community. For example, a data series collected at 5 year intervals, packaged in different data sets, with varying formats, has been restructured in to a single data set with a common format. A number of other data sets will undergo similar restructuring to improve usability (e.g., vegetation inventory). For almost a decade, we have averaged 10 data downloads per day, from users identifying themselves as Academic, K-12 and post-secondary educators, LTER, and government agencies.

Data Access Policy - HBR adheres to the LTER Network Data Access Policy. To date, all the data collected at HBR are considered Type I, with a goal of release to the general public within 2 years from the time of collection. When users view or download data from the local HBR data catalog, they self-identify by entering their name, affiliation, email address. This information is stored in a database and provides statistics on data use and users. Datasets accessed through the LTER-NIS are tracked through 'Data Package Access Reports'.

Website: The HBR website (<http://hubbardbrook.org>) is the primary means by which HBR information is disseminated, with additional non-digital data (charts, maps, photographs) made available upon request. Online access to HBR information and data has been available since the early 1990s, with several major upgrades in the intervening years. The most recent HBR website redesign occurred in 2012, following the Guidelines for LTER Web Site Design and Content. A

more comprehensive update to the website is currently underway. In this effort, we are using a Drupal framework to combine the research-based content on <http://hubbardbrook.org>, with the education and outreach content on the <http://hubbardbrookfoundation.org>. Additional funding for this substantial website upgrade is provided by an NSF Division of Research on Learning (DRL), Advancing Informal STEM Learning (AISL) Grant, awarded to the Hubbard Brook Research Foundation: *Pathways: Forest Science Dialogues* (NSF # 1322871 PI: Sarah Garlick, co-PI: David Sleeper)

All HBR publications are uploaded to the central LTER bibliography database at <http://bibliography.lternet.edu>.

HBR Environmental Sensors: HBR Information management provides support for the environmental sensor network at the site; the core sensor network monitors stage height/temperature/conductivity from streams in 9 watersheds in the Hubbard Brook valley, and meteorological data from 10+ stations throughout Hubbard Brook. Maintenance and operation of these sensors is done by Forest Service staff, and the HBR-IM works closely with that team on the implementation and operation of data processing and quality control.

In the *Smart Forests for the 21st Century* initiative, Hubbard Brook takes the lead in extending this sensor technology to other USDA Forest Service Experimental Forests. In the past year, the Penobscot Experimental Forest and the Milford Experimental Forest at Grey Towers have been added to this network (operational sites include Hubbard Brook, Marcell (MN) and Fernow (WV) Experimental Forests and Alley Pond Park in Queens NYC). The LTER-funded GCE Toolbox provides both the quality control workflow for data from these site, and the centralized data portal for this environmental sensor network (<http://smartforests.org>). Funding to the HBR-IM for support of SmartForests comes from a USFS cooperative agreement with UNH.

Hubbard Brook Sample Archive: A dedicated building on-site serves as the archive facility, and now houses approximately 100,000 samples. Our efforts in the sample archive facility are all targeted at improving researcher interest and access in further resampling and analysis. Samples are preserved, barcoded, and cataloged with associated metadata in the HBR centralized database; a process that ensures the discoverability and access to samples for future research. A sample archive subsampling policy has been developed to 1) maintain the chemical integrity of these samples; 2) preserve sample volume for future analysis; 3) to document the use of these samples, and any resulting changes; 4) inform principal investigators of interest in sample use; and 5) to acknowledge the appropriate funding sources for their original collection. Requests for analysis of these samples (e.g. isotopic analyses, heavy metals) are received regularly, and have resulted in at least 37 publications (soils n=8; water n=15; forest floor n=11; plant material n=3). During this current funding cycle, the establishment of the HBR Archive Committee and archive support from LTER supplemental funding have improved our capability to move forward in cataloging and storing additional samples. We have been able to make extensive updates to the inventory, organization, and sample volume data for the streamwater and precipitation samples. The development of a data entry station in the archive building that incorporates bar-code scanning and direct scale-to-computer entry of sample weights has streamlined this process.

Other projects involving HBR-IM:

Innovative data outreach: A water cycle visualization and sonification have been developed for Hubbard Brook (<http://waterviz.org>). To support this collaborative between hydrological scientists, artists, musicians, and computer scientists, the HBR-IM has developed a real-time data workflow that combines data from multiple dataloggers, calculates variables on-the-fly (e.g. evapotranspiration), and stages an hourly custom datafile for access by this interdisciplinary team. Initial funding for this collaborative effort has come from a number of different entities (see [waterviz](http://waterviz.org) website). In August 2015, an interdisciplinary team was funded by a NSF-EAGER grant to further this work. Funding for the grant, *Collaborative Research: The Confluence of Music, Art and Science at Long Term Ecological Research Sites* (\$300K), went to three institutions: UNH (lead institution with HBR-IM as PI with summer salary), Dartmouth College (Casey PI) and the Hubbard Brook Research Foundation (Garlick PI). Both RET and REU supplemental proposals were recently submitted to fund additional work on this project at Hubbard Brook.

* What opportunities for training and professional development has the project provided?

The Hubbard Brook LTER project takes very seriously its responsibilities for the training and development of scientists and educators. Most of these activities are coordinated through the auspices of the Hubbard Brook Research Foundation, a non-profit group dedicated to synthesis, outreach, education, and support of facilities associated with the HBR LTER.

During 2016 these activities included: 1) an undergraduate research program; 2) our Environmental Literacy Program (ELP), which is a cooperative effort with the USDA-Forest Service and the Schoolyard LTER aimed at supporting secondary science teachers through training events and the development of teaching resources;

3) posting of related educational-support material on our web pages (www.hubbardbrook.org and www.hubbardbrookfoundation.org); 4) cooperation with other regional groups engaged in secondary education teacher development; 5) conducting field trips at the site for visiting schools and the general public.

Undergraduate Research Program: We did not receive continued funding for our REU site program, yet continued to offer a cohort experience for as many undergraduates as possible. Using a combination of LTER funds, a no-cost extension on the REU site award, REU supplements to existing grants, USDA-Forest Service funds, and other support from research mentor teams, we supported eight undergraduates from around the country for a 10-week REU program. Students were paired with Hubbard Brook researchers and developed and conducted independent research projects on topics representing the range of research at the Hubbard Brook LTER. These students also interacted and lived with graduate students, other undergraduates serving on field crews, and a spectrum of Hubbard Brook scientists at weekly Science Night dinner/talks. We are planning on submitting a renewal grant for our REU site program in 2017.

Environmental Literacy Program (ELP): ELP is a joint project of the HBRF and the USDA Forest Service Northern Research Station to use ecological knowledge to promote informed decision-making for a sustainable future. It is funded through both the USDA-Forest Service and the LTER Schoolyard program. ELP has three main components, as follows:

1. Teaching resources: A central aim of our ELP program is to provide HBES data to teachers in a format which supports their efforts at building both science-process skills and content knowledge in their students. To this end we have worked with teachers and scientists to develop data sets, lessons, and slideshows that emphasize the evaluation of data as well as the thought processes that lead to the research questions. These resources are supported by teacher workshops and on-going interactions with HBRF staff. Current offerings can be found at:

<http://hubbardbrookfoundation.org/middle-and-high-school-2/>

2. Teacher professional development: We continue to present at teacher workshops and are active cooperators with the New Hampshire Science Teachers' Association. We also partner with the New Hampshire Education and Environment Team (NHEET) to provide teacher workshops focusing on science process skills, including a state-wide Math-Science Partnership which works with 2 school districts in the state with the aim of integrating their science education from grades K-8. In addition, in 2016 we continued our summer research experience for teachers (RET) program through supplements to other NSF grants, incorporating one new teacher and continuing work with a veteran teacher from our program.

