Preview of Award 0949854 - Annual Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	0949854
Project Title:	Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests
PD/PI Name:	Christine L Goodale, Principal Investigator Timothy J Fahey, Co-Principal Investigator
Recipient Organization:	Cornell University
Project/Grant Period:	07/01/2010 - 06/30/2015
Reporting Period:	07/01/2013 - 06/30/2014
Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

*** What are the major goals of the project?**

The Cornell portion of the project focuses on addressing the proposal's objective 2, to evaluate mechanisms for maintaining co-limitation of N and P in young and old stands at Bartlett Forest. Work has been expanded to also cover young and stands at two other sites: Hubbard Brook, and Jeffers Brook, NH. Specific hypotheses include:

2a) Total belowground C allocation will be reduced by addition of limiting nutrients.

2b) Total mycorrhizal colonization, similarly, will be lowest where nutrients are least limiting.

2c) Under conditions of greater P limitation, plants will allocate more effort to phosphatase enzyme production, apatite weathering (including deployment of ectomycorrhizal roots at depth), root uptake of P, and P resorption from leaves, compared to conditions of less P limitation.

2d) Under conditions of greater N limitation, plants will allocate more effort to surface roots and mycorrhizae, root uptake of N, and N resorption from leaves, and mineralization of organic N will be higher compared to conditions of less N limitation.

2e) Higher N availability feeds back to slow enzymatic breakdown of complex organic matter substrates and mineralization of N, whereas higher P availability enhances organic matter breakdown and mineralization of N.

The Cornell portion of the project addresses these hypotheses through a suite of measurements of fine and coarse root

biomass and distribution, mycorrhizal infection, and soil C. This work was to be conducted largely in year 1 (pre-treatment) and year 4 (after 3 years of fertilization).

Our efforts during the first years of the project were directed towards site characterization prior to the initiation of treatments in spring 2011, including characterization of fine roots, soil respiration, and soil C and N stocks. Most of financial support for these activities was received in year 1, with moderate support to Fahey in year 2 for continued sample processing, and nominal support in year 3 to wrap up sample processing (Cornell total <$1000). Support from year 4 is largely extended to year 5, consistent with the 1-year delay to treatment initiation.

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

Major Activities:

Fine root biomass and mycorrhizal colonization. We quantified fine root biomass in all the research plots prior to the initiation of treatments. Fine roots were measured in over 1,000 soil cores collected to 30 cm depth. Fine root biomass was significantly lower in young (< 35 yrs) than old (> 100 yr) forests ($p < 0.01$) and significantly higher on the less fertile Bartlett sites ($p < 0.01$). These data will be essential for evaluating root response to fertilization treatments.

We also evaluated a method for quantifying the response of mycorrhizal colonization to treatment. We measured the proportion of fine root tips in three categories: ectomycorrhizal (EM), arbuscular mycorrhizal (AM) and non-mycorrhizal. Pre-treatment analysis was conducted for eight plots in two stands. We were able to demonstrate the statistical power of the technique: we concluded that we could detect a 15% change in the ratio of EM/AM fine roots with a sample size of 10 cores at alpha = 0.05. This work indicates that it will be prudent to increase our sampling effort in post-treatment.

Soil respiration. The flux of CO2 from the soil provides the most sensitive measurement of belowground responses to fertilization treatment. We have been monitoring total soil respiration (TSR) at roughly monthly interval during the snow-free season in each plot since 2009.

Soil carbon and nitrogen stocks. We quantified pre-treatment soil C and N stocks at all plots, using five quantitiative soil cores per plot cored to 50 cm depth and sepaarted into 10 cm increments.

Specific Objectives:

Significant Results:

Soil respiration: To date, we have summarized soil respiration measurements through the third year of treatment. Across the entire experiment (13 stands) no significant change in TSR has been observed; however, in some of the individual stands, highly significant declines in TSR have been detected. In particular, in two of the young stands in the low fertility site (Bartlett EF), TSR has declined significantly in both N and N+P treatments. Most intriguing, we observed that the response of TSR to treatments depends strongly of pre-treatment site fertility: in the most naturally N-rich stands, TSR increased in response to N and N+P addition, whereas it strongly declined in infertile stands (Figure #1). Also, before treatments, much of the variation in TSR across plots could be explained by two independent variables: fine root biomass and annual fine litterfall flux (r2 = 0.58l; n = 48 plots).

Soil C and N: Pre-treatment soils contained on average 142 t C/ha and 7.0 t N/ha to 50 cm depth, values broadly similar to past measurements of whole-profile pre-clearcut soil C and N stocks (160 t C/ha and 7.2 t N/ha) at watershed 5 at Hubbard Brook. Soil C stocks varied nearly two-fold across sites, ranging from 109 t C/ha at Bartlett stand C7 to 194 tC/ha at the Old Hubbard Brook stand (Figure 4). Soil N stocks varied even more, ranging from 4.2 t N/ha at the young Bartlett site up to 10.8 t N/ha at the old Jeffers Brook site. These detailed pre-treatment measurements provide essential baseline information against which future changes

can be measured. This soil processing and analysis was completed by the end of year 2, as anticipated, and described in greater detail in prior annual reports.

Key outcomes or
Other achievements:

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

To date, the Cornell portion of this project has cumulatively supported 1 undergraduate honors thesis, one REU, one masters thesis, pilot projects for two PhD students, and an reserach assistantship for another, as well as reserach opportunities for multiple undergraduates assistants. It has also provided partial support for three research support specialists and two research associates.

