

**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 11-1					<b>FOR NSF USE ONLY</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					<b>NSF PROPOSAL NUMBER</b>	
<b>DEB - Ecosystem Studies</b>					<b>1214425</b>	
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
12/01/2011	1	08010000 DEB	1181	152606125	03/14/2013 1:21pm S	
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL <b>0949324</b>		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input type="checkbox"/> IF YES, LIST ACRONYM(S)		
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE <b>SUNY College of Environmental Science and Forestry</b>			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE <b>SUNY College of Environmental Science and Forestry PO Box 9 Albany, NY. 122010009</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN) <b>0028514000</b>						
NAME OF PRIMARY PLACE OF PERF			ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE			
IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)		<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE
TITLE OF PROPOSED PROJECT <b>Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests</b>						
REQUESTED AMOUNT \$ <b>15,500</b>	PROPOSED DURATION (1-60 MONTHS) <b>0</b> months	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE			
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW						
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2)		<input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____				
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)		<input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)				
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)		_____				
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)		<input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)				
<input type="checkbox"/> EAGER* (GPG II.D.2) <input type="checkbox"/> RAPID** (GPG II.D.1)		_____				
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____		_____				
PI/PD DEPARTMENT <b>Forest and Natural Resources Management</b>		PI/PD POSTAL ADDRESS <b>1 Forestry Drive 210 Marshall Hall Syracuse, NY 13210 United States</b>				
PI/PD FAX NUMBER <b>315-470-6954</b>						
NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address		
PI/PD NAME <b>Ruth D Yanai</b>	<b>PhD</b>	<b>1990</b>	<b>315-470-6955</b>	<b>rdyanai@syr.edu</b>		
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						
CO-PI/PD						

## SUMMARY OF PROPOSED WORK

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**This is a request for an REU supplement.**

**We propose to involve additional undergraduate students in our research of nutrient co-limitation in hardwood forests of different ages. The project is well suited to undergraduate participation because we will have a team of researchers (undergraduate and graduate students, professors, and Forest Service scientists and others) working together at the Bartlett Experimental Forest in New Hampshire.**

**Christy Goodale and Tim Fahey at Cornell intended to request an REU supplement on their portion of our collaborative research project. In case they did not, we are requesting two REU students.**

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We are requesting a supplement for Research Experience for Undergraduates to support two REU students.

The project on Multiple Element Limitation in Northern Hardwood Ecosystems (MELNHE) provides excellent opportunities for exposure to scientific research because it involves so many researchers and so many topic areas, with work centered in an attractive geographic location that promotes interaction. In addition to the nine stands of three ages at Bartlett originally funded by NSF, we are working in young and mature stands at Jeffers Brook and Hubbard Brook, which provide a gradient in site fertility. There were five PIs initially funded on collaborative proposals, and four more have written other proposals to fund their work in our sites. There are five graduate students currently funded on the main project and more are being recruited. There are undergraduates on the field crew, each with responsibility for a project area, and there is a constant flow of visiting scientists, foreign exchange students, and visitors from other projects. The center of activity is the White House at Bartlett, with the nearby dorm and lab. Sharing housing, meals, and cooking responsibilities contributes to the chances for interactions with scientists at all levels of development.

Because of the large number of researchers involved, REU participants will have the opportunity to learn about and contribute to a wide variety of measurements at these sites, including tree inventory, herb and seedling inventory, root biomass, root imaging, soil sampling, soil respiration, nitrogen mineralization, leaf area, collecting litterfall, and shooting fresh foliage. There are opportunities for laboratory experiments, for example on nitrogen mineralization and microbial respiration, as well as field experiments. They will also have access to reams of data collected during the previous funding cycle at Bartlett (<http://www.esf.edu/melnhe>) and collected over decades at the Hubbard Brook Experimental Forest ([http://www.hubbardbrook.org/data/dataset\\_search.php](http://www.hubbardbrook.org/data/dataset_search.php)).

We hope to have additional REU students on our team at Bartlett, supported on the HBR LTER or by the REU Site at Plymouth State University, if renewed. Regardless of how they are funded, we treat all our team members as researchers, not just as grunt labor, and we give them the support they need to learn about experimental design, research planning, time management, project coordination, data analysis, and the scientific communication of results. The integration of efforts across a range of backgrounds and experiences, from REU, to RET, to visiting professors, provides everyone an opportunity to better understand the process of scientific research, and everyone gains exposure to a wide range of subjects within the fields of forest ecology and ecosystem nutrient cycling. Each student has primary responsibility for a research project, and each aspect of the research has a student with lead responsibility. We depend on REUs, volunteers, and interns to provide undergraduates to our summer crew, because our main grant does not include any undergraduate student salary in any year of the project.

### **Possible projects**

Participants in this year's field operations will develop focused research projects in the context of the overall experimental design. Some possible projects are listed here.

- Root dynamics: Filming minirhizotrons can tell us the effect of nutrient treatments on root production. Also, we have power-cored samples for deep root biomass (30 - 50 cm), and soil cores for shallow root biomass (0 - 30 cm) in 2009. We will compare root biomass by soil depth using soil cores, and deep roots biomass across forest ages and across sites for pre-treatment data.
- Heterotrophic respiration: In 2010, we trenched plots in five stands to exclude roots; a comparison of soil respiration in the trenched plots and outside the plots permits an estimate of autotrophic and heterotrophic respiration. In 2011, there were still no treatment effects on soil respiration. This year, we expect to be able to differential heterotrophic and autotrophic responses to nutrient additions in young and old stand in two contrasting sites.

- The development of leaf area could be monitored using an LAI-2000. We will be monitoring sap flow in some of our stands to test for an increased in transpiration in response to nutrient additions, as observed in the whole-watershed Ca addition at Hubbard Brook. Differences in leaf area development with treatment could be important to explaining patterns of sap flow.
- Coarse woody debris was measured in transects in 2004; remeasurement would permit an estimate of the rate of CWD production, which is rarely reported but is essential to estimates of ecosystem productivity and nutrient cycling. Fine woody debris could be monitored in plots.
- A student with a background in entomology could characterize the meso and macroinvertebrate forest floor community in our plots and test for treatment differences.
- Stand dynamics: We will inventory trees in a chronosequence of 13 stands previously measured in 1994 and 2003. This presents opportunities to ask questions about regeneration, recruitment, and mortality. We have data on environmental variables such as soil chemistry, soil depth, aspect, slope and elevation that could be used in a multivariate analysis to explore causes of the variation in forest structure.

### **Other program elements**

We have developed a culture for mentoring students and developing skills essential to the conduct of scientific research and a spirit of cooperation in the field crew. Some of the program elements are outlined below. Last year we added a weekly seminar series, modeled on the successful Science Night tradition at Hubbard Brook.

- Identify research interests in advance of the field season, then pair graduate student mentors with REU students, and provide them with relevant background reading.
- Proposals for each research project will be developed by the leading student and reviewed by the team within the first two weeks. Approved proposals will be posted on our web site. Formal review of proposals can prevent many misunderstandings and errors in implementation.
- Data documentation: We train students to follow our protocols for data documentation, including providing peer review of data sets and the accompanying metadata.
- Presentations at the annual Hubbard Brook Cooperators meeting in July (many of our undergraduates have made presentations at this meeting, including three last year).
- Field crew blog: We post photos, results, and stories. Last year's blog is available at <http://shoestringproject.wordpress.com/>
- Wednesday night discussions series. Scientists such as Herb Bormann and Tony Federer have already agreed to give presentations; many other prominent researchers work at Bartlett in addition to those associated with our project (Scott Ollinger, Andrew Richardson, Dave Hollinger, Bill Leak, Chris Costello). In addition to scheduling seminars on scientific topics, we will discuss the impacts of scientific research on society.

### **Results from Previous REU Supplements**

Last year we had one REU on this project and one provided by the HBR LTER, in addition to three undergraduates funded by other sources. They presented their research projects on tree height, sap flow, decomposition of lignin and cellulose, and beech bark disease at the Hubbard Brook Cooperators meetings. Some of these projects are still ongoing and will contribute to future publications.

### **Diversity**

The crew leader at our field site is a woman, Corrie Blodgett (a veteran of our 2004 field crew, when she was an undergraduate). Half of the 6 PIs are women, including two in leadership positions. Thus the male and female students on the crew will be exposed to both female and male role models. This is important for students from institutions such as ESF, which still has only 15% women on the faculty. We also benefit from broad cultural diversity, with students hailing from India, China, and Korea, as well as Hawaii and the mainland US.

**Participant selection**

We will select students based on academic and career interests, previous academic course work and field experience, and aptitude for research. We have contact with many potential students through teaching and academic year lab employment; where we don't have first-hand knowledge of student ability and interests, we will interview their referees, rather than relying solely on written references.

# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>SUNY College of Environmental Science and Forestry</b>				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Ruth Yanai</b>				AWARD NO.	Proposed	Granted
				A. SENIOR PERSONNEL: PI/PP, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		
				CAL	ACAD	SUMR
1. <b>Ruth D Yanai - Principal Investigator</b>				0.00	0.00	0.00
2.						
3.						
4.						
5.						
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. ( 0 ) GRADUATE STUDENTS						0
4. ( 0 ) UNDERGRADUATE STUDENTS						0
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6. ( 0 ) OTHER						0
TOTAL SALARIES AND WAGES (A + B)						0
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						0
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 \$ <u>8,000</u>						
2. TRAVEL <u>5,000</u>						
3. SUBSISTENCE <u>0</u>						
4. OTHER <u>500</u>						
TOTAL NUMBER OF PARTICIPANTS ( 2 )				TOTAL PARTICIPANT COSTS		<b>13,500</b>
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3. CONSULTANT SERVICES						0
4. COMPUTER SERVICES						0
5. SUBAWARDS						0
6. OTHER						0
TOTAL OTHER DIRECT COSTS						0
H. TOTAL DIRECT COSTS (A THROUGH G)						<b>13,500</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
<b>F1 (Rate: 25.0000, Base: 8000)</b>						
TOTAL INDIRECT COSTS (F&A)						<b>2,000</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						<b>15,500</b>
K. RESIDUAL FUNDS						0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						<b>15,500</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$		
PI/PP NAME <b>Ruth Yanai</b>				FOR NSF USE ONLY		
ORG. REP. NAME* <b>William nicholson</b>				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

# SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION <b>SUNY College of Environmental Science and Forestry</b>				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Ruth Yanai</b>				AWARD NO.		
A. SENIOR PERSONNEL: PI/PP, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months			Funds Requested By proposer	Funds granted by NSF (if different)	
	CAL	ACAD	SUMR			
1. <b>Ruth D Yanai - Principal Investigator</b>	0.00	0.00	0.00	<b>0</b>		
2.						
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	<b>0</b>		
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	<b>0</b>		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	<b>0</b>		
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	<b>0</b>		
3. ( <b>0</b> ) GRADUATE STUDENTS				<b>0</b>		
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS				<b>0</b>		
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				<b>0</b>		
6. ( <b>0</b> ) OTHER				<b>0</b>		
TOTAL SALARIES AND WAGES (A + B)				<b>0</b>		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				<b>0</b>		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT				<b>0</b>		
E. TRAVEL						
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				<b>0</b>		
2. FOREIGN				<b>0</b>		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____	<b>8,000</b>					
2. TRAVEL _____	<b>5,000</b>					
3. SUBSISTENCE _____	<b>0</b>					
4. OTHER _____	<b>500</b>					
TOTAL NUMBER OF PARTICIPANTS ( <b>2</b> )	TOTAL PARTICIPANT COSTS			<b>13,500</b>		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				<b>0</b>		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				<b>0</b>		
3. CONSULTANT SERVICES				<b>0</b>		
4. COMPUTER SERVICES				<b>0</b>		
5. SUBAWARDS				<b>0</b>		
6. OTHER				<b>0</b>		
TOTAL OTHER DIRECT COSTS				<b>0</b>		
H. TOTAL DIRECT COSTS (A THROUGH G)				<b>13,500</b>		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)				<b>2,000</b>		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				<b>15,500</b>		
K. RESIDUAL FUNDS				<b>0</b>		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				<b>15,500</b>		
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>		AGREED LEVEL IF DIFFERENT \$				
PI/PP NAME <b>Ruth Yanai</b>				FOR NSF USE ONLY		
ORG. REP. NAME* <b>William nicholson</b>				INDIRECT COST RATE VERIFICATION		
		Date Checked	Date Of Rate Sheet	Initials - ORG		

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## Budget Justification Page

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This will provide funding for Research Experience for two undergraduate students. This budget includes a stipend; travel, housing, and supplies; and an administrative allowance.

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