3. School partnerships: We are active with a number of local schools and school districts. Through our RET program we have developed close working relationships with Lin-Wood School (grades 6-12), Kennett Middle School (grades 6-12), Bartlett Middle School (grades 6-12), Newfound Regional High School (9-12), and Oyster River High school (9-12) all of which are fairly close to the site and have had one or more teachers engaged with us for multiple years. In addition we work with Plymouth Elementary (grades 6-8), Bethlehem Elementary (4-6), Littleton High School (9-12), and Plymouth Regional High School (9-12) on an as-requested basis. Together these represent the 5 school districts closest to Hubbard Brook. We also provide tours to other schools as requested.

Children's Book: Late 2015 saw the completion of HBR-LTER's contribution to the LTER Children's book series, and 2016 saw the outreach and distribution of the majority of the first run of the book, entitled "Seeking the Wolf Tree." In total, 2639 copies of the book were distributed by the site, including 83 class sets going to primarily public schools in NH (56 of these). Five hundred and sixty eight copies went to libraries in the state, including both school libraries (333 copies) and town libraries (235 copies). Two teacher workshops were held exclusively to support the use of the book as a classroom resource, and two others featured the book in a broader teacher-training agenda. In addition to the in-person trainings, teaching resources which support the use of the book in the classroom are posted on the website (<http://hubbardbrookfoundation.org/classroom-resources/seeking-the-wolf-tree/>).

Other K-12 support activities: The Hubbard Brook Research Foundation is a member of the New Hampshire Education and Environment Team (NHEET), which is a collaboration of organizations working to support science education in the state. Additional members include the GLOBE Program, Project Learning Tree, Project WET at NH Department of Environmental Services, Projects WILD and Aquatic WILD at NH Fish and Game Department, and the USDA Forest Service. The focus of the group is to support the vertical alignment of science curriculum within districts and to assist teachers in the acquisition of content and development of science process skills. The main activity of the group in 2016 was the Math-Science Partnership program, described above. Additionally, HBRF and USDA Forest Service staff give elementary and secondary school tours of the site upon request. Six schools, in addition to our regular school partnership schools, visited Hubbard Brook in the past year.

On-site tours: The HBEF provides educational tours of the research site on a frequent basis throughout the academic year. Undergraduate partner schools bring at least one class per year to the site and provide the Hubbard Brook staff with syllabi and written statements describing how the site visit is incorporated into the course curriculum. These schools include: Plymouth State University, the University of New Hampshire, Colby-Sawyer College, Boston University, Cornell University, and Wellesley College. Secondary school tours are offered to our ELP partner schools (described above) and other schools where our teaching resources are being used in the classroom.

In addition to the activities above, nine co-investigators mentored a total of 36 students in their high school, undergraduate and graduate research.

* How have the results been disseminated to communities of interest?

The Hubbard Brook Research Foundation spearheads a project called Forest Science Dialogues, co-funded by an Advancing Informal STEM Learning grant from the National Science Foundation. In 2016 we:

- Ran an AAAS Science Communication Workshop for the Hubbard Brook Committee of Scientists at the Cary Institute for Ecosystem Studies, January 6, 2016. This was a 5-hour workshop and it involved ~28 Hubbard Brook scientists;
- Launched new social media campaigns for Hubbard Brook on Twitter and Facebook;
- Worked with a professional videographer and photographer and the media relations offices of the Forest Service, NSF, and other collaborating institutions to share imagery and news from the Ice Storm Experiment, leading to the story being picked up in national and local outlets. NSF produced a Science Nation video about the project, released December 12 (https://www.nsf.gov/news/special_reports/science_nation/icestorms.jsp);
- Presented work from the Forest Science Dialogues project at a meeting of the Advancing Informal STEM Learning PIs in Bethesda, Maryland. (Poster presentation);
- Created a series of Science Pub Nights in North Conway, NH. These were three informal science education events that reached more than 250 audience members in a rural region near the Hubbard Brook and Bartlett experimental forests;
- Held a Hubbard Brook Roundtable about Winter Climate Change in Woodstock, Vermont on March 4 with 23 participants – a mix of scientists and stakeholders;
- Held a Hubbard Brook Roundtable about Biodiversity Research Agenda in Woodstock, Vermont on June 10 with 25 participants. The outcomes of this roundtable will be published in a report from the Vermont Center for Ecostudies in 2017.

The publication of our synthesis paper on invasive forest pests (Lovett et al. 2016, *Ecological Applications*, 26:1437-1455) was accompanied by an extensive media outreach effort which resulted in coverage of the paper in over 300 media outlets including major newspapers such as the New York Times, Washington Post, and Boston Globe. We have also had two congressional briefings on the results of this study and interacted extensively with Congressional and federal agency staff to inform them of the findings of the study and policy options for dealing with the problem.

* What do you plan to do during the next reporting period to accomplish the goals?

We plan to continue our long-term activities in ecosystem monitoring, biogeochemical experiments, landscape studies, modeling and quantitative analysis, data management, education and outreach during the next reporting period.

Products

Books

R. T. Holmes and G. E. Likens (2016). *Hubbard Brook: The Story of a Forested Ecosystem First. One*. Yale University Press. New Haven and London. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = No ; ISBN: 9780300203646

Book Chapters

Inventions

Journals or Juried Conference Papers

- Aulenbach, Brent T. and Burns, Douglas A. and Shanley, James B. and Yanai, Ruth D. and Bae, Kikang and Wild, Adam D. and Yang, Yang and Yi, Dong (2016). Approaches to stream solute load estimation for solutes with varying dynamics from five diverse small watersheds. *Ecosphere*. 7 (6), n/a--n/a. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/ecs2.1298
- Beier, Colin M. and Caputo, Jesse and Lawrence, Gregory B. and Sullivan, Timothy J. (2017). Loss of ecosystem services due to chronic pollution of forests and surface waters in the Adirondack region (USA). *Journal of Environmental Management*. 191 19--27. Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1016/j.jenvman.2016.12.069
- Berton, Rouzbeh and Driscoll, Charles T. and Chandler, David G. (2016). Changing climate increases discharge and attenuates its seasonal distribution in the northeastern United States. *Journal of Hydrology: Regional Studies*. 5 164--178. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.ejrh.2015.12.057
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Licenses

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Zhou, Z. (2016). *An Intriguing Nitrogen Story in a Northern Forest from the Hubbard Brook Experimental Forest. Oral presentation..* Terrestrial Carbon and Nitrogen Cycling Workshop. Beijing, China. Status = OTHER; Acknowledgement of Federal Support = Yes

