NSF Award 0949854 – Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests

Progress Report, year 3 (6/30/12 - 7/1/13), Cornell University

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Timothy Fahey, Department of Natural Resources (DNR)

Project Collaborators:

Ruth Yanai, Project Lead PI, SUNY-ESF, Syracuse, NY

Ed Rastetter, Ecosystems Center, Marine Biological Lab, Woods Hole, MA

Melany Fisk, Miami University, Oxford OH

Joel Blum, University of Michigan, Ann Arbor, MI

Cornell-Associated Personnel (Cumulative over 3 years):

Fine Root and Soil Respiration Work

Timothy Fahey, Professor, Cornell University, Department of Natural Resources (DNR) 0 person-months.

Natalie Cleavitt, nlc4@cornell.edu, Staff Scientist (doctoral level), Cornell University, DNR, nlc4@cornell.edu ; Field coordination of routine sampling of fine roots using minirhizotrons and of soil respiration. Laboratory analysis of mycorrhizal colonization of fine roots. 1 person month.

Alexis Heinz, akh24@cornell.edu, technician, Cornell University, DNR Responsible for laboratory coordination of sample processing for fine root biomass. Data management and analysis. 1 person month.

Cynthia Wood, technician, Cornell University, DNR (not re-entered for 2013)

Ang Li, MS 2012, Cornell University, DNR, al654@cornell.edu (not re-entered for 2013)

Kikang Bae, PhD 2013, SUNY-ESF, kbae02@syr.edu (not re-entered for 2013)

Soil Carbon and Nitrogen Pools

Christine Goodale, clg33@cornell.edu, Associate Professor, Cornell University, EEB, 0 months; 0.25 mo/yr worked on project during 2012-13, support from Cornell Univ.

Guinevere Fredriksen, Technician, EEB, gf44@cornell.edu (not re-entered for 2013)

Gavin Mackellar, BS 2011, Cornell University, DNR, gmm64@cornell.edu; led processing of soils for C/N analysis (sieving, grinding, etc.) (not re-entered for 2013)

Moustafa Abu Areda, BS 2012, Cornell University, EEB, mma75@cornell.edu (not re-entered for 2013)

April Melvin, PhD Jan 2012, Cornell University, EEB, amm243@cornell.edu; Led field collection of quantitative soil samples August/Sept 2010 and trained and oversaw sample processing by undergraduates. (not re-entered for 2013)

Bhavya Sridhar, 1 month, graduate student (not Research Assistant), Cornell University, EEB. Bhavya has initiated work to characterize the stable isotopic composition of respired CO2 as part of her graduate research. Other support: Cornell Fellowship (Academic year and summer, 2012-2013); Small Grant for Cross-Scale Biogeochemistry and Climate research.

Modelling, Multiple Element Limitation (MEL) model

R. Quinn Thomas, PhD Jan 2013, Cornell University, EEB, rqt2@cornell.edu; (not re-entered for 2013)

Project Accomplishments

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).

During the past year (2012-13), Fahey et al. completed the arduous job of quantifying pre-treatment fine root biomass in 52 plots at 13 sites (total of 1040 soil core samples!). The data management and statistical analysis of this data set is in progress. We anticipate developing a published paper relating fine root biomass to leaf biomass, soil respiration and total belowground C allocation across these plots. Moreover, these data will be used in a statistical power analysis to estimate the required sample size for detecting fine root biomass response to treatment; that sampling for is scheduled for summer 2014.

Also during the past year we completed methods development for quantifying the response of mycorrhizal colonization to fertilization. This work involved measurement of the proportions of root tips in three categories (ectomycorrhizal, arbuscular mycorrhizal, non-mycorrhizal) for two soil depths in eight plots of two of the sites. We are currently conducting the statistical power analysis on this data set to determine sampling needs for detecting responses to treatments, sampling scheduled for summer 2014.

Goodale et al. are responsible for characterizing pre-treatment soil carbon and nitrogen stocks across all plots. Summarizing briefly: in summer 2010, prior to fertilization, we sampled all 24 plots, or 4 plots at each of six locations: Mid-aged and Old-aged stands at Hubbard Brook, Jeffers Brook, and Bartlett Forest. Soils were collected from five locations per plot: four in the buffer (fertilized) area near the plot corners, and one location near the plot center. At each coring location, the Oi/Oe and Oa forest floor layers were collected from a 15 cm x 15 cm area using a pin-block device. Underlying mineral soils were collected using an engine-driven, diamond-tipped rotary corer (Rau et al. 2011; *Soil Sci*), internal diameter of 9.5 cm, in 4 depth

increments: 0-10, 10-20, 20-30, and 30-50 cm. Processing of the 720 soil samples included air-drying, sieving (6 mm for forest floor; 2 mm for mineral soil), grinding with a ball mill, and analysis for C, N, and S content with a vario-EL III (Elementar Analysensysteme, Hanau, Germany). 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, estimated through > 60 quantitative pits (Johnson 1995; *CJFR*). 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.

No work was budgeted for the last year (year 3), but we have initiated additional measurements supported by other sources of funding. Support for a Cornell-based REU was approved in mid-April, 2013. The late date of its final approval, combined with plans for major Cornell-led field work to be conducted during year 4, led us to conclude that the REU support would more optimally be used during summer 2014 than summer 2013, and so we aim to postpone this REU opportunity until next year. In addition to developing plans for the REU, we are taking pilot measurements for stable isotope work. That is, using independent funding, first-year Cornell graduate student Bhavya Sridhar has built new soil gas chambers designed to enable measurements of d13C-CO2 at the study's plots where soil respiration has been measured (see year 2 Cornell or Yanai report). We anticipate that Bhavya will seek related additional independent funding during 2013-14 to support stable isotopic analysis of the archived soil samples described above. Together, these new isotopic measurements will advance understanding about the effects of nutrient addition on soil C stabilization and decomposition.