COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 10-1

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

1112749

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

DEB - Ecosystem Studies

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
12/01/2010	1	08010000 DEB	1181	152606125	03/07/2013 4:24pm S

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

0949324

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☐ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

SUNY College of Environmental Science and Forestry

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

SUNY College of Environmental Science and Forestry
PO Box 9
Albany, NY. 122010009

AWARDEE ORGANIZATION CODE (IF KNOWN)

0028514000

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

PERFORMING ORGANIZATION CODE (IF KNOWN)

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 25,167	0 months		

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number ________
Exemption Subsection ________ or IRB App. Date ________
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Forest and Natural Resources Management

PI/PD POSTAL ADDRESS
1 Forestry Drive
210 Marshall Hall
Syracuse, NY 13210
United States

PI/PD FAX NUMBER
315-470-6954

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Ruth D Yanai	PhD	1990	315-470-6955	rdyanai@syr.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Soil Moisture Response to Calcium Fertilization in Northern Hardwood Forest Plots

Hypothesis: Calcium-fertilized plots will have lower soil moisture than control plots because of greater transpiration in the treated plots.

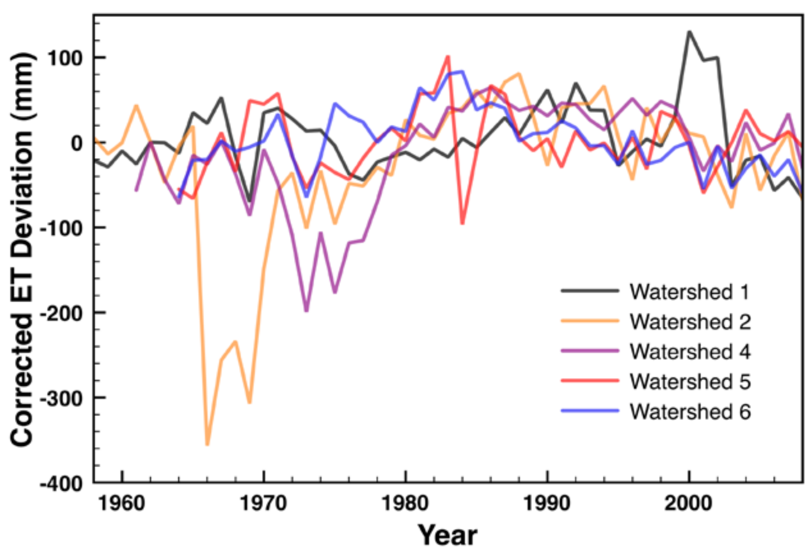
Supporting objectives:

- Establish soil moisture instrumentation on experimental plots to measure high-frequency soil moisture prior to, during, and after forest fertilization.
- Use monitored soil moisture, sapflow data, and hydrologic measurements at nearby sites (Hubbard Brook and Bartlett Experimental Forests) to observe whole water balance changes due to fertilization.

Project Justification and Relevance:

A watershed-scale wollastonite ($CaSiO_3$) addition to Watershed 1 at the Hubbard Brook Experimental Forest apparently stimulated 20% of additional transpiration for three years (Green et al., in preparation). This transpiration response was not a direct measure of transpiration, it was detected by measuring ET by calculating the difference between precipitation and stream runoff. Thus, the transpiration signal was detected in stream runoff data – the largest scale detection of a hydrologic change due to fertilization that I am aware of. This large-scale response to fertilization demonstrates how fertilization can drastically change a watershed water balance, comparable to deforestation (Figure 1). Such a large change highlights a potential unintended consequence of forest fertilization. The response also raises questions about how calcium loss from White Mountains soils due to acid rain (Likens et al. 1996) may have negatively impacted transpiration.

Figure 1. Evapotranspiration (ET) deviation from the reference watershed during the monitored record at Hubbard Brook. The largest changes are the forest harvest treatments in 1965, 1970, and 1983 – and the wollastonite treatment in 1999.



The hydrologic response at Watershed 1 is not well understood because direct measurement of transpiration was not conducted. Thus, post-response experiments are necessary to try to identify mechanisms responsible for the hydrologic change. We know from previous studies that forest fertilization often stimulates transpiration because primary production increases, causing stomata to be more frequently open to exchange

CO_2 for O_2 with the atmosphere (Hubbard et al. 2004, Samuelson et al. 2008, Silva et al. 2008). Excess water for stimulated transpiration comes from soil moisture. However, few investigations have simultaneously measured transpiration rates and soil moisture (Phillips et al. 2001). Supplemental funding from the Hubbard Brook LTER project (DEB-0423259) is funding Dr. Green and his students to measure sapflow in trees on plots associated with Dr. Yanai et al.'s project (DEB-0949324). The current supplemental request is to add soil moisture monitoring to attempt to link soil moisture dynamics to sapflow dynamics on fertilized plots in the Northern Hardwood Forest.

Research Approach:

Soil moisture sensors (Decagon EC-5 capacitance/frequency domain probes) will be deployed at control and newly established calcium-treatment plots at Jeffers Brook, the Bartlett Experimental Forest, and the Hubbard Brook Experimental Forest. Moisture sensor arrays will consist of capacitance moisture probes placed at three depths in the soil column (10 cm, 30 cm, and 90 cm). The arrays will be located in the center of the plots. Two additional arrays will be placed in the nitrogen and phosphorus treatments of the mid-aged stands at Bartlett Experimental Forest in order to gain some preliminary data on hydrologic response to fertilization with other elements. The soil moisture sensors will operate beginning in the Spring of 2011 and continue into the foreseeable future. Long-term monitoring at each site by Yanai et al., including leaf area, root biomass, and root production, will provide a context for interpreting continued hydrologic monitoring at the fertilization plots. The timing of this project allows us, to obtain pre-treatment as well as post-treatment data.

The wollastonite will be applied in October 2011 to replicate the timing of the wollastonite application in Watershed 1 (October 1999). The application rate will be 3500 kg of wollastonite per hectare, as for Watershed 1, which equates to 1200 kg of calcium per hectare.

Based on the soil moisture data, the total volume of water in the top 1 m of soil will be estimated. Given this soil water volume, transpiration rates estimated from sapflow data, evapotranspiration rates calculated by whole-watershed water balances at Hubbard Brook, evapotranspiration rates estimated with the eddy flux tower operated by David Hollinger (U.S. Forest Service) at Bartlett, and precipitation monitoring throughout the region (including local monitoring at Hubbard Brook), we will be able to construct approximate water balances for each plot. Further, we will be able to estimate the alteration of each water balance by fertilization.

Expected Products and Outcomes:

The data from the combined soil moisture and sapflow monitoring will be unique to ecohydrologic studies, and will help explain other ecological dynamics occurring in these plots. The collected data will provide the basis for a manuscript documenting the hydrologic response to fertilization in the White Mountains. This manuscript will complement the Green et al. (in preparation) work by providing direct measurements of transpiration and the hydrologic effects – providing insight into the whole-watershed hydrologic response in Watershed 1. Another important outcome of this work will be providing research experience for a Plymouth State University undergraduate student. Working with the Yanai et al. team and contributing valuable information on soil moisture will provide a new perspective for this student on how science is practiced.

Statement from the host

Yanai's role is in coordinating the larger MELNHE project, which has included the recruitment of several new cooperators, including Mark Green. She has responsibility for the overall operation of the field crew and the integration of the many research activities occurring on the site. Day-to-day operations are coordinated by Corrie Blodgett, manager of the field operations.

Mark has already had an important influence on the project; many other members of the MELNHE team are interested in the addition of a Ca treatment plot to five of our stands. We will include these plots in our extensive system of measurements, including stand inventory this summer, for example. It will be interesting to compare the responses we see in our plots at Bartlett and Jeffers Brook to the Ca treatment at HB Watershed 1, which we are replicating in terms of timing and application rate, and the material applied (wollastonite).

We expect Mark to remain an active member of the MELNHE team, monitoring the long-term effects of the nutrient manipulations that we will begin this year.Impact on

Visitor's Research Plan and Home Institution

Dr. Green is actively developing ecohydrology research projects in the Northern Forest. This supplemental funding would allow him to develop a novel study with a distinguished team of scientists in the region. It is anticipated that the research relationships established during the project will persist because of the regional proximity of the collaborators and the common interest in Northern Forest ecosystems. Because the impact of fertilization on forest hydrology remains poorly understood, the proposed work would establish Dr. Green as a resource for understanding regional ecohydrology. The participation of Green and the proposed undergraduate student will directly benefit Plymouth State University (PSU) by creating an opportunity for PSU to be engaged in cutting-edge research.

Work Cited:

Green, M. B., A. S. Bailey, S. Bailey, J. L. Campbell, C. Eagar, L. Lepine, G.E. Likens, S. Ollinger, and P. Schaberg. 2010. A catchment-scale hydrologic response to a soil calcium amendment. In preparation.

Hubbard, R. M., M. G. Ryan, C. P. Giardina, and H. Barnard. 2004. The effect of fertilization on sap flux and canopy conductance in a Eucalyptus saligna experimental forest. Global Change Biology 10:427-436.

Likens, G. E., C. T. Driscoll, and D. C. Buso. 1996. Long-term effects of acid rain: Response and recovery of a forest ecosystem. Science 272:244-246.

Phillips, N., J. Bergh, R. Oren, and S. Linder. 2001. Effects of nutrition and soil water availability on water use in a Norway spruce stand. Tree Physiology 21:851-860.

Samuelson, L. J., M. G. Farris, T. A. Stokes, and M. D. Coleman. 2008. Fertilization but not irrigation influences hydraulic traits in plantation-grown loblolly pine. Forest Ecology and Management 255:3331-3339.

Silva, C. E. M. D., J. F. D. C. Gonzalves, and T. R. Feldpausch. 2008. Water-use efficiency of tree species following calcium and phosphorus application on an abandoned pasture, central Amazonia, Brazil. Environmental and Experimental Botany 64:189-195.

JUSTIFICATION FOR SUPPLEMENTAL FUNDING

We propose to involve a faculty member and undergraduate students from Plymouth State University in our research of nutrient co-limitation in hardwood forests of different ages.

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
SUNY College of Environmental Science and Forestry

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ruth Yanai

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Ruth D Yanai - Principal Investigator	0.00	0.00	0.00	0	
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				3,810	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				3,810	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				190	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				4,000	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				10,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				5,974	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				15,974	
H. TOTAL DIRECT COSTS (A THROUGH G)				19,974	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) G1, G3 (Rate: 26.0000, Base: 19974)					
TOTAL INDIRECT COSTS (F&A)				5,193	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				25,167	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				25,167	

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Ruth Yanai	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
William nicholson			

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
SUNY College of Environmental Science and Forestry

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ruth Yanai

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ruth D Yanai - Principal Investigator**	0.00	0.00	0.00	**0**	
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**3,810**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**3,810**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**190**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**4,000**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**10,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**5,974**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**15,974**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**19,974**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**5,193**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**25,167**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**25,167**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Ruth Yanai

ORG. REP. NAME*
William nicholson

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification Page

The impact of this budget revision is to include an undergraduate student from ESF during the summer rather than from Plymouth State University through the fall. Materials and supplies still include raw wollastonite (Calcium source, 4 U.S. tons at ~$200 per ton plus transportation costs) and soil moisture arrays to measure soil moisture at control and calcium fertilized sites ($9000). Mark Green will serve as a consultant, conducting soil moisture monitoring and subsequent data analysis.