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Yanai, R.D., H.L. Buckley, B.S. Case, and R.C. Woollons (2016). *Avoiding errors in error analyses: How to propagate uncertainty in regression models.* Ecological Society of America Annual Meeting. Fort Lauderdale, FL. Status = OTHER; Acknowledgement of Federal Support = Yes

Johnson, Chris E. (2016). *Carbon and Nitrogen Dynamics in Forest Soils Affected by Acid Rain.* Seminar at the Chinese Academy of Sciences, Research Center for Environmental Sciences. Beijing, China. Status = OTHER; Acknowledgement of Federal Support = Yes

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Hallworth, M., S. Sillett, N. Rodenhouse, and P. Marra (2016). *Oral presentation: 'The strength of migratory connectivity affects demography of two Neotropical migratory songbirds'*. American Ornithological Conference. Washington, D.C.. Status = OTHER; Acknowledgement of Federal Support = Yes

Sillett, T.S. (2016). *Oral presentation: Demographic and behavioral responses of a migratory songbird to climate variation*. University of North Carolina. Chapel Hill, NC. Status = OTHER; Acknowledgement of Federal Support = Yes

Lowe, W.K. (2016). *Oral presentation: Population processes unite ecology and evolution*. Kellogg Biological Station. Hickory Corners, MI. Status = OTHER; Acknowledgement of Federal Support = Yes

Lowe, W.K. (2016). *Oral presentation: Population processes unite ecology and evolution.*. University of Montana. Missoula, MT. Status = OTHER; Acknowledgement of Federal Support = Yes

Lambert, Kathy Fallon, Marissa Weiss, Sarah Garlick (2016). *Overcoming Barriers to Public Engagement through a Multi-Institution Consortium. Abstract.*. American Geophysical Union meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

- Yanai, R.D. (2016). *QUEST: Quantifying Uncertainty in Ecosystem Studies*. International Long-Term Ecological Research Open Science Meeting. Skukuza, South Africa. Status = OTHER; Acknowledgement of Federal Support = Yes
- Johnson, Chris E. (2016). *Soil Carbon Dynamics in a Temperate Forest Affected by Acid Rain*. Seminar at Fujian Agriculture and Forestry University. Fuzhou, China. Status = OTHER; Acknowledgement of Federal Support = Yes
- Johnson, Chris E. (2016). *Soil Carbon Dynamics in a Temperate Forest Affected by Acid Rain*. Seminar at Fujian Normal University. Fuzhou, China. Status = OTHER; Acknowledgement of Federal Support = Yes
- Johnson, Chris E. (2016). *Soil Carbon and Nitrogen Dynamics in a Hardwood Forest: Climate Change Effects and Recovery from Chronic Acidification*. Seminar at Norwegian Life Sciences University. Ås, Norway. Status = OTHER; Acknowledgement of Federal Support = Yes
- Yang Y., R. D. Yanai, F. R. Fatemi, C. R. Levine, P. J. Lilly, and R. D. Briggs (2016). *Sources of variability in tissue chemistry in northern hardwood species*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Sillett, T.S. and C.S. Rushing (2016). *Survival of passerines during spring and fall migration*. North American Ornithological Conference. Washington, D.C.. Status = OTHER; Acknowledgement of Federal Support = Yes
- Yanai R.D., Y. Yang, M. Montesdeoca, and C. Driscoll (2016). *The importance of mercury in leaves, bark and wood of eight tree species across four northeastern forests*. AGU Fall Meeting. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Carrillo, O, and R.D. Yanai (2016). *Uncertainty Workshop, Module 3: Monte Carlo Error Propagation*. International Long-Term Ecological Research Open Science Meeting. Skukuza, South Africa. Status = OTHER; Acknowledgement of Federal Support = Yes
- Zhou, Z., S. Ollinger, G. Lovett, A. Ouimette, C. Goodale (2016). *Validation of modeled soil carbon dynamics in northeastern forests using radiocarbon measurements*. Abstract. 27th annual Harvard Forest ecology symposium program, Fisher Museum, Harvard Forest. Petersham, MA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Bailey, S.W. (2016). *What if the Hubbard Brook weirs had been built somewhere else? Spatial uncertainty in the application of catchment budgets*, Abstract B11J-03. Fall Meeting, AGU. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Bailey, S.W. (2016). *Where does the forest end and the stream begin: Seasonal streams in New Hampshire*. New Hampshire Water and Watersheds Conference. Plymouth, NH. Status = OTHER; Acknowledgement of Federal Support = Yes
- Bailey, S.W. (2016). *Where does the forest end and the stream begin: Seasonal streams in New Hampshire*. New Hampshire Assoc. Natural Resource Scientists. Concord, NH. Status = OTHER; Acknowledgement of Federal Support = Yes

Other Products

Databases.

http://www.hubbardbrook.org/data/dataset_search.php

Educational aids or Curricula.

Secondary Education

Sillett, T.S. worked with Jackie Wilson (Hubbard Brook Research Foundation) and Mary Deinlein (SMBC) to bring the Migratory Bird Center's "Bridging the Americas" program to secondary school students in Plymouth, New Hampshire.

An educational activity for high school students that uses our data on the reproductive success of a migratory songbird is provided at the following two sites:

<http://rydberg.biology.colostate.edu/langink/HubbardBrook>

<http://hubbardbrookfoundation.org/what-limits-the-reproductive-success-of-migratory-birds/>

Educational aids or Curricula.

Blog: Chasing Answers: Salamanders, Insects and Resource Retention in Headwater Streams

URL:

<http://wildlifebiologymontana.tumblr.com/post/149473073354/chasing-answers-salamanders-insects-and-resource>

Data set (citable).

Johnson, C. E., W. Clymans, and T. Siccama. 2016. Mass and Nutrient Loss in Decomposing Hardwood Boles on Watershed 1 at the Hubbard Brook Experimental Forest, 1990 - present. Long Term Ecological Research Network.
<http://dx.doi.org/10.6073/pasta/84ad2512898a93e99808c6aa8c5fb794>

Map/Data sets.

Ollinger, Scott. A map of canopy nitrogen concentration based on Lepine et al. (2016) derived from field measurements and a high spectral and spatial resolution data set has been generated for both Hubbard Brook and Bartlett Experimental Forests. The Bartlett map has been published in the Knowledge Network for Biocomplexity (KNB) data repository, with a permanent doi (see below). The Hubbard Brook map is published in Chapter 15 of Holmes & Likens 2016 (Holmes, R.T. & Likens, G.E. 2016. Hubbard Brook—The Story of a Forest Ecosystem. Yale University Press. 288pp. ISBN: 9780300203646), and has also been submitted to the Hubbard Brook Data Catalog, and is awaiting publication. These high-resolution remote sensing data sets will serve as model input to enable new spatial and temporal extrapolations under future environmental conditions.

University of New Hampshire Earth Systems Research Center. 2016. Canopy Nitrogen, Bartlett Experimental Forest, NH USA, 2012. KNB Data Repository. PUBLISHED doi:10.5063/F1V9860T.

University of New Hampshire Earth Systems Research Center. 2016. Canopy Nitrogen, Hubbard Brook Experimental Forest, NH USA, 2012. SUBMITTED to Hubbard Brook data catalog; awaiting publication.

