Annual Report for Period:07/2010 - 06/2011 **Submitted on:** 06/29/2011

Principal Investigator: Yanai, Ruth D. **Award ID:** 0949324

Organization: SUNY Col Env Sci&Forestry

Submitted By:

Yanai, Ruth - Principal Investigator

Title:

Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests

Project Participants

Senior Personnel

Name: Yanai, Ruth

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Yanai coordinates the project, oversees study design, staff and students, and coordinates communication among collaborators.

Name: Garrison-Johnston, Mariann

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Johnston has been responsible for fertilization calculations and applications.

Post-doc

Graduate Student

Name: Bae, Kikang

Worked for more than 160 Hours: Yes

Contribution to Project:

student in the Department of Forest and Natural Resources at SUNY ESF. She is measuring soil respiration and estimating total belowground carbon allocation as a function of nutrient availability. She is paid from our project but is also reported on the collaborative project from Cornell because Tim Fahey is advising her.

Name: Pitel, Nicholas

Worked for more than 160 Hours: No

Contribution to Project:

Master's student in Department of Forest and Natural Resources at SUNY ESF. Nick collected green foliage samples.

Name: Vadeboncoeur, Matthew

Worked for more than 160 Hours: No

Contribution to Project:

Matt is one of the leaders of the summer field crew. He has long experience with our sites, having supervised field crews under the earlier Ca project.

Name: See, Craig

Worked for more than 160 Hours: Yes

Contribution to Project:

Craig is a new MS student at SUNY ESF. He is on the management team for the summer field crew. For his research project, his is analyzing nutrient resorption in senescing leaves.

Undergraduate Student

Name: Murphy, Elizabeth

Worked for more than 160 Hours: Yes

Contribution to Project:

Elizabeth processed samples during the academic year. She did an independent study project on vector analysis of nutrient response to fertilization in sugar maple and American beech.

Name: Liu, Lin

Worked for more than 160 Hours: Yes

Contribution to Project:

Lin is an exchange student from Sichuan University completing her junior year at SUNY ESF. She has been contributing to the summer field crew through independent study projects investigating root biomass at depth and developing better predictions of height-diameter relationships in trees.

Name: Lim, Zhen

Worked for more than 160 Hours: Yes

Contribution to Project:

Amos is a junior at ESF, in the Biology department. He is contributing to the summer field crew through an independent study project study of cellulose and lignin decomposition.

Name: Smeltzer, Neal

Worked for more than 160 Hours: Yes

Contribution to Project:

Neal is a student at Colorado College. He has been contributing to the summer field crew effort through a project measuring sap flow in sugar maple and yellow birch, supervised by Heidi Asbjornsen at University of New Hampshire.

Technician, Programmer

Name: Blodgett, Corrie

Worked for more than 160 Hours: Yes

Contribution to Project:

Corrie is a Research Support Specialist at SUNY-ESF. She is one of the leaders of the summer field crew. She is a veteran of our earlier Bartlett project.

Other Participant

Research Experience for Undergraduates

Name: Nywening, Kelly

Worked for more than 160 Hours: No

Contribution to Project:

Kelly has been contributing to the summer field crew effort through a project comparing productivity measured by DBH remeasurements versus increment cores, in softwood and hardwood stands at two sites.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2011

REU Funding: No Info

Organizational Partners

Miami University Oxford Campus

Cornell University

University of Michigan Ann Arbor

Marine Biological Laboratory

Hubbard Brook Research Foundation

USDA Forest Service - Northeastern Forest Experiment Station

Other Collaborators or Contacts

Mark Green, Plymouth State University, Heidi Asbjornsen and Virginia Hernandez , University of New Hampshire, are also using these sites.

Activities and Findings

Research and Education Activities:

Activities this year included collecting foliar and litter samples, trenching respiration plots, installing minirhizotrons, collecting soil samples, incubating soils for carbon and nitrogen mineralization, measuring trees, surveying herbs, and processing and analyzing samples and data.

Findings: (See PDF version submitted by PI at the end of the report)

See attached file.

Training and Development:

Training and development rely on active interactions among PIs and senior scientists, science teachers, post-docs, graduate students, undergraduates and technicians. We use weekly conference calls to involve PIs when they are off site, and frequent email on specific topics. We have weekly Science Nights with visiting speakers, alternating between the dormitories at Bartlett and Hubbard Brook. Each undergraduate and graduate student has a mentor or a committee of mentors, who review proposals and consult on implementation of projects. Most of our students,including the summer crew, will present talks at the annual HBES Cooperators' Meeting. They will also present their final reports at a symposium in August, shared with REU students from Hubbard Brook.

