

Final Report for Period: 03/2006 - 02/2007**Submitted on:** 06/01/2007**Principal Investigator:** Yanai, Ruth D.**Award ID:** 0235650**Organization:** SUNY Col Env Sci&Forestry**Title:**

Biotic Control of Calcium Supply: Distinguishing Sources to Regrowing Forests

Project Participants**Senior Personnel****Name:** Yanai, Ruth**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Ruth Yanai was responsible for the overall coordination of the project. She was responsible, together with Byung Bae Park, a graduate student, for the analysis of roots collected from soil pits. She was the major professor for Farrah Fatemi, who was responsible for designing and implementing sampling and analysis for allometric equations.

Name: Fisk, Melany**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Melany Fisk and a graduate student are characterizing soil fungal communities. They are using molecular genetic approaches to quantify the relative frequency of different dominant fungal species throughout an intensively sampled site. This work is paired with quantification and identification of the fungi colonizing mineral baits in the lower B horizon soils. Work is in progress to identify which members of the soil fungal community are attracted to the baits. This work is funded by the US Forest Service.

Name: Blum, Joel**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Professor Joel Blum was the geochemist on the project. He was responsible for the sequential leaching and chemical analysis of soil and vegetation, which included major and trace element analyses by ICP-OES and ICP-MS as well as high precision measurement of Sr isotope ratios by TIMS.

Name: Hamburg, Steve**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Steve Hamburg led the field effort to locate sites and sample soils. He also participated in the design of the tree analysis required for allometric equations.

Name: Arthur, Mary**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dr. Mary Arthur was the graduate supervisor of Marty Acker who was responsible for characterizing litter fall and coarse woody debris at our study sites. She was also involved in vegetation analysis.

Post-doc**Name:** Hane, Elizabeth**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Elizabeth Hane was primarily responsible for understory vegetation and regeneration and played a role in analysis of overstory vegetation.

Graduate Student**Name:** Lilly, Paul**Worked for more than 160 Hours:** Yes

Contribution to Project:

Paul Lilly undertook a study of soil acidity funded by the Sussman Foundation in the summer of 2004. He assisted in our field work in exchange for getting help with his field work in the summer of 2003. For his Master's thesis, he measured soil acidity in four old forest liming studies, which we have made part of our study system, following up with measurements of vegetation and soil processes.

Name: Ritchie, Karen

Worked for more than 160 Hours: Yes

Contribution to Project:

Karen Ritchie is working on a Master's thesis on microbial communities in soil funded by the US Forest Service.

Name: Nezat, Carmen

Worked for more than 160 Hours: Yes

Contribution to Project:

Carmen Nezat wrote a dissertation on weathering rates of minerals in soil.

Name: Acker, Marty

Worked for more than 160 Hours: Yes

Contribution to Project:

Marty Acker wrote a Master's thesis on litterfall and coarse woody debris. He coordinated field efforts for these collections during the summer of 2004.

Name: Ash, Amanda

Worked for more than 160 Hours: Yes

Contribution to Project:

Amanda Ash performed field work and chemical analyses, and wrote a dissertation on translocation of calcium and strontium in vegetation.

Name: Boley, Jeremy

Worked for more than 160 Hours: Yes

Contribution to Project:

Jeremy Boley worked for us in the field in the summer of 2003.

Name: Fatemi, Farrah

Worked for more than 160 Hours: Yes

Contribution to Project:

Farrah's wrote a Master's thesis on allometric equations for biomass and nutrient content.

Name: Fanelli, Rosemary

Worked for more than 160 Hours: No

Contribution to Project:

Rosemary, a graduate student from ESF, processed roots collected from quantitative pits during the summer of 2004.

Name: Park, Byung

Worked for more than 160 Hours: Yes

Contribution to Project:

BB supervised the sorting of roots from the quantitative soil pits excavated in 2003 and 2004 and published, with Yanai and others, two papers, including one comparing this method to coring and allometric equations.

Name: Bohn, Kimberly

Worked for more than 160 Hours: Yes

Contribution to Project:

Kimberly reviewed data, analyses, and presentations for other ESF graduate students during the winter of 2004.

Undergraduate Student

Name: Phillips, Erick

Worked for more than 160 Hours: Yes

Contribution to Project:

Erick provided field work support during the summer of 2003.