Other Publications

Berg, Chelsea; Ellis, Cary; Gucwa, Cory; Melendez, Kristen; Mooney, Curtis; Loos, Jonathon Loos; and Scott, Sophia (2015). *Informing Community-Relevant Research in the Northern Forest.* A Hubbard Brook White Paper published via the Hubbard Brook Research Foundation website.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Botter, G., Benettin, P., McGuire, K., Rinaldo, A. (2016). *Water age and stream solute dynamics at the Hubbard Brook Experimental Forest (US).* Geophysical Research Abstracts, 18, EGU2016-13527. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Gu, Weiyao. *Aluminum is more tightly bound in soil after Wollastonite treatment to a forest watershed, M.S. Thesis.* (2016). Syracuse University, Syracuse, NY. Acknowledgement of Federal Support = Yes

Bayer, Clarice S.. *Food Web Complexity and Retentiveness in Low Productivity Environments, Ph.D. Status = Dissertation in progress.* (2016). University of Montana, Missoula, MT. Acknowledgement of Federal Support = Yes

Darby, B.A.. *Microbial activity in deeper mineral soil important for nitrogen cycling across successional stand age in a northern hardwood forest M.S. Thesis.* (2016). Cornell University. Acknowledgement of Federal Support = Yes

Fakhraei, Habibollah. *Modeling the effects of acid deposition and natural organic acids on surface waters, Ph.D. Dissertation.* (2016). Syracuse

University, Syracuse New York. Acknowledgement of Federal Support = Yes

Savides, Kimberly. *Undergraduate Honors Thesis: 'Does nest distance to territory edge influence extra-pair paternity'?*. (2016). SUNY-ESF, Syracuse, NY. Acknowledgement of Federal Support = No

Harris, Jennifer. *Undergraduate independent research: 'Forty years of change in the beetle community of the Hubbard Brook Experimental Forest'. Building on data collected by using window traps, Jennifer re-sampled in the same locations that were sampled in the mid 1970s and expanded sampling across an elevation gradient to determine the extent to which beetle communities are affected by long-term differences in climate..* (2016). Wellesley College. Acknowledgement of Federal Support = No

Russell, Sarah. *Undergraduate independent research: 'Stable isotope analysis of the foliar food web at multiple elevations in northern hardwoods forest'. Sarah sampled leaves of multiple woody species, grazers of those leaves (Lepidoptera larvae) and predators (birds and spiders) to determine if differences in 15N at the base of the food web across a 500-m elevation (climate) gradient occur at higher trophic levels..* (2016). Wellesley College. Acknowledgement of Federal Support = No

Websites

Bird population and community studies at HBEF

<http://www.hubbardbrook.org/research/animals/bird/holmes-intro03.htm>

What's new?

Two teaching modules:

The first teaches students how to analyze abundance and occupancy data, using the Hubbard Brook valley-wide bird survey dataset. The second teaches students how to analyze bird migration data collected from light-level geolocators. Data for ovenbirds, collected at Hubbard Brook, are used.

https://github.com/SCBI-MigBirds/scbi-migbirds.github.io/blob/master/Abundance_Occupancy.Rmd

https://github.com/SCBI-MigBirds/scbi-migbirds.github.io/blob/master/Geocator_GeoLight.Rmd

Climate Change Across Seasons Experiment (CCASE)

<http://www.hubbardbrook.org/research/climate/templer.shtml>

This web-site provides a summary of our Climate Change Across Seasons Experiment (CCASE) at Hubbard Brook.

Education Programs at Hubbard Brook

<http://hubbardbrookfoundation.org/education-programs-at-hubbard-brook-an-overview/>

Sharing information: The Hubbard Brook Research Foundation hosts a dynamic website with teaching resources developed with support of the LTER Schoolyard program and the USDA-Forest Service. It contains data activities developed by our RET teachers, mock-NECAP exams developed with our partner schools, and teaching guides on acid rain and migratory birds. Contents of the website are promoted at state-wide and regional science teacher

conferences and through our various partnerships with teacher professional development organizations.

Hubbard Brook Hydropedology Project

<http://hydro.vwrrc.vt.edu/research/projects/hubbard-brook-hydropedology-project/>

This is a webpage containing documents, project description, publications and data associated with Hubbard Brook hydropedology.

Multiple Element Limitation in Northern Hardwood Ecosystems

<http://www.esf.edu/MELNHE>

This project includes two stands at Hubbard Brook and is considered a part of the Hubbard Brook LTER, although it also includes stands at Jeffers Brook and Bartlett.

Network Streamwater Chemistry Project

<http://hydro.vwrrc.vt.edu/research/projects/network-stream-water-chemistry-project/>

A web page containing document project description and publications associated with the Hubbard Brook Network Stream Chemistry project.

This web site was established before QUEST was funded as a Research Coordination Network; the uncertainty effort was proposed in the LTER. Hubbard Brook data are featured in many of QUEST projects.

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Lovett, Gary	PD/PI	2
Bailey, Scott	Co-Investigator	2
Battles, John	Co-Investigator	2
Blum, Joel	Co-Investigator	1
Driscoll, Charles	Co-Investigator	2
Fahey, Timothy	Co-Investigator	2
Fisk, Melany	Co-Investigator	3
Goodale, Christine	Co-Investigator	1
Groffman, Peter	Co-Investigator	1
Johnson, Chris	Co-Investigator	2
Lavallee, Anthea	Co-Investigator	12
Likens, Gene	Co-Investigator	1
McGuire, Kevin	Co-Investigator	1
Ollinger, Scott	Co-Investigator	1
Pardo, Linda	Co-Investigator	2
Richardson, Andrew	Co-Investigator	1
Templer, Pamela	Co-Investigator	1
Yanai, Ruth	Co-Investigator	1
Dumont, Peter	K-12 Teacher	1
Burakowski, Elizabeth	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Fakhraei, Habibollah	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Hallworth, Michael	Postdoctoral (scholar, fellow or other postdoctoral position)	3
Cleavitt, Natalie	Other Professional	8
Garlick, Sarah	Other Professional	8
Martin, Mary	Other Professional	11

Wilson, Geoff	Other Professional	9
Wilson, Jackie	Other Professional	6
Castagno, Andrew	Technician	2
DePietro, Deanna	Technician	1
Ellison, Sharon	Technician	3
Glick, Nicholas	Technician	5
Harrison, Jamie	Technician	2
Jakubek, Nicholas	Technician	3
Koppers, Mary	Technician	6
LoRusso, Nicholas	Technician	7
Martel, Lisa	Technician	3
McTaggart, Audrey	Technician	4
Miners, Matthew	Technician	2
Montesdeoca, Mario	Technician	6
Gleason, Jamie	Staff Scientist (doctoral level)	1
Ouimette, Andrew	Staff Scientist (doctoral level)	2
Zhou, Zaixing	Staff Scientist (doctoral level)	1
Bayer, Clarice	Graduate Student (research assistant)	4
Berton, Rouzbeh	Graduate Student (research assistant)	6
Goswami, Shinjini	Graduate Student (research assistant)	8
Gu, Weiyao	Graduate Student (research assistant)	5
Harrison, Sophia	Graduate Student (research assistant)	3
Hong, Sunghoon	Graduate Student (research assistant)	2
Lee, David	Graduate Student (research assistant)	1
Lepine, Lucie	Graduate Student (research assistant)	1
Madison, Conor	Graduate Student (research assistant)	2
Phelps, Kara	Graduate Student (research assistant)	1
Shan, Shan	Graduate Student (research assistant)	8
Valipour, Mahnaz	Graduate Student (research assistant)	6
Anderson, Josh	Undergraduate Student	2
Aube, Danielle	Undergraduate Student	3
Dean, Jacqueline	Undergraduate Student	2
Devons, Hannah	Undergraduate Student	1
Diaz De Villegas, Sofia	Undergraduate Student	1
Ferguson, Camila	Undergraduate Student	1