Outreach Activities:

Undergraduate Research Program: Several undergraduate students are contributing to the project for college credit (e.g., independent study) coordinated by collaborators. Each student has primary responsibility for some part of the overall project, and assists in other projects for mutual benefit. Students interact regularly with REU students and RET participants affiliated with other Hubbard Brook Experimental Forest programs.

Yanai has presented research findings to general and professional audiences:

Yanai, R.D. 'Calcium depletion in northern hardwoods: acid rain or aging forests?' Manlius-Pebble Hill School, Dewitt, NY, May 26, 2010.
Yanai, R.D. Nutrient co-limitation in young and old northern hardwood forests: Has nitrogen deposition tipped the balance? Joint program: Centre de foresterie de Laurentiedes & Le Centre d'?tude de la For?t, Qu?bec, QC, Canada, Oct 13, 2010
Yanai, R.D. Is P more limiting than N in young northern hardwood forests? Korea Forest Research Institute, Aug 30, 2010
Yanai, R.D. 'Nutrient co-limitation: a case study in hardwood forests of the northeastern USA', Kyoto University, Kyoto, Japan, June 16, 2011

Journal Publications

Fisk, MC; Yanai, RD; Fierer, N, "A molecular approach to quantify root community composition in a northern hardwood forest - testing effects of root species, relative abundance, and diameter", CANADIAN JOURNAL OF FOREST RESEARCH-REVUE CANADIENNE DE RECHERCHE FORESTIERE, p. 836, vol. 40, (2010). Published, 10.1139/X10-02

Lucash, M.S., R.D. Yanai, J.D. Blum and B.B. Park., "Foliar nutrient concentrations related to soil sources across a range of sites in the northeastern USA.", Soil Sci. Soc. Am. J., p. , vol. , (2011). Submitted,

Fatemi, F. R., R. D. Yanai, S. P. Hamburg, M. A. Vadeboncoeur, M. A. Arthur, R. D. Briggs, C. R. Levine., "Allometric equations for young northern hardwoods: the importance of age-specific equations for estimating aboveground biomass", Canadian Journal of Forest Research, p. 881, vol. , (2011). Published, 10.1139/x10-248

Books or Other One-time Publications

Yanai, R.D., E.B. Rastetter, M.C. Fisk, T.J. Fahey, F.R. Fatemi, and S.P. Hamburg., "Nutrient co-limitation in aggrading northern hardwood forests", (2010). Conference Proceeding, Published
Bibliography: ECANUSA meeting, October 14-16, 2010, Edmundston, NB, Canada.
http://crsf.umaine.edu/files/2010/10/ProgFECANUSA.pdf

Web/Internet Site

URL(s):

http://www.esf.edu/MELNHE

Description:

The MELNHE website provides public information, including links to published materials. It has also has a password-protected area for data, documents, contact information, and meeting minutes. The web site also provides links to weather, road, and hunting season notices; a web cam that helps monitor leaf-out; and the Shoestring Project blog (http://shoestringproject.wordpress.com). Field crew students and staff share responsibility for posting timely publicly accessible activity updates.

Other Specific Products

Product Type:

Physical collection (samples, etc.)

Product Description:

Many samples with long-term value are archived at SUNY-ESF and tracked through a system developed by the Soil Fertility Laboratory. Samples in active use are at many locations. Archived and active samples are tracked on our project web site.

Sharing Information:

Sample data is shared among cooperators via http://www.esf.edu/MELNHE.

Contributions

Contributions within Discipline:

Nothing to add yet.

Contributions to Other Disciplines:

Nothing to add yet.

Contributions to Human Resource Development:

Nothing to add yet.

Contributions to Resources for Research and Education:

Nothing to add yet.

Contributions Beyond Science and Engineering:

Nothing to add yet.

Conference Proceedings

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Conference

Nitrification and N mineralization across sites

During Summer 2010, we took pre-treatment measurements for an experiment exploring the effects of N and P fertilization on microbial N transformations in three mature northern hardwood stands in the Bartlett Experimental Forest, NH (C7, C8, and C9). Prior research investigating microbial responses to N and P additions in *in situ* incubation responses in soils from these sites suggests that microbial activity is N limited, or possibly co-limited by N and P. We sampled soils in stands in 2010 before any fertilization took place, and these same stands will be resampled after the plots are treated with N and P.

The objective of the 2010 measurements was to observe and document pre-treatment differences between plots (within-stand variability) and between stands in net N mineralization and net nitrification, as well as differences during the growing season. We can use this information to better understand any patterns that we observe after fertilization.