Name: Ross, Noam

Worked for more than 160 Hours: Yes

Contribution to Project:

Noam, an undergrad from Brown University, provided support in our field work in 2003 and lab work in 2004.

Name: Just, Allan

Worked for more than 160 Hours: Yes

Contribution to Project:

Allan provided support for our field work over the summer of 2003.

Name: Clark, Heather

Worked for more than 160 Hours: Yes

Contribution to Project:

Heather, an undergrad from the University of Kentucky provided support during the summer of 2003 for our field work. She continued in the lab sorting litter samples during the 2003-2004 academic year.

Name: O'Donnell, Emily

Worked for more than 160 Hours: Yes

Contribution to Project:

Emily, an undergrad from the University of Michigan, began as summer field help, and has continued to assist us with the lab work in 2004.

Name: Coria, Alexandria

Worked for more than 160 Hours: Yes

Contribution to Project:

Alexandria supported the project in the summer of 2003 by assisting with field work.

Name: Averbek, Robin

Worked for more than 160 Hours: Yes

Contribution to Project:

Robin, an undergrad from Brown University, helped with field work over the summer of 2004.

Name: Blodgett, Corrie

Worked for more than 160 Hours: Yes

Contribution to Project:

Corrie helped with field work over the summer of 2004. She was funded by the Rochester Institute of Technology.

Name: Deringer, Molly

Worked for more than 160 Hours: Yes

Contribution to Project:

Molly, an undergrad from Brown University, helped with field work over the summer of 2004.

Name: Matsuzaki, Asuka

Worked for more than 160 Hours: Yes

Contribution to Project:

Asuka, an undergrad from ESF, helped with field work and also processed roots collected from quantitative pits during the summer of 2004.

Name: Miftari, Shefije

Worked for more than 160 Hours: Yes

Contribution to Project:

Shefije, an undergrad from ESF, helped with field work over the summer of 2004.

Name: Shapiro, Nicole

Worked for more than 160 Hours: Yes

Contribution to Project:

Nicole, an undergrad from Brown University, helped with field work over the summer of 2004.

Name: Tucker, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Dan, an undergrad from Brown University, helped with field work over the summer of 2004.

Name: Weeks, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Brian, an undergrad from Brown University, helped with field work over the summer of 2004, and worked in the lab during the 2004-5 academic year.

Name: Glenday, Julia

Worked for more than 160 Hours: Yes

Contribution to Project:

Julia, an undergrad from Brown University, helped with lab work over the summer of 2004.

Name: He, Judy

Worked for more than 160 Hours: Yes

Contribution to Project:

Judy He, an undergrad from Brown University, helped with lab work during the 2004-5 academic year.

Name: Kernan, Gwen

Worked for more than 160 Hours: Yes

Contribution to Project:

Gwen Kernan, an undergrad from ESF, processed roots collected from quantitative pits during the summer of 2004.

Name: Khatana, Sameed

Worked for more than 160 Hours: Yes

Contribution to Project:

Sameed, an undergrad from Brown University, helped with lab work during the 2004-5 academic year.

Name: Nishii, Mutsumi

Worked for more than 160 Hours: Yes

Contribution to Project:

Mutsumi Nishii, an undergrad from ESF, processed roots collected from quantitative pits during the summer of 2004.

Name: Smith, Grant

Worked for more than 160 Hours: Yes

Contribution to Project:

Grant, an undergrad from Brown University, helped with lab work during the 2004-5 academic year.

Name: Wu, Eva

Worked for more than 160 Hours: Yes

Contribution to Project:

Eva, an undergrad from Brown University, helped with lab work during the 2004-5 academic year.

Name: Beem-Miller, Jeffery

Worked for more than 160 Hours: Yes

Contribution to Project:

Jeff, an undergrad at Oberlin College, interned at Brown University in Winter 2005, running C and N analysis on long-term forest floor samples.

Name: Dejong, Hans

Worked for more than 160 Hours: Yes

Contribution to Project:

Hans, an undergrad from Brown University, helped with field work over the summer of 2005.

Name: Drum, Bochay

Worked for more than 160 Hours: Yes

Contribution to Project:

Bochay, an undergrad from Brown University, helped with lab work during the 2005-6 academic year.

Name: George, Valerie

Worked for more than 160 Hours: Yes

Contribution to Project:

Valerie, an undergrad at the Rochester Institute of Technology, helped with field work in the summer of 2005.