Galantino, Christopher	Undergraduate Student	3
Graham, Patricia	Undergraduate Student	1
Harris, Jennifer	Undergraduate Student	3
Hastings, John	Undergraduate Student	1
Hess, Benjamin	Undergraduate Student	3
Kang, Christine	Undergraduate Student	1
Kernen, Hannah	Undergraduate Student	1
Lee, Mitchell	Undergraduate Student	2
Morrison, Taran	Undergraduate Student	2
Scalisi, Emma	Undergraduate Student	1
Sharp, Andrew	Undergraduate Student	3
Silva, Anya	Undergraduate Student	2
Suttenberg, Stephanie	Undergraduate Student	1
Tavares-Carreiro, Joao	Undergraduate Student	1
Tiller, Jenna	Undergraduate Student	2
Uche, Chinonye	Undergraduate Student	3
Washburn, Brittany	Undergraduate Student	1
Liu, Kristina	High School Student	2
Amaya, Gabriel	Research Experience for Undergraduates (REU) Participant	2
Ammon, Chase	Research Experience for Undergraduates (REU) Participant	3
Clyne, Ailis	Research Experience for Undergraduates (REU) Participant	2
Dustan, Stephanie	Research Experience for Undergraduates (REU) Participant	2
Hallett, Torrin	Research Experience for Undergraduates (REU) Participant	3
Hollister, Samantha	Research Experience for Undergraduates (REU) Participant	3
LeBeau, Brittany	Research Experience for Undergraduates (REU) Participant	2
Sotelo, Johali	Research Experience for Undergraduates (REU) Participant	3
Casey, Kaari	Other	1

Full details of individuals who have worked on the project:

<p>Gary M Lovett Email: lovettg@caryinstitute.org Most Senior Project Role: PD/PI Nearest Person Month Worked: 2</p> <p>Contribution to the Project: PI</p> <p>Funding Support: LTER and other sources</p> <p>International Collaboration: No International Travel: No</p>
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Scott W Bailey

Email: swbailey@fs.fed.us

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Lead researcher and field coordinator on the hydrogeology study. Responsible for soil and geochemical characterization in the reference watershed – WS3. Expanding hydrogeological mapping to include parts of Cascade and Zig-zag Brook watersheds and studying chemical spatial variation in headwater streams and its link to critical zone structure.

Funding Support: This grant and US Forest Service

International Collaboration: No

International Travel: No

John J Battles

Email: jbattles@berkeley.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Co-lead scientist for long-term monitoring of primary productivity, forest composition, and tree demography. Co-chair of the Science Coordinating Committee for the Hubbard Brook Ecosystem Study.

Funding Support: This award

International Collaboration: No

International Travel: No

Joel D Blum

Email: jdblum@umich.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Analyses of vegetation and stream water, data interpretation and publication.

Funding Support: Faculty position at University of Michigan

International Collaboration: No

International Travel: No

Charles T. Driscoll

Email: ctdrisc@sy.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Designs and coordinates project, works with students and technicians.

Funding Support: This grant

International Collaboration: No

International Travel: No

Timothy J Fahey

Email: tjf5@cornell.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Co-lead scientist for long-term monitoring of primary productivity, forest composition, and tree demography.

Funding Support: This award

International Collaboration: No

International Travel: No

Melany Fisk

Email: fiskmc@miamioh.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 3

Contribution to the Project: Melany Fisk's research focuses on nutrient cycling and soil organisms. She is involved in studies of winter climate and snowpack controls of carbon and nitrogen processing, and of plant-microbe processes that mediate interactions among different nutrients (calcium, nitrogen, phosphorus).

Funding Support: Faculty position

International Collaboration: No

International Travel: No

Christine Goodale

Email: clg33@cornell.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Direct measurements of soil and water stable isotopes and lead data analysis and interpretation

Funding Support: N/A

International Collaboration: No

International Travel: No

Peter Mark Groffman

Email: groffmanp@caryinstitute.org

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Leads long-term monitoring of soil microbial biomass and activity, winter climate change and nitrogen gas flux research.

Funding Support: NSF Hubbard Brook LTER

International Collaboration: No

International Travel: No

Chris E. Johnson

Email: cejohns@syr.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Research on soil biogeochemistry; supervision of students and technician.

Funding Support: This grant

International Collaboration: Yes, Australia, China

International Travel: Yes, Australia - 0 years, 0 months, 15 days; China - 0 years, 0 months, 13 days; Norway - 0 years, 0 months, 3 days

Anthea Lavalley

Email: alavalley@hbresearchfoundation.org

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 12

Contribution to the Project: Executive director of the Hubbard Brook Research Foundation (HBRF) - oversees the education and outreach efforts undertaken by the HBRF on behalf of the HBR-LTER.

Funding Support: This grant and HBRF

International Collaboration: No

International Travel: No

Gene Likens

Email: likensg@ecostudies

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Overall project supervision, ecosystem and biogeochemical research on forest, stream, and lake ecosystems of the Hubbard Brook Valley.

Funding Support: Other sources

International Collaboration: No

International Travel: No

Kevin J McGuire

Email: kevin.mcguire@vt.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Conducts research on hydrology and hypedopedology, which examines feedbacks between hydrology, soil characteristics and critical zone structure, and catchment biogeochemistry. Also, investigating chemical spatial variation in headwater streams.

Funding Support: This grant

International Collaboration: No

International Travel: No

Scott Ollinger

Email: scott.ollinger@unh.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Carbon and nitrogen cycling, remote sensing, ecosystem modeling and regionalization.

Funding Support: Home institution and other grants

International Collaboration: No

International Travel: No

Linda H. Pardo

Email: lpardo@fs.fed.us

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Conducts research on nitrogen and carbon cycling across the Geo-spatial template and co-ordinates long-term monitoring of foliar chemistry.

Funding Support: This grant

International Collaboration: No

International Travel: No

Andrew D Richardson

Email: arichardson@oeb.harvard.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Managed CO2 flux measurements at Bartlett Experimental Forest; supervised undergraduates and postdocs conducting empirical and model-data fusion analyses of Bartlett Data.

Funding Support: Funded through Harvard faculty position

International Collaboration: No

International Travel: No

Pamela Templer

Email: ptempler@bu.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Soil carbon fluxes, as well as soil nitrogen cycling measurements in the laboratory and field. An elected member of the Scientific Coordinating Committee and on the Hubbard Brook Research Foundation Board of Trustees. Supports graduate students and technicians working at Hubbard Brook.

