

Previous Research Experience Essay

2006 NSF Graduate Research Fellowship Application

Undergraduate Research in N. Michele Holbrook Lab: Leaf Diversity within Tree Canopy

My first scientific research experience was volunteering in the lab of Dr. N. Michele Holbrook, a plant physiologist and my undergraduate academic advisor. I investigated factors influencing diversity of leaf form and structure within a canopy. The samples for the study had already been collected, so I was responsible for processing the samples. A post-doctoral fellow in the lab taught me to use microscopy and computer imaging software for leaf and stomatal analysis, but I worked independently to collect the data. My efforts resulted in my co-authorship on the manuscript soon to be submitted to the *Journal of American Botany*.

Undergraduate Research in Steven Wofsy Lab: Carbon Cycling at Harvard Forest

At the same time that I started volunteering in Dr. Holbrook's lab, I began working as an undergraduate research assistant for Dr. Steven Wofsy, an atmospheric chemist. Dr. Wofsy uses an eddy covariance tower to measure the exchange of carbon dioxide (CO₂) between the forest and the atmosphere. He corroborates the tower data with biometric measurements, including soil respiration, tree growth and leaf litter flux. My junior year I sorted, dried, and weighed all of the litter samples for the lab under the supervision of a full-time research assistant. I also helped the group with other activities including making litter decomposition bags, measuring tree growth with dendrometers, and measuring soil respiration using a Licor infrared gas analyzer (IRGA).

My experience in the Wofsy group piqued my interest in carbon (C) cycling, so I conducted my senior honors thesis research with Dr. Wofsy as my advisor. Under the guidance of a post-doctoral fellow, I investigated the contribution of coarse woody debris (CWD), or decaying wood, to the C budget of Harvard Forest. I used an IRGA to measure CWD respiration; this was a novel method used in only two published studies, so I designed and conducted tests to quantify and minimize methodological artifacts. I conducted fieldwork intensively during the summer before and throughout my senior year to obtain seasonal respiration measurements. These measurements required more than one person in the field, so I supervised and worked with other undergraduates to collect my data. I analyzed and interpreted my data with statistics and S-plus tutorials from members of the Wofsy group. In 2003, I presented my results in a poster at the Long-Term Ecological Research network's national All-Scientists meeting in Seattle. I also wrote a manuscript incorporating data from my thesis and additional data I collected after I completed my thesis; it is now in revision for publication in *Oecologia*. Having had an early experience in going through the entire scientific process from formulating a question to writing a manuscript for peer-reviewed publication, I feel well prepared to perform rigorous research for my Ph.D. dissertation.

Employment in Whendee Silver Lab: Rainfall Effects on Carbon and Nitrogen Cycling

The year in-between college and graduate school, I worked full-time as a field and lab technician for Dr. Whendee Silver on a project assessing the feedback effects of climate change-induced alterations in rainfall on trace gas fluxes and C storage in California annual grasslands. I joined the project just as the rainfall manipulations were being initiated, so I was involved in researching, ordering, and installing the appropriate equipment. I learned to balance the need for precise and accurate instruments with budgetary constraints. My main role was to assist a graduate student with field and lab work including measurements of soil oxygen concentration, net nitrogen (N) mineralization, and surface fluxes of CO₂, methane and nitrous oxide (N₂O). By experiencing the first year of a major field experiment, I learned the perseverance required to overcome the many unexpected obstacles that arise when initiating field manipulations.

Graduate Research in Whendee Silver Lab: Measurement of N₂ Production from Soil

During my first year of graduate school in Dr. Silver's lab, I began evaluating and developing techniques that will be integral to my Ph.D. research. I used the acetylene inhibition (AI) and ¹⁵N methods to measure dinitrogen (N₂) production from soils in laboratory assays. I performed pilot tests to estimate the number of replicates needed for future experiments (using power tests) and to determine the appropriate sampling time points needed to calculate N₂ and N₂O production rates. This past summer I collaborated with Dr. Bibit Traut, a post-doctoral fellow in the Silver lab, on a ¹⁵N pool dilution experiment in the lab to measure rates of dissimilatory nitrate reduction to ammonium, gross nitrification, and denitrification (including N₂O and N₂) in salt marsh soils. I also performed parallel experiments with AI and ¹⁵N both alone and together to evaluate the artifacts in measuring N₂ production with these methods.

Last year I also established collaborations with Drs. Ralph Keeling (UC-San Diego) and Robert Rhew (UC-Berkeley) in developing the N₂ to argon elemental ratio (N₂:Ar) method for measuring N₂ production from upland soils. With practical and theoretical advice from Dr. Rhew, I built a closed dynamic chamber that samples gas using a pumping module designed by Dr. Keeling for sampling Ar:N₂ of atmospheric air. Dr. Keeling has advised me on potential methodological artifacts, lent me equipment, and given me free instrument time on his isotope ratio mass spectrometer modified for highly sensitive N₂:Ar analysis. I have used the N₂:Ar method to successfully measure N₂ emissions from grasslands at the UC-Berkeley campus. I am continuing to rigorously test the method in California to ensure that I will be able to use the method to measure N₂ production from humid tropical forest soils in Puerto Rico.

Publications

- Liu, W.H., D.M. Bryant, L. Hutrya, S.R. Saleska, E. Hammond-Pyle, D.C. Curran, and S.C. Wofsy. Woody debris contribution to the carbon budgets of selectively-logged and maturing mid-latitude forests. In revision, *Oecologia*.
- Liu, W.H., R.F. Keeling, R.C. Rhew, and W.L. Silver. Measurement of N₂ emissions from upland soils using the N₂:Ar method. In preparation for submission to *Ecology*.
- Liu, W.H., B.H. Traut, and W.L. Silver. The effectiveness of acetylene inhibition and ¹⁵N₂ gas flux methods for measuring N₂ production from salt marsh soils. In preparation for submission to *Wetlands*.
- Liu, W.H., L. Hennessy, and W.L. Silver. Urban sustainability and forest recovery in developing tropical countries: linking rural emigration and reforestation of agricultural land. In preparation for submission to *Frontiers in Ecology and the Environment*.
- Sack, L., P.J. Melcher, W.H. Liu, and N.M. Holbrook. Sources of variation in intracanalopy leaf and twig characteristics in temperate deciduous trees. In preparation for submission to *American Journal of Botany*.

Presentations

- Liu, W.H., L. Hennessy, and W.L. Silver. 2006 (planned). Urban sustainability and forest recovery in developing tropical countries: linking rural emigration and reforestation of agricultural land. Ecological Society of America's "Ecology in an Era of Globalization" conference poster presentation. Merida, Mexico.
- Liu, W.H., D.M. Bryant, L. Hutrya, S.R. Saleska, and S.C. Wofsy. 2003. The contribution of

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coarse woody debris respiration to the carbon budget of a northern hardwood forest.
LTER Network All-Scientist Meeting poster presentation. Seattle, WA.