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

Manuscripts are in preparation.

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

Complete and submit manuscripts.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Annual report year 4 FIGURE.pdf	Figure to illustrate results completed this reporting period (soil respiration).	Christine Goodale	06/09/2014

Products

Books

Book Chapters

Conference Papers and Presentations

Inventions

Journals

Rastetter, EB, RD Yanai, RQ Thomas, MA Vadeboncoeur, TJ Fahey, MC Fisk, BL Kwiatkowski, and SP Hamburg. (2013). Recovery from disturbance requires resynchronization of ecosystem nutrient cycles. *Ecological Applications*. 23 (3), 621. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/12-0751.1

Licenses

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Terry, Rebecca. *Influence of Stand Age and Soil Fertility on the Fine Root Biomass and Belowground Carbon Allocation in Northern Hardwood Forests. Senior Honors Thesis.*. (2014). Cornell University. Acknowledgement of Federal Support =

Yes

Websites

Participants/Organizations

Research Experience for Undergraduates (REU) funding

Form of REU funding support:	REU supplement
How many REU applications were received during this reporting period?	1
How many REU applicants were selected and agreed to participate during this reporting period?	1
REU Comments:	REU support was received late-spring 2013, and deferred until this the field season of 2014 (this summer). An excellent student, Eli Egan Anderson, was recruited into this position to work on the project at Hubbard Brook, NH.

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Goodale, Christine	PD/PI	0
Fahey, Timothy	Co PD/PI	1
Heinz, Alexis	Technician	2
Cleavitt, Natalie	Staff Scientist (doctoral level)	0
Sherman, Ruth	Staff Scientist (doctoral level)	1
Sridhar, Bhavya	Graduate Student (research assistant)	1
Terry, Rebecca	Undergraduate Student	2

Name	Most Senior Project Role	Nearest Person Month Worked
Egan-Anderson, Eli	Research Experience for Undergraduates (REU) Participant	1

Full details of individuals who have worked on the project:

Christine L Goodale
Email: clg33@cornell.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 0

Contribution to the Project: PI for the Cornell portion of this award, to C. Goodale and T. Fahey. Cornell received funding in years 1 & 4 only. Contribution was ~0.4 mo. (rounded to 0 as nearest integer).

Funding Support: NSF-LTER support to Hubbard Brook.

International Collaboration: No
International Travel: No

Timothy J Fahey
Email: tjf5@cornell.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Co-PI on the Cornell portion of the award; oversee and conduct various analyses of soil respiration and fine root biomass.

Funding Support: NSF LTER support to Hubbard Brook.

International Collaboration: No
International Travel: No

Alexis Heinz
Email: akh24@cornell.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 2

Contribution to the Project: Ms. Heinz supervised and conducted measurement of fine root biomass pre-treatment.

Funding Support: N/A

International Collaboration: No
International Travel: No

Natalie Cleavitt
Email: nlc4@cornell.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 0

Contribution to the Project: Dr. Cleavitt worked on the project in its first year but not for the reporting year 2013-2014.

Funding Support: N/A.

International Collaboration: No
International Travel: No

Ruth Sherman
Email: res6@cornell.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Sherman conducted statistical analysis of fine root biomass and soil respiration (0.5 months; rounded to 1.0 as grants.gov does not allow fractions).

Funding Support: N/A

International Collaboration: No
International Travel: No

Bhavya Sridhar
Email: bs662@cornell.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

Contribution to the Project: Graduate Student participant / non-Research Assistant. Bhavya has initiated work to characterize the stable isotopic composition of respired CO2 as part of her graduate research.

Funding Support: Cornell Fellowship (Academic year and summer, 2012-2013); Small Grant for Cross-Scale Biogeochemistry and Climate research.

International Collaboration: No
International Travel: No

Rebecca Terry
Email: rst56@cornell.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 2

Contribution to the Project: Ms. Terry completed Senior Honors Thesis at Cornell University on pre-treatment fine root dynamics.

Funding Support: N/A

International Collaboration: No
International Travel: No

Eli Egan-Anderson
Email: eje47@cornell.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 1

Contribution to the Project: As of July 1, 2014, Mr. Egan Anderson will have completed ~ 1 mo of his 3-month REU.

Funding Support: REU Supplement to 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: 2013

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Miami University of Ohio	Academic Institution	Oxford, OH
SUNY-ESF	Academic Institution	Syracuse, NY
The Ecosystems Center, Marine Biological Laboratory	Academic Institution	Woods Hole, MA
University of Michigan	Academic Institution	Ann Arbor, MI

Full details of organizations that have been involved as partners:

Miami University of Ohio

Organization Type: Academic Institution
Organization Location: Oxford, OH

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Miami University is a collaborator on this award.

SUNY-ESF

Organization Type: Academic Institution
Organization Location: Syracuse, NY

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: SUNY-ESF is the lead institution on this award.

The Ecosystems Center, Marine Biological Laboratory

Organization Type: Academic Institution
Organization Location: Woods Hole, MA

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: The Ecosystem Center (MBL) is a collaborative partner on this award.

University of Michigan

Organization Type: Academic Institution
Organization Location: Ann Arbor, MI

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: U. Michigan is a formal collaborator on this award.

Have other collaborators or contacts been involved? No

Impacts

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

The project has advanced understaning of the belowground response of forests to nutrient additions (see "accomplishments").

What is the impact on other disciplines?
Nothing to report.

What is the impact on the development of human resources?
Nothing to report.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?
Nothing to report.

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.