Funding Support: This grant and a NSF CAREER grant

International Collaboration: No

International Travel: No

Ruth D Yanai

Email: rdyanai@syr.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Ruth coordinates the MELNHE project (Multiple Element Limitation in Northern Hardwood Ecosystems), which was proposed as an activity of the Hubbard Brook LTER. 2016 was the sixth year of treatment of N, P, and Ca in stands of different ages at Hubbard Brook, Jeffers Brook, and Bartlett Experimental Forests. Uncertainty analysis was another theme of the HBR LTER. This effort has since been funded as a Research Coordination Network called QUEST (Quantifying Uncertainty in Ecosystem Studies), led by Yanai and other HBR researchers (Mark Green and John Campbell) as well as researchers at other institutions.

Funding Support: State University of New York, MELNHE, and QUEST grants from NSF.

International Collaboration: No

International Travel: No

Peter Dumont

Email: pdumont@sau4.org

Most Senior Project Role: K-12 Teacher

Nearest Person Month Worked: 1

Contribution to the Project: High-school science teacher who participated in our Research Experience for Teachers program. He worked on the ice storm experiment.

Funding Support: NSF 1457575

International Collaboration: No

International Travel: No

Elizabeth Burakowski

Email: elizabeth.burakowski@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 1

Contribution to the Project: Remote sensing, albedo, ecosystem-climate interactions

Funding Support: Other (UNH Institutional support, NCAR Fellowship)

International Collaboration: No

International Travel: No

Habibollah Fakhraei

Email: hfakhrae@syr.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 2

Contribution to the Project: Conduct model simulations and field research on experimental ice storm.

Funding Support: Another research grant

International Collaboration: No

International Travel: No

Michael Hallworth

Email: mhallwor@masonlive.gmu.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 3

Contribution to the Project: Spatial and temporal components of community dynamics identify assembly rules, Smithsonian Institution, Washington, D.C.

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Natalie L Cleavitt

Email: nlc4@cornell.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 8

Contribution to the Project: Dr. Cleavitt oversees the tree survey crew and runs several other long-term plant ecology projects. She conducts the collection of fine litter, coarse woody debris and leaves for foliar chemistry. This season she mentored one REU student and three senior thesis projects related to student work at HB. She curates the long-term vegetation data sets. She takes full part in data analysis and paper writing. She also conducted outreach activities with NH public schools for "Seeking the Wolf Tree", the schoolyard book for Hubbard Brook.

Funding Support: This award and Cornell University

International Collaboration: No

International Travel: No

Sarah Garlick

Email: sarahgarlick@gmail.com

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 8

Contribution to the Project: Director of Science Policy and Outreach for the Hubbard Brook Research Foundation and directs the site's Forest Science Dialogs project.

Funding Support: This grant and NSF award #DRL 1322871

International Collaboration: No

International Travel: No

Mary Martin

Email: mary.martin@unh.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 11

Contribution to the Project: Information management

Funding Support: this grant, US Forest Service, USDA, NSF NH-EPSCOR, NSF-EAGER grant #1548175

International Collaboration: No

International Travel: No

Geoff Wilson

Email: gwilson@hbresearchfoundation.org

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 9

Contribution to the Project: Director of Facilities and Programs for the Hubbard Brook Research Foundation. His primary responsibilities include the REU program and the management of the facilities. Other education and outreach activities on behalf of the site as needed.

Funding Support: This grant and HBRF

International Collaboration: No

International Travel: No

Jackie Wilson

Email: jackie03262@gmail.com

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 6

Contribution to the Project: An educational associate for the Hubbard Brook Research Foundation and is very involved with the K-12 education for the site, including lesson development and participation in a state-wide teacher professional development team.

Funding Support: This grant and HBRF

International Collaboration: No

International Travel: No

Andrew Castagno

Email: apc59@cornell.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 2

Contribution to the Project: Syracuse University - preparing soil and water samples for stable isotope analyses

Funding Support: Institutional support

International Collaboration: No

International Travel: No

Deanna DePietro

Email: dipietrod@caryinstitute.org

Most Senior Project Role: Technician

Nearest Person Month Worked: 1

Contribution to the Project: Field, laboratory, and data analysis.

Funding Support: NSF Hubbard Brook LTER

International Collaboration: No

International Travel: No

Sharon Ellison

Email: sellison497@gmail.com

Most Senior Project Role: Technician

Nearest Person Month Worked: 3

Contribution to the Project: Conducted point-counts of birds and assisted with arthropod and vegetation sampling

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Nicholas Glick

Email: nblick@syr.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 5

Contribution to the Project: Sampling and analysis of soil solution and stream samples.

Funding Support: This grant

International Collaboration: No

International Travel: No

Jamie Harrison

Email: harrisoj@bu.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 2

Contribution to the Project: Assisted with field and laboratory work at Hubbard Brook and Boston University, respectively.

Funding Support: This NSF LTER grant and funds from a NSF CAREER grant to Pamela Templer.

International Collaboration: No

International Travel: No

Nicholas Jakubek

Email: jakubekN@caryinstitute.org

Most Senior Project Role: Technician

Nearest Person Month Worked: 3

Contribution to the Project: Field, laboratory, and data analysis.

Funding Support: NSF Hubbard Brook LTER

International Collaboration: No

International Travel: No

Mary Margaret Koppers

Email: mmkopper@syr.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 6

Contribution to the Project: Research on soil biogeochemistry.

Funding Support: This grant

International Collaboration: No

International Travel: No

Nicholas LoRusso

Email: nlorusso@syr.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 7

Contribution to the Project: Sampling and analysis of soil solution and stream samples.

Funding Support: This grant

International Collaboration: No

International Travel: No

Lisa Martel

Email: martelL@caryinstitute.org

Most Senior Project Role: Technician

Nearest Person Month Worked: 3

Contribution to the Project: Field, laboratory and data analysis

Funding Support: NSF Hubbard Brook LTER

International Collaboration: No

International Travel: No

Audrey McTaggart

Email: mctaggartaudrey@gmail.com

Most Senior Project Role: Technician

Nearest Person Month Worked: 4

Contribution to the Project: Assisted with valley-wide salamander sampling and various experiments with salamanders

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Matthew Miners

Email: mminers01@yahoo.com

Most Senior Project Role: Technician

Nearest Person Month Worked: 2

Contribution to the Project: Conducted point-counts of birds valley-wide; assisted with arthropod surveys

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Mario Montesdeoca

Email: mmontesd@syr.edu

Most Senior Project Role: Technician

Nearest Person Month Worked: 6

Contribution to the Project: supervised laboratory activities at Syracuse University

Funding Support: Syracuse University

International Collaboration: No

International Travel: No

Jamie D. Gleason

Email: jdgleaso@umich.edu

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: Performed lab analysis

Funding Support: other funding

International Collaboration: No

International Travel: No

Andrew Ouimette

Email: andres.ouimette@unh.edu

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 2

Contribution to the Project: Carbon balances and sequestration estimates

Funding Support: This grant and other

International Collaboration: No

International Travel: No

Zaixing Zhou

Email: zaixingzhou@gmail.com

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: Enhancements to PnET ecosystem models model, simulation of of net primary production and N cycling

Funding Support: This grant and other

International Collaboration: No

International Travel: No

Clarice S. Bayer

Email: clarice.bayer@umontana.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 4

Contribution to the Project: Food Web Complexity and Retentiveness in Low Productivity Environments. Ph.D. Dissertation in progress, University of Montana, Missoula, MT

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Rouzbeh Berton

Email: rouzbeh_berton@yahoo.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: Hydrologic analysis of the Merrimack River.