Methods

Soils were collected from four plots in three mature stands at the Bartlett Experimental Forest (C7, C8, and C9). Four to six soil cores (1.5 inch diameter) were taken in four 5m x 5m subplots located in the buffer zone adjacent to the experimental plot (Figure 1). The Oe and Oa layers and the top 10 cm of the mineral soil were sampled. Soil horizons were divided in the field and all samples from a single plot were composited. In 2010, soils were collected June 4-7, July 15-19, and August 9.

Figure 1. A soil core showing (from left to right): the Oie layer (leafy material), Oa layer (dark brown), E horizon (gray), and mineral B layer (light brown).

In the lab, soils were sorted to remove rocks and roots > ~1mm. Approximately 10 g organic soil and 20 g mineral soil were extracted with 100 ml 2M KCl within 24 hours of removal from the field to measure initial NH_4^+ and NO_3^- concentrations. A second subsample was incubated at room temperature for 14 days. After 14 days, the incubated samples were extracted in the same manner as the initial samples. Samples were analyzed for NH_4^+ and NO_3^- in the Fisk Lab at Miami University.

Results

In general, net N mineralization and net nitrification were highly variable. We treated the horizons as independent samples, and were able to discern some stand differences within horizons. For example, C7 had consistently high N mineralization in the B horizon, while C9 had consistently high N mineralization in the Oa horizon. There did not seem to be any consistent patterns in either N mineralization or nitrification relative to the timing of the samples (June vs. July vs. August; Figure 2).

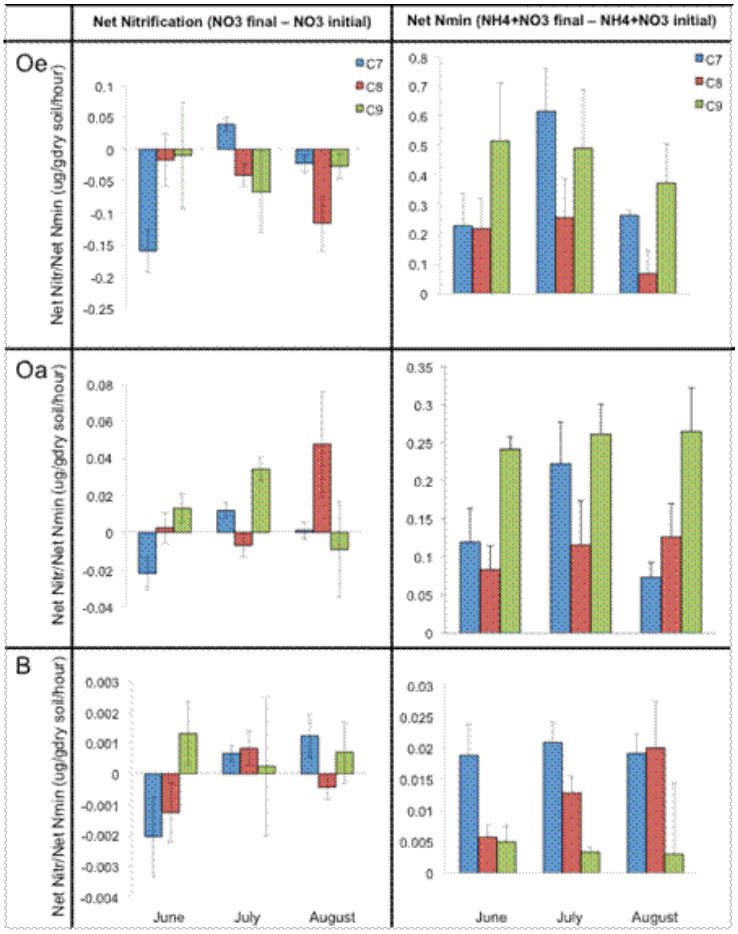

Figure 2.Net nitrification and net N mineralization (+/- standard error) of stands C7, C8 and C9, in the Oe, Oa, and B horizons throughout the growing season.

To analyze the pre-treatment data, we used an ANOVA model with a randomized complete block design (stands were considered the blocking factor) to test for differences between months.

	Net nitrification results for differences between months		**Net N mineralization results for differences between months:**	
	P value (a=0.05)	Tukey's HSD	P value (a=0.05)	Tukey's HSD
Oe	Not sig.		Not sig.	
Oa	Not sig.		0.01	July < August
B	0.005	June < July and August	0.01	July < August

We then removed the blocking factor to look for differences between stands, with plot as the replicate.

