

School of Natural Resources and Environment

University of Florida

A university-wide program in ecology, environmental sciences, and sustainability



Mini-Grant Programs Annual Report

2004-2005





UNIVERSITY OF FLORIDA

School of Natural Resources and Environment

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A university-wide program in ecology, environmental sciences, and sustainability, hosted by IFAS in collaboration with the colleges of Agricultural and Life Sciences; Business Administration; Design, Construction, and Planning; Engineering; Health and Human Performance; Liberal Arts and Sciences; Journalism and Communications; Law; Medicine; Veterinary Medicine; and the Florida Museum of Natural History

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Table of Contents

| | |
|---|----|
| INTRODUCTION | 1 |
| MINI-GRANT PROGRAMS FY 2004-2005 | 1 |
| SEED FUNDING GRANTS..... | 5 |
| 1. Bonzongo, Jean-Claude J. Nanotechnology and the Environment: Assessing the Potential Impacts of Engineered Nanomaterials on Biota and Ecosystem Functions..... | 5 |
| 2. Cuda, James P. Biocontrol of Brazilian Peppertree with <i>Episimus utilis</i> : An Innovative Application of F ₁ Sterility for Field Host Range Testing | 9 |
| 3. Levey, Doug Fostering Professional Development of Scientists and Engineers in Ecosystem Health and Sustainability | 17 |
| 4. Martin, Jonathan Support for Preparation of the NSF Proposal: “Development of a Hydrologic Observatory in the Suwannee River Watershed” | 19 |
| 5. Perz, Stephen ROADIES: An Interdisciplinary Approach to Modeling the Impacts of Infrastructure Connectivity on the Resilience of Social-Ecological Systems | 22 |
| 6. Rathinasabapathi, Bala Molecular Biology of Arsenic Reduction, Detoxification, and Hyperaccumulation in <i>Pteris vittata</i> | 25 |
| 7. Sickman, James O. Quantifying Dissolved Organic Matter Sources to Surface Waters in the St. Johns River Basin Using Radiocarbon Dating | 28 |
| NEW FACULTY SUPPORT GRANTS | 31 |
| 1. Branham, Marc A. The Development of Virtual Teaching Collections for the Natural Sciences..... | 31 |
| 2. Brennan, M.A. Growth Management, Sustainability, and Community Well-Being in Rural Florida: A Pilot Study | 33 |
| 3. Bruna, Emilio M. Seed Predation and Herbivory in Neotropical Savannas: Are There Demographic Consequences for Plants?..... | 35 |
| 4. Mack, Michelle C. The Role of Soil Nitrogen in Plant Litter Decomposition | 37 |

| | |
|---|----|
| 5. Oyuela-Caycedo, Augusto | |
| An Investigation of Anthropogenic Soils in the Upper Amazon: Stratigraphic and Temporal Variability and Cultural Context..... | 39 |
| 6. Peter, Gary | |
| Increased Productivity of Forest Plantations to Conserve Native Forests..... | 43 |
| 7. Schuur, Ted | |
| The Age of Carbon Fluxes from Arctic Tundra: Detecting Ecosystem Change with a Geochemical Tool..... | 45 |
| 8. Southworth, Jane | |
| Interactions among Protected Areas, Agricultural Change, and Biodiversity in East Africa..... | 48 |
| 9. Stepp, Richard | |
| Belizean Maya Medicinal Plant Ethnoecology..... | 51 |
| 10. Zimmerman, Andrew R. | |
| An Investigation of Peruvian Black Soil (<i>Terra preta</i>): Chemical Variability and Mechanisms of Organic Carbon Preservation | 54 |

School of Natural Resources and Environment Mini-Grant Programs Summary for FY 2004-2005

Introduction

The School of Natural Resources and Environment (SNRE) is the programmatic home of interdisciplinary undergraduate and graduate programs in ecology and environmental science that prepare students to understand and address complex science, policy, management, social, and economic issues.

SNRE supports research and outreach/Extension programs that advance solutions to ecological and environmental challenges at the local, state, national, and international levels. SNRE promotes research among UF faculty and external stakeholders and supports and funds outreach efforts.

Approximately 300 UF faculty members are affiliated with the school. SNRE is hosted by the Institute of Food and Agricultural Sciences (IFAS) in collaboration with the colleges of Agricultural and Life Sciences; Business Administration; Design, Construction, and Planning; Engineering; Health and Human Performance; Liberal Arts and Sciences; Journalism and Communications; Law; Medicine; Veterinary Medicine, and the Florida Museum of Natural History.

Mini-Grant Programs FY 2004-2005

The Mini-grant Programs are a successful venue for securing extramural dollars to UF and advancing program development. In 2004-2005, SNRE provided two mini-grant funding opportunities to UF faculty: Seed Funding Grants (SFG) and New Faculty Support (NFS).

The purpose of the Seed Funding Grant Program is to develop collaborative proposals in (1) new and emerging interdisciplinary activities or (2) cross-cutting perspectives on historically important issues. The New Faculty Support Program provides funding to assist new faculty in developing innovative and important programs in the area of natural resources and environment.

The SNRE Mini-grant Programs are funded by the deans for the colleges of Agricultural and Life Sciences, Engineering, Liberal Arts and Sciences, and Veterinary Medicine; IFAS Dean for Research; and the UF Vice President for Research.

Participation and awards:

- Sixty-two proposals from faculty within 27 departments/units across six colleges were submitted.
- Seven SFG proposals were funded for a total of \$150,000.
- Ten NFS proposals were funded for a total of \$50,000.
- The 17 funded projects involved 118 collaborators; 76 collaborators were at UF, housed across 42 departments, and 38 were external collaborators.

Deliverables from the 17 funded projects, as of June 2006:

- Thirty-four extramural proposals were written thus far. Of these, 16 were funded, and 12 are still pending.
- To date, \$8,193,207 was generated as a direct result of the Mini-grant Programs.
- Other deliverables produced from these projects include: 23 publications, 18 presentations/poster presentations, a memorandum of agreement with Universidade Federal of Uberlandia, two educational computer programs, support for five international undergraduate students, development of a new Web site, two databases, a bibliography, a workshop, a pamphlet, and submission of registration for the archeological site of Quistococha as a national patrimony of Peru. Further deliverables are anticipated.

Additional information about the 2004-2005 SNRE Mini-grant Programs is provided in Figures 1, 2, and 3 and Table 1.

Figure 1. Total Funds Contributed and Awarded to Participating College for SNRE Mini-Grant Programs FY 2004-05.

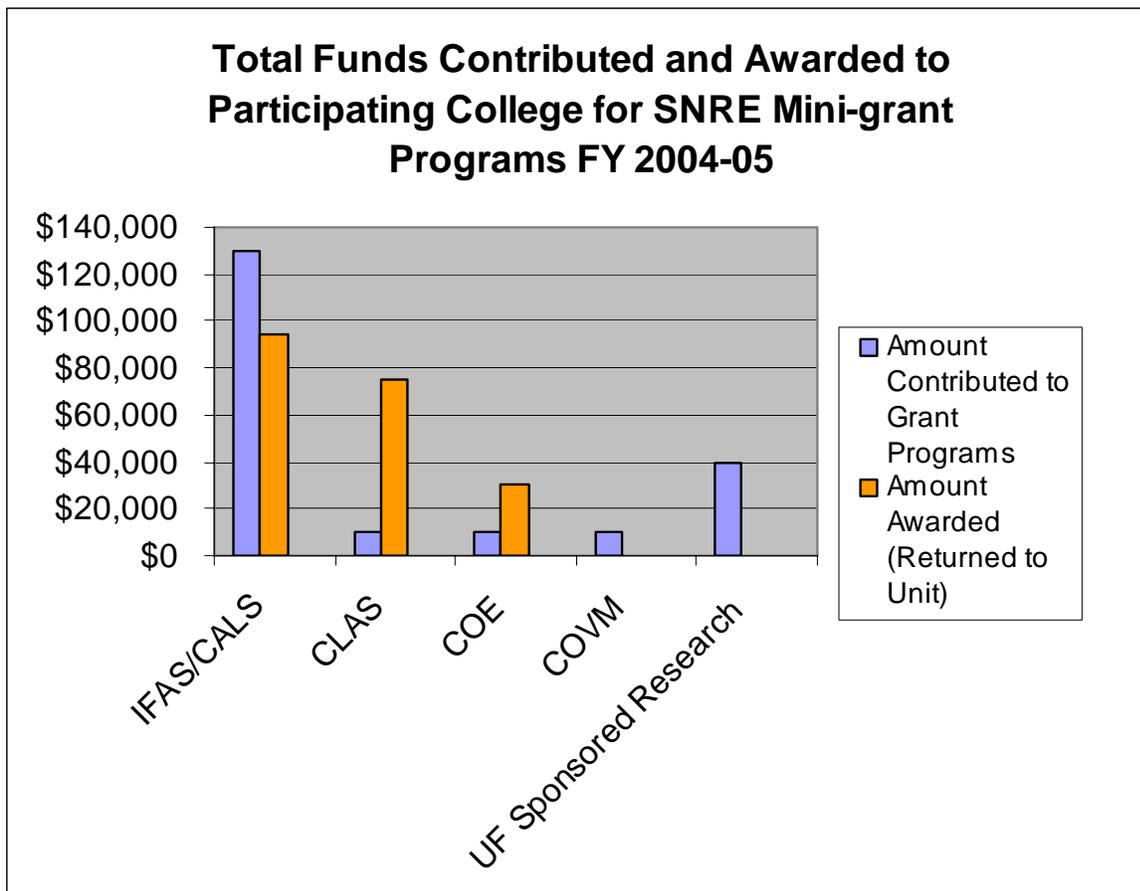


Figure 2. Number of Extramural Grant Proposals Submitted by and Awarded to PI's of the SNRE Mini-grant Programs FY 2004-05 as of June 2006.

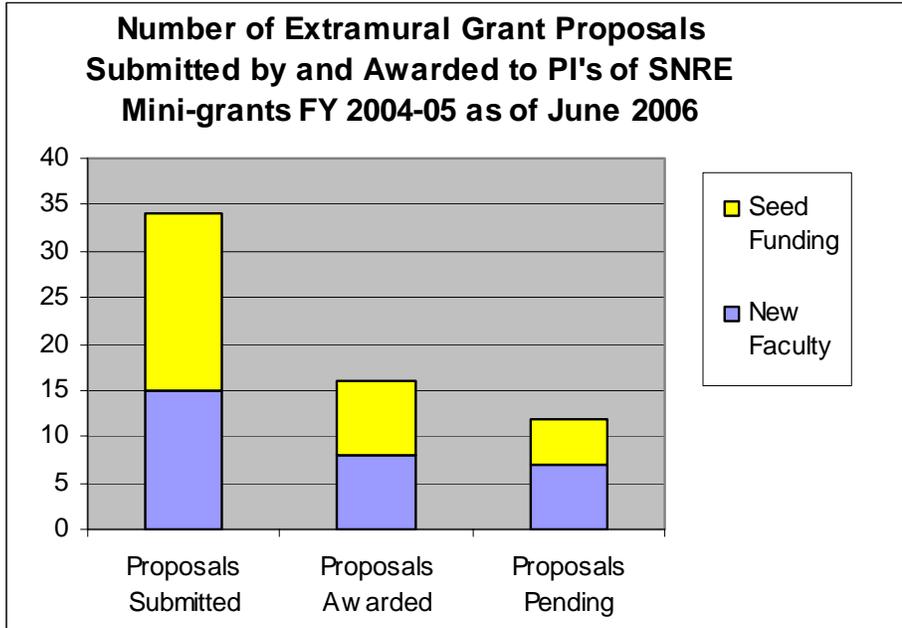


Figure 3. Data for Total UF Dollars Allocated and Funds Received from Outside Sources for the 2004-05 Mini-grant Programs as of June 2006