Funding Support: This grant

International Collaboration: No

International Travel: No

Shinjini Goswami

Email: goswams@miamioh.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 8

Contribution to the Project: Shinjini Goswami is a PhD student at Miami University studying nitrogen and phosphorus limitation in forests

Funding Support: This grant and Miami University

International Collaboration: No

International Travel: No

Weiyao Gu

Email: wgu100@syr.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 5

Contribution to the Project: Research on soil biogeochemistry

Funding Support: This grant

International Collaboration: No

International Travel: No

Sophia Harrison

Email: sopharr@umich.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Completed trace element analyses.

Funding Support: This grant

International Collaboration: No

International Travel: No

Sunghoon Hong

Email: hoone0416@gmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 2

Contribution to the Project: Daniel Hong is working on foliage and leaf litter collected in the MELNHE study, using samples collected in 2016.

Funding Support: 50% this project

International Collaboration: No

International Travel: No

David P Lee

Email: dplee@vt.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

Contribution to the Project: First-year masters student who will focus on sources of stream chemical spatial variation in headwater streams of the Hubbard Brook.

Funding Support: Virginia Polytechnic Institute and State University

International Collaboration: No

International Travel: No

Lucie Lepine

Email: lucie.lepine@unh.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

Contribution to the Project: Remote sensing using high spectral resolution aircraft data. Preparation of spatial data layers for modeling.

Funding Support: This grant and other

International Collaboration: No

International Travel: No

Conor Madison

Email: conormadison9@gmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 2

Contribution to the Project: Forest productivity and leaf physiology

Funding Support: This grant and other

International Collaboration: No

International Travel: No

Kara Phelps

Email: kephelps@syr.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

Contribution to the Project: Kara Phelps's MS thesis consists of several papers that compare foliar chemistry and leaf litter chemistry in the MELNHE study, based on samples collected in 2014 and 2015.

Funding Support: 25% this project and 25% teaching assistant

International Collaboration: No

International Travel: No

Shan Shan

Email: shans@miamioh.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 8

Contribution to the Project: Shan Shan is a PhD student at Miami University studying interactions of nutrient limitation and rhizosphere microbial processes

Funding Support: This grant and Miami University

International Collaboration: No

International Travel: No

Mahnaz Valipour

Email: mvalipou@syr.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: Model simulations of soil and water response to clear-cutting disturbance.

Funding Support: This grant

International Collaboration: No

International Travel: No

Josh Anderson

Email: joshjanderson56@gmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Conducted point-counts of birds valley-wide; assisted with arthropod surveys

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Danielle Aube

Email: aube.danielle@gmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Crew co-leader; assisted plot teams with data collection; organized data entry and proofing, etc.

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Jacqueline Dean

Email: jmd368@cornell.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Cornell University - Jackie helped to resurvey 170 valleywide plots (20yr) and all trees on W1 (5yr).

Funding Support: This grant

International Collaboration: No

International Travel: No

Hannah Devons

Email: devenshr@miamioh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Studied fine root responses to nutrient additions

Funding Support: Miami University of Ohio and this grant

International Collaboration: No

International Travel: No

Sofia Diaz De Villegas

Email: sdiazdev@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assisted with processing insect samples from earlier years

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Camila Ferguson

Email: cofergus@syr.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Leaf and root sorting, supervising high school students and beginning undergraduates in the lab, and other activities in support of operations in Syracuse.

Funding Support: Federal work study

International Collaboration: No

International Travel: No

Christopher Galantino

Email: crg226@cornell.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Chris helped to resurvey 170 valleywide plots (20yr) and all trees on W1 (5yr).

Funding Support: This grant

International Collaboration: No

International Travel: No

Patricia Grahman

Email: pgrahman@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assisted with data entry management and verification

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Jennifer Harris

Email: jharri11@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Managed arthropod sampling, sorting and data entry for: Malaise traps, visual surveys, window traps

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

John Hastings

Email: jhc33@wildcats.unh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Leaf chemistry field work, soil N data analysis

Funding Support: Other (UNH student research support)

International Collaboration: No

International Travel: No

Benjamin J. Hess

Email: bjhess@syr.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Research on forest ecology.

Funding Support: This grant

International Collaboration: No

International Travel: No

Christine Kang

Email: ckang6@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assisted with processing insect samples from earlier years

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Hannah Kernen

Email: hkernen@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assisted with processing insect samples from earlier years

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Mitchell Lee

Email: mal364@cornell.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Mitchell helped to resurvey 170 valleywide plots (20yr) and all trees on W1 (5yr).

Funding Support: This grant

International Collaboration: No

International Travel: No

Taran Morrison

Email: taranosaurus@gmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Assisted with salamander sampling, maintained experimental stream pools.

Funding Support: This grant

International Collaboration: No

International Travel: No

Emma D. Scalisi

Email: escalisi@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assisted with processing insect samples from earlier years

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Andrew Sharp

Email: sharpaj@dukes.jmu.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Conducted point-counts of birds valley-wide; assisted with arthropod surveys

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Anya Silva

Email: asilva@wellesley.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Assisted with processing insect samples from earlier years

Funding Support: This grant and Wellesley College

International Collaboration: No

International Travel: No

Stephanie Suttnerberg

Email: slsuttner@syr.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Leaf and root sorting, supervising high school students and beginning undergraduates in the lab, and other activities in support of operations in Syracuse.

Funding Support: Federal work study

International Collaboration: No

International Travel: No

Joao Tavares-Carreiro

Email: jrr222@wildcats.unh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Leaf chemistry field work, analysis of terrain effects

Funding Support: Other (UNH student research support)

International Collaboration: No

International Travel: No

Jenna Tiller

Email: tillerjr@miamioh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 2

Contribution to the Project: Studied the recycling of litter-derived N

Funding Support: Miami University of Ohio and this grant

International Collaboration: No

International Travel: No

Chinonye Uche

Email: cru5@cornell.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: Chinonye helped to resurvey 170 valleywide plots (20yr) and all trees on W1 (5yr). She also stayed longest of the crew and helped with end of season tasks and data cleanup.

Funding Support: This grant

International Collaboration: No

International Travel: No

Brittany Washburn

Email: bawashbu@syr.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Leaf and root sorting, supervising high school students and beginning undergraduates in the lab, and other activities in support of operations in

Syracuse.

Funding Support: Federal work study

International Collaboration: No

International Travel: No

Kristina Liu

Email: kristyliu.2000@gmail.com

Most Senior Project Role: High School Student

Nearest Person Month Worked: 2

Contribution to the Project: Research on forest ecology.

Funding Support: This grant

International Collaboration: No

International Travel: No

Gabriel Amaya

Email: gvamaya@syr.edu

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 2

Contribution to the Project: Spatial Analysis of Ice Storm Effects on Soil Temperature & Moisture, and Causes of Spatial Variability.

Funding Support: NSF 1457575

International Collaboration: No

International Travel: No

Year of schooling completed: Other

Home Institution: Syracuse University

Government fiscal year(s) was this REU participant supported: 2016

Chase Ammon

Email: chase.ammon@yale.edu

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: The Effects of Canopy Gaps on Soil Respiration.

Funding Support: NSF 1457575

International Collaboration: No

International Travel: No

Year of schooling completed: Sophomore

Home Institution: Yale University

Government fiscal year(s) was this REU participant supported: 2016

Ailis Clyne

Email: abc237@cornell.edu

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 2

Contribution to the Project: Gastropod Gastronomy: The Cause of Lichen Losses?

Funding Support: This award

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: Cornell University

Government fiscal year(s) was this REU participant supported: 2016

Stephanie Dustan

Email: saduston@gmail.com

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 2

Contribution to the Project: Determination of Hydropedologic Units Present Within the Upper Cascade Brook Watershed

Funding Support: This award

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: Virginia Polytechnic and State University

Government fiscal year(s) was this REU participant supported: 2016

Torrin J Hallett

Email: trumpettorin@gmail.com

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: Water Cycle Music: Sonifying Hubbard Brook Data. National Geographic website article:

<http://voices.nationalgeographic.com/2016/10/11/creating-music-from-data-sonification-of-hubbard-brook/>

Funding Support: EAGER: NSF #1548182

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: Oberlin College

Government fiscal year(s) was this REU participant supported: 2016

Samantha Hollister

Email: sjhollis@syr.edu

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: Caterpillar growth rate as a measure of sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) leaf quality following an icing event.

Funding Support: NSF 1457575

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: SUNY Environmental Science and Forestry

Government fiscal year(s) was this REU participant supported: 2016

Brittany LeBeau

Email: brittany.lebeau@uvm.edu

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 2

Contribution to the Project: Analysis of Hydropedologic Units in the Bedrock-Controlled Environment of the Zig Zag Watershed

Funding Support: This award

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: University of Vermont

Government fiscal year(s) was this REU participant supported: 2016

Johali Sotelo

Email: johalisotelo@yahoo.com

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: Classification of Hydropedologic Units in and around seeps of the Zig-Zag Watershed.

Funding Support: DEB #1156844

International Collaboration: No

International Travel: No

Year of schooling completed: Sophomore

Home Institution: Agnes Scott College

Government fiscal year(s) was this REU participant supported: 2016

Kaari Casey

Email: kcasey@cityparksfoundation.org

Most Senior Project Role: Other

Nearest Person Month Worked: 1

Contribution to the Project: Kaari is an Education Fellow at the New York City Parks Foundation and serves as the program manager of their Green Girls program. She worked on the water cycle visualization project.

Funding Support: EAGER: NSF #1548182

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
USDA Forest Service	Other Organizations (foreign or domestic)	West Thornton, NH

Full details of organizations that have been involved as partners:

USDA Forest Service

Organization Type: Other Organizations (foreign or domestic)

Organization Location: West Thornton, NH

Partner's Contribution to the Project:

In-Kind Support

Facilities

Collaborative Research

More Detail on Partner and Contribution: The USFS maintains the Hubbard Brook Experimental Forest and its scientists are collaborators in the project.

What other collaborators or contacts have been involved?

Dr. Matthew Ayres, Dartmouth College

Dr. Steven Matthews, Ohio State University

Dr. Winsor Lowe, University of Montana
Dr. T. Scott Sillett, Smithsonian Institution
Dr. Michael Webster, Cornell University
Dr. Richard Holmes, Dartmouth College
Dr. Alan Strong, University of Vermont
Dr. Matthew Betts, Oregon State University
Dr. Lynn Christenson, Vassar College
Dr. Dorata Czeszczewik, Siedlce Univerity, Poland
Dr. Wieslaw Walankiewicz, Siedlce Univerity, Poland
Dr. Sara Kaiser, Cornell University
Dr. Lindsey Rustad, US Forest Service
Ms. Amey S. Bailey, USDA Forest Service
Dr. John Campbell, USDA Forest Service
Dr. Daniel Conley, Lund University, Sweden
Dr. Mark Green, Plymouth State University

Impacts

What is the impact on the development of the principal discipline(s) of the project?

Research in the Hubbard Brook LTER program seeks a better basic understanding of the discipline of ecosystem biology, especially biogeochemistry and energy flow. Our long-term measurements of a suite of large-scale experiments has contributed to refined understanding of the interactions between ecological processes and biogeochemical cycles. A suite of simulation modeling studies allows us to synthesize understanding at regional scales and in future scenarios of environmental change. Our studies of energy flow through the complex herbivore and detrital food webs integrates knowledge across sub-disciplinary lines including vegetation dynamics, microbial ecology and heterotrophy population dynamics.

What is the impact on other disciplines?

Beyond the core disciplines of ecosystem biology and biogeochemistry, the HBR LTER Program contributes to allied research disciplines in the physical and biological sciences. Our work attracts the interest of geochemists and physical hydrologists as well as that of molecular and cell biologists. The continuity of standardized and well-documented data collection is a hallmark of the HBR LTER; this aspect of the long-term studies at our site provides an internationally recognized benchmark for many disciplines of field-oriented research.

What is the impact on the development of human resources?

The Hubbard Brook LTER Project makes an active effort to develop human resources at many stages of development, from K-12 through post-doctoral. Through our educational and research activities numerous students and technicians have advanced their capacity for addressing the environmental problems that face 21st Century society. A continuous stream of researchers has been nurtured in the HBR LTER, eventually to reach prominent positions in academic, governmental and private sector institutions. We have encouraged the participation of females and minorities in our project through recruitment at our participating Universities and throughout the world.

What is the impact on physical resources that form infrastructure?

During the past year we continued to improve the physical infrastructure at HBR in two ways: 1)

we refined our realtime environmental sensor network and completed cross-checking with historic analog data sets, and 2) we expanded the capacity of our physical sample archive and began linking archive samples with data streams.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

The website for Hubbard Brook (<http://hubbardbrook.org>) is now hosted on a server at the University of NH, providing local control of the system to the HBR-IM. The physical location of this server is at the Research Computing and Instrumentation (RCI) Center, in a climate controlled environment, with emergency power. RCI provides system administration, upgrades, backups, helpdesk support, and expertise for special projects as needed. Changes to the website now take place on a separate development server, providing a platform for developing/testing new datasets, metadata, changes in webpage functionality, etc.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

Society is confronted with difficult choices about the degree of pollution abatement that is necessary to achieve desirable outcomes in terms of environmental quality. The long-term data sets from HBR-LTER provide among the best objective information available on which to base judgments about the threats of pollution to forest health, soil and water quality, and about the effectiveness of pollution abatement efforts in reducing those threats. Temporal trends can be evaluated against the backdrop of natural variation in reference and manipulated catchments, providing both parameter values and validation data for predictive models. Cost-effective environmental protection depends upon using these models to project the benefits of particular pollution abatement strategies. Hubbard Brook is a cornerstone of such efforts.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.