	Net nitrification results for differences between stands:		Net N mineralization results for differences between stands:	
	P value (a=0.05)	Tukey's HSD	P value (a=0.05)	Tukey's HSD
Oe	Not sig.		0.05	C9 > C8
Oa	Not sig.		Not sig.	
B	<0.0001	C9> C7 and C8	Not sig.	

We also applied the future N and P treatment designations to the plots to look for pre-treatment patterns between the four treatments. There were no significant differences (α=0.05) between treatment types when treatments were blocked by stand (Figure 3).

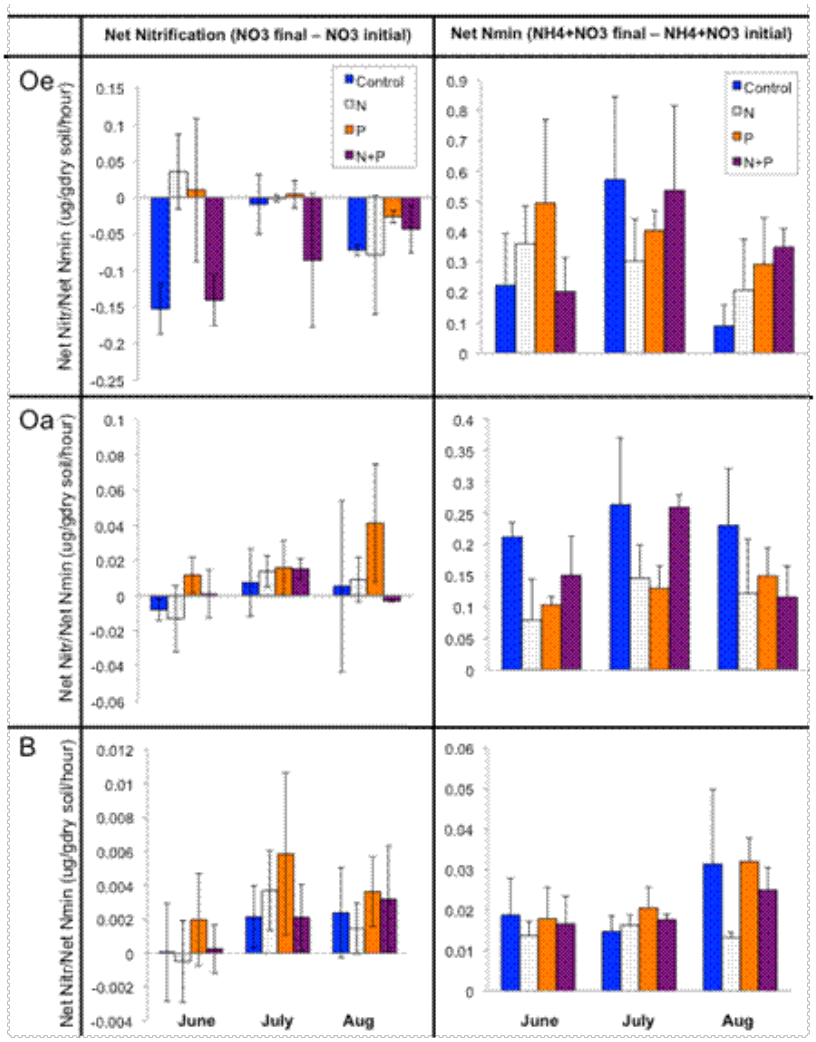

Figure 3. Net nitrification and net N mineralization (ug N/g dry soil/hr) in the Oe, Oa, and B horizons throughout the growing season, shown by future randomly assigned fertilization treatment (stands will be fertilized May 2011).

Summary of Results

We were able to detect some differences in net nitrification and net N mineralization over the growing season. On average, net nitrification in the B horizon was 7.6 times higher in July

than June, and 5.9 times higher in August than in June. Net N mineralization in the Oa horizon was twice as high in August as July, and the same pattern was observed the B horizon.

We also observed differences in net nitrification and net N mineralization by stand. Average net nitrification across the growing season in the B horizon was positive in C9 (0.007 gN/g dry soil/hr), but negative in C7 (-0.0003 gN/g dry soil/hr) and C8 (-5.1 x 10^{-5} gN/g dry soil/hr). Net N mineralization in the Oe horizon was 2.5 times greater in C9 than C8 across the growing season.

Finally, we did not observe any significant differences between the future fertilization treatments (N, P, NxP, control) when blocked by site, therefore we can be confident that treatment differences which we observe in future experiments will not be artifacts of preexisting differences between the randomly assigned treatments.

Nutrient Resorption among Species and Stands

We are in the initial stages of determining nitrogen and phosphorus resorption rates, or the withdrawal of nutrients within leaves prior to their senescence, among the species of interest in our stands. This is being accomplished by comparing the nutrient content of green leaves harvested during the growing season to that collected from fallen leaves.

Methods

Fresh foliar samples were collected from sun leaves of five trees of the three dominant species in each plot using a 12-gauge shot gun. Freshly fallen leaves (leaf litter) were also collected using 3 litter nets per plot, 12 per stand, following rain-free periods; collections were sorted by species in the field. Samples were dried, ground and analyzed for C and N and on ICP.

In an effort to assess the total mass represented by each species, 5 litter baskets per plot were installed to collect leaf litter that accumulated over the winter. Samples were frozen and stored to be sorted, dried, and weighed this summer.

Results

For American beech, the percent N resorbed decreases relative to P with increasing stand age (Figure 4). A significant decrease is seen between white birch in young (C1, C2) and mid C4, C6, HB-mid, JB-mid) aged stands (Figure 5). Both findings suggest greater P limitation in older stands, which is consistent with recent MEL model predictions.

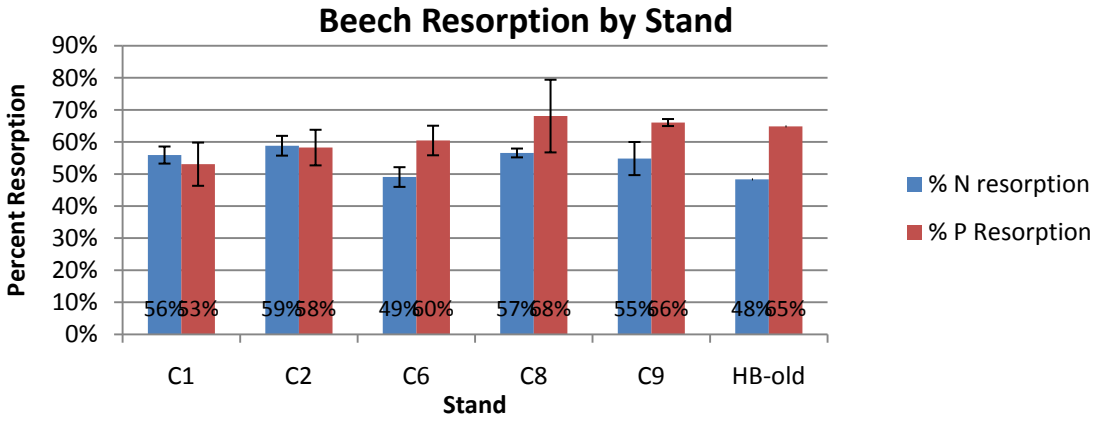

Figure 4. The percent of foliar nitrogen and phosphorus resorbed by American Beech (*Fagus grandifolia*) prior to leaf abscission. Data shown was collected in 2009.

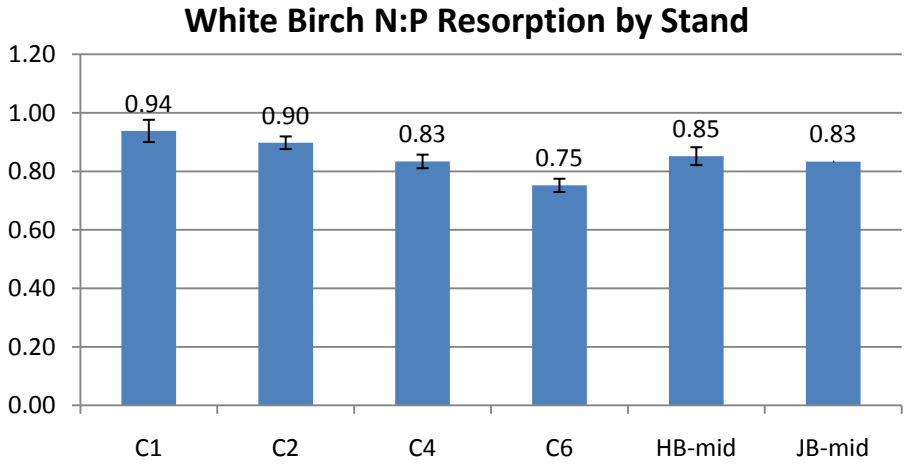

Figure 5. Bars represent the ratio of percent Nitrogen to Phosphorus resorption in white birch (*Betula papyrifera*) prior to abscission. Data shown was collected in 2009.

Summary of Results

Initial results from resorption studies support recent MEL model predictions of greater P limitation in older stands.