Name: Gonzalez, Elena

Worked for more than 160 Hours: Yes

Contribution to Project:

Elena, an undergrad from Brown University, helped with lab work during the 2004-5 academic year.

Name: Hagamen, Lindsay

Worked for more than 160 Hours: Yes

Contribution to Project:

Lindsay, an undergrad from Brown University, helped with field work over the summer of 2005.

Name: Molinar, Marissa

Worked for more than 160 Hours: Yes

Contribution to Project:

Marissa, an undergrad from Brown University, helped with field work over the summer of 2005.

Name: Mubita, Lynn

Worked for more than 160 Hours: Yes

Contribution to Project:

Lynn, an undergrad from Brown University, helped with lab work during the 2005-6 academic year.

Name: Skeldon, Monica

Worked for more than 160 Hours: Yes

Contribution to Project:

Monica, an undergrad from Brown University, helped with field work over the summer of 2005.

Name: Goodloe, Katherine

Worked for more than 160 Hours: No

Contribution to Project:

Katherine, an undergrad from the University of Kentucky, processed samples during the academic year 2004-2005, including sample grinding, leaf litter sorting and sample weighing.

Name: Black, Devin

Worked for more than 160 Hours: No

Contribution to Project:

Devin, an undergrad from the University of Kentucky, provided some lab help.

Name: Germain, Meredith

Worked for more than 160 Hours: Yes

Contribution to Project:

Meredith, an undergrad from ESF, worked in the field in the summer of 2004.

Name: Messmer, David

Worked for more than 160 Hours: Yes

Contribution to Project:

David, an undergrad from ESF, worked in the field in the summer of 2005

Name: Getman, Jacquelyn

Worked for more than 160 Hours: Yes

Contribution to Project:

Jacque, an undergrad from ESF, worked in the field in the summer of 2005.

Name: DeSantis, Jonathan

Worked for more than 160 Hours: No

Contribution to Project:

Jon, an undergrad from ESF, processed samples in the lab in Syracuse

Name: Perez, Jessica

Worked for more than 160 Hours: No

Contribution to Project:

Jessica, an ESF undergrad, processed samples in the spring of 2004.

Name: Vore, William

Worked for more than 160 Hours: No

Contribution to Project:

Will, an ESF undergrad, processed samples in the fall of 2005.

Name: Reinhardt, Sarah

Worked for more than 160 Hours: Yes

Contribution to Project:

Sarah, an undergrad from ESF, processed samples in the lab in Syracuse in 2006.

Technician, Programmer

Name: Vadeboncoeur, Matthew

Worked for more than 160 Hours: Yes

Contribution to Project:

Matt Vadeboncoeur was the full-time technician on this project. During the field season, he was responsible for organizing the field crew and their efforts. He is also responsible for sample management and data coordination.

Name: Andronokova, Irina

Worked for more than 160 Hours: No

Contribution to Project:

Irina Andronokova was a part-time technician on the project. She performed sample digestions and chemical analyses in the geochemistry laboratories at the University of Michigan.

Name: Klaue, Andrea

Worked for more than 160 Hours: Yes

Contribution to Project:

Andrea Klaue was a senior technician on the project. She performed sample digestions and chemical analyses in the geochemistry laboratories at the University of Michigan.

Name: Knowlden, Amber

Worked for more than 160 Hours: Yes

Contribution to Project:

Amber replaced Megan to supervise sample processing and coordinate activities in the Syracuse lab.

Name: Newhouse, Megan

Worked for more than 160 Hours: Yes

Contribution to Project:

Megan worked in Syracuse to supervise sample processing and coordinate activities in the lab.

Name: Griffin, Carolyn

Worked for more than 160 Hours: Yes

Contribution to Project:

Carolyn replaced Amber, working in Syracuse to supervise sample processing and coordinate activities in the lab.

Name: Kim, Heejae

Worked for more than 160 Hours: Yes

Contribution to Project:

Heejae replaced Carolyn, working in Syracuse to supervise sample processing and coordinate activities in the lab.

Other Participant

Name: Fuss, Colin

Worked for more than 160 Hours: Yes

Contribution to Project:

Colin helped with field work over the summer and through the fall of 2004, he continued to help us in the lab with sample preparation.

Name: Garrett, Brendon

Worked for more than 160 Hours: No

Contribution to Project:

Brendon helped with field work during the fall of 2004.

Name: Eaton, Derek

Worked for more than 160 Hours: No

Contribution to Project:

Derek worked in the field in the fall of 2004 and 2005.

Research Experience for Undergraduates**Organizational Partners**

USFS Northeast Forest Experiment Station

USFS White Mountain National Forest

Other Collaborators or Contacts**Activities and Findings****Research and Education Activities:**

Pennsylvania (public lands) and analyzed them to determine the importance of apatite in the parent materials. We also collected soils and surveyed vegetation in six stands of different ages in New Hampshire. We engaged 6 graduate students and 6 undergraduate students in these research activities.

In the second year of the project, we began work on 'intensive' study sites at the Bartlett Experimental Forest. We identified three replicate stands of each of three ages. Each stand has three plots 50 m x 50 m (some of the younger sites may have smaller buffers) with a 30 m x 30 m

core area in which all trees >10 cm have been measured and tagged. Subplots were established for measurement of smaller trees and saplings. Three soil pits were dug in six of the sites (2 of each of three ages), two to a minimum of 25 cm below the B-C transition, one to 50 cm into the C. We sampled trees in four of the younger sites for allometric analysis, including nutrient contents. We are writing proposals for future experiments involving fertilization of 2 of the plots in each stand.

In the third year of the project we completed field-based data collection, data entry and laboratory analysis of vegetation and soil samples collected during the first two field seasons. We collected tree cores, bark samples, and canopy leaf samples from mature trees to better estimate nutrient stocks in mature stands. We validated vegetation inventory data in plots where we suspected errors, and improved the permanent plot markers at some sites. We measured coarse woody debris and litterfall at our extensive research sites and litterfall at our intensive sites. Chemical analyses of litterfall and soil samples continued. As part of the ROA project, we visited three forested sites that had been formerly limed and collected vegetation data, soil samples and tree cores. Incubations and collections to examine soil nitrogen processes were also done at these sites.

In the final year, we completed sample processing and analysis. We also focused on data analysis and manuscript preparation.

Findings:

We found that patterns of regeneration in the chronosequence show that yellow birch sapling density is increasing in the youngest stands but declining in others, sugar maple is increasing in middle-aged stands and declining in the others, and beech is increasing in the oldest stands and changing little in other stands. These changes may reflect a sequence of microsuccession as outlined in Forcier (1975).

We analyzed roots from the soil pits excavated in 2003 and 2004 and both data sets are published (see below). A related paper describing root biomass predicted by allometric equations is in press.

Additional papers are in preparation (see below).

Training and Development:

A very large number of undergraduate students have been involved in the project, several of whom have used their work on this project as a basis for undergraduate honors theses. Two graduate students, one from U of Kentucky and two from ESF, have used this project to provide the focus of their Master's theses. In addition two doctoral students at the University of Michigan have utilized this project as part of their dissertation research. Additional graduate students from Appalachian State University and SUNY-ESF have taken on projects that are ancillary to their thesis research.

Outreach Activities:

We have been involved in outreach projects focused on a new teacher education initiative as well as a regular lecture series that exposes the larger community around our study region to the ideas we and our colleagues are working on. These lectures are organized by one of the co-PIs. The Hubbard Brook Ecosystem Study, of which this project is part, has active programs in outreach and education described at <http://www.hubbardbrook.org>.

We have presented our work at the professional meetings listed below. In addition, we presented at the Hubbard Brook Cooperators' Meeting every year, and gave lectures around the world (including Massachusetts, Nevada, Tokyo, Kyoto)

Journal Publications

R.D. Yanai, J.D. Blum, S.P. Hamburg, M.A. Arthur, C.A. Nezat, and T. Siccama, "New insights into calcium depletion in northeastern forests.", *Journal of Forestry*, p. 14, vol. 103, (2005). Published

S.P. Hamburg, R.D. Yanai, M.A. Arthur, J.D. Blum, and T.G. Siccama, "Biotic control of Ca cycling in northern hardwood forests: acid rain and aging forests.", *Ecosystems*, p. 399, vol. 6, (2003). Published

Ruth D. Yanai, Steven Hamburg, Byung B. Park, and Elizabeth J. Schwartz, "The effects of stand age on land gastropod dynamics in northern New England", *NA*, p. NA, vol. NA, (2005). will be submitted in 2005

Byung B. Park, Ruth D. Yanai, and Steven P. Hamburg, "Fine and coarse root biomass distribution as stand age with comparing coring method with quantitative soil pits. (Likely to change).", NA, p. NA, vol. NA, (2006). will be submitted in 2006

Hamburg, Smith, Arthur et al., "Northern hardwood forest productivity: influence of air pollution, land use history and climate change", NA, p. NA, vol. NA, (2006). will be submitted in 2006

Steve Hamburg, Matthew Vadeboncoeur, Joel Blum et al., "Sampling forest soils: a critical look at the quantitative pit method", NA, p. NA, vol. NA, (2006). will be submitted in 2006

Steve Hamburg, Joel Blum, et al., "Nutrients in northern hardwood forest soils: the role of forest age and disturbance history", NA, p. NA, vol. NA, (2007). will be submitted in 2007

Joel Blum and Carmen Nezat, "Variation in long-term chemical weathering rates across the White Mountains Region of New Hampshire", NA, p. NA, vol. NA, (2005). will be submitted in October 2005

Nezat et al., "The importance of soil parent material in assessing calcium availability in soils across the northeastern US", NA, p. NA, vol. NA, (2005). will be submitted in April 2005

J.D. Blum et al., "Sources and translocation of Ca and Sr to various hardwood tree species.", NA, p. NA, vol. NA, (2007). in preparation

Hane et al., "Stand Dynamics Along a Chronosequence", NA, p. NA, vol. NA, (NA). in preparation

Yanai, R.D., B.B. Park, S.P. Hamburg, "The vertical and horizontal distribution of roots in northern hardwood stands of varying age.", Canadian Journal of Forest Research, p. 450, vol. 36, (2006). Published

Park, B. B., R. D. Yanai, M. A. Vadeboncoeur, and S. P. Hamburg, "Estimating root biomass in rocky soils using pits, cores and allometric equations.", Soil Science Society of America Journal, p. 206, vol. 71, (2007). Published

Vadeboncoeur, M. A., S.P. Hamburg, and R.D. Yanai, "Validation and refinement of allometric equations for roots of northern hardwoods", Ecology, p. , vol. , (). Accepted

Nezat, C.A., J.D. Blum, R.D. Yanai, S.P. Hamburg., "A sequential extraction to selectively dissolve apatite for determination of soil nutrient pools with an application to Hubbard Brook Experimental Forest, New Hampshire", Applied Geochemistry, p. , vol. , (). Submitted

Yanai, R.D., M. Fisk, T. Fahey, N. Cleavitt, and B.B. Park., "Identifying roots of northern hardwood species: patterns with diameter and depth.", tbd, p. , vol. , (). in preparation

Yanai, R.D., M.A. Arthur, M. Acker, and B.B. Park., "Interannual variation in litterfall mass and nutrient concentrations in northern hardwood stands.", Can. J. For. Res., p. , vol. , (). in preparation

Park, B.B., R.D. Yanai, T.J. Fahey, T.G. Siccama, S.W. Bailey, J.B. Shanley, N.L. Cleavitt, "Fine root dynamics and forest production across a calcium gradient in northern hardwood and conifer ecosystems.", Ecosystems, p. , vol. , (). Submitted

Skeldon, M.A., Vadeboncoeur, M.A., Hamburg, S.P., and Blum, J.D., "Terrestrial gastropod responses to an ecosystem-level calcium manipulation in a northern hardwood forest.", Canadian Journal of Zoology, p. , vol. , (). Submitted

Books or Other One-time Publications

George, Valerie and Hane, Elizabeth, "Long-Term Effects of Lime Addition on Forest Understory Biodiversity in New England Forests", (2005). Poster Presentation, Published

Bibliography: Rochester Academy of Sciences poster presentation, November, 2005.

Acker, M.D. and M. A. Arthur., "Mass and nutrient dynamics of coarse and fine woody debris in a chronosequence of northern hardwood forest stands.", (2005). Abstract, Published

Bibliography: Abstracts of the 90th Annual Meeting of the Ecological Society of America, Montreal, Canada. August, 2005.

Fatemi, F.R. and R.D. Yanai, "Aboveground biomass and nutrient content in developing northern hardwood stands.", (2005). Abstract, Published

Bibliography: Abstracts of the 90th Annual Meeting of the Ecological Society of America, Montreal, Canada. August, 2005.

Yanai, R.D., B.B. Park, C.A. Nezat and J.D. Blum, "Apatite as a Calcium Source to Forests", (2005). Abstract, Published

Bibliography: Abstracts of the 90th Annual Meeting of the Ecological Society of America, Montreal, Canada. August, 2005.

Nezat, C.A. and J.D. Blum., "A Sequential Leach Method and Pb Isotope Approach to Studying Apatite Weathering in Granitoid Soils at Hubbard Brook Experimental Forest, NH, USA.", (2005). Poster Presentation, Published

Bibliography: Am Geophys. Union Fall Meeting, San Francisco, December, 2005.

Molly Deringer, "From Woodlots to House Lots? A Parcel-level analysis of Private Forestry in Four Central New Hampshire towns.", (2006). Thesis, Published

Bibliography: Honors Thesis, Brown University

Brian Weeks, "The impacts of an ice storm on the forest canopy of a Northern Hardwood Forest", (2006). Thesis, Published

Bibliography: Honors Thesis, Brown University

Monica Skeldon, "The Ecology of Terrestrial Gastropod Distribution in the Northern Hardwood Forest", (2006). Thesis, Published

Bibliography: Honors Thesis, Brown University

Yanai, R.D., S.P. Hamburg, J.D. Blum, M.A. Arthur, M. Acker, F.R. Fatemi, and M.A. Vadeboncoeur, "What controls calcium budgets in northern hardwood forests: species composition or parent material?", (2006). Abstract, Published

Bibliography: Soil Sci. Soc. Am. Annual Meeting.

Fatemi, F.R., R.D. Yanai, S.P. Hamburg, and M.A. Arthur, "Nutrient contents and aboveground biomass in developing northern hardwood stands", (2006). abstract, Published

Bibliography: Ecol. Soc. Am. Annual Meeting

Yanai, R.D., P.J. Lilly, and B.B. Park, "Patterns of soil acidity and base saturation 14 to 40 years following in northern hardwood sites in New York, Massachusetts, Vermont and New Hampshire.", (2006). Abstract, Published

Bibliography: Ecol. Soc. Am. Annual Meeting.

Yanai, R.D., B.B. Park, C.A. Nezat, and J.D. Blum, "Apatite as a Calcium Source to Forests in NY State", (2005). Poster Presentation, Published

Bibliography: New York State Energy Research and Development Authority's Environmental Monitoring, Evaluation and Protection Annual Conference. <http://www.nyserda.org/programs/Environment/EMEP/>

Nezat, C.A., J.D. Blum, R.D. Yanai, and S.P. Hamburg., "The importance of soil mineralogy to plant nutrient availability in the northeastern US.", (2004). Abstract, Published

Bibliography: Eos Trans. AGU, 85(47), Fall Meet. Suppl.

Yanai, R.D., B.B. Park, and S.P. Hamburg., "Root distribution with depth in young and old northern hardwood stands measured using quantitative soil pits.", (2004). Abstract, Published

Bibliography: Ecol. Soc. Am. Annual Meeting.

Yanai, R.D., J.D. Blum, M.A. Arthur, and S.P. Hamburg., "Whether repeated harvest and acid rain threaten Ca supply in northern hardwood

forests may depend on weathering of apatite.", (200). Abstract, Published
Bibliography: Ecol. Soc. Am. Annual Meeting.

Web/Internet Site

URL(s):

<http://envstudies.brown.edu/research/calcium/>

Description:

Login Information:

username: Acer

password: saccharum

Other Specific Products

Contributions

Contributions within Discipline:

Our information changes our understanding of Ca sources and Ca supply.

Contributions to Other Disciplines:

Our focus on distinguishing the behavior of young and old stands has implications for interpreting changes in streamwater chemistry over time (Hamburg et al. 2003).

Contributions to Human Resource Development:

See education and development, above.

Contributions to Resources for Research and Education:

Through publications and presentations, as described above.

Contributions Beyond Science and Engineering:

Our research is relevant to environmental policy concerning acid rain and forest harveting, both of which may cause calcium depletion. For this reason, supporting studies have been funded by both the Agenda 2020 collaboration between the US Forest Service and industry and the New York State Energy Research and Development Authority (NYSERDA), which is the research branch of the electric power industry.

Categories for which nothing is reported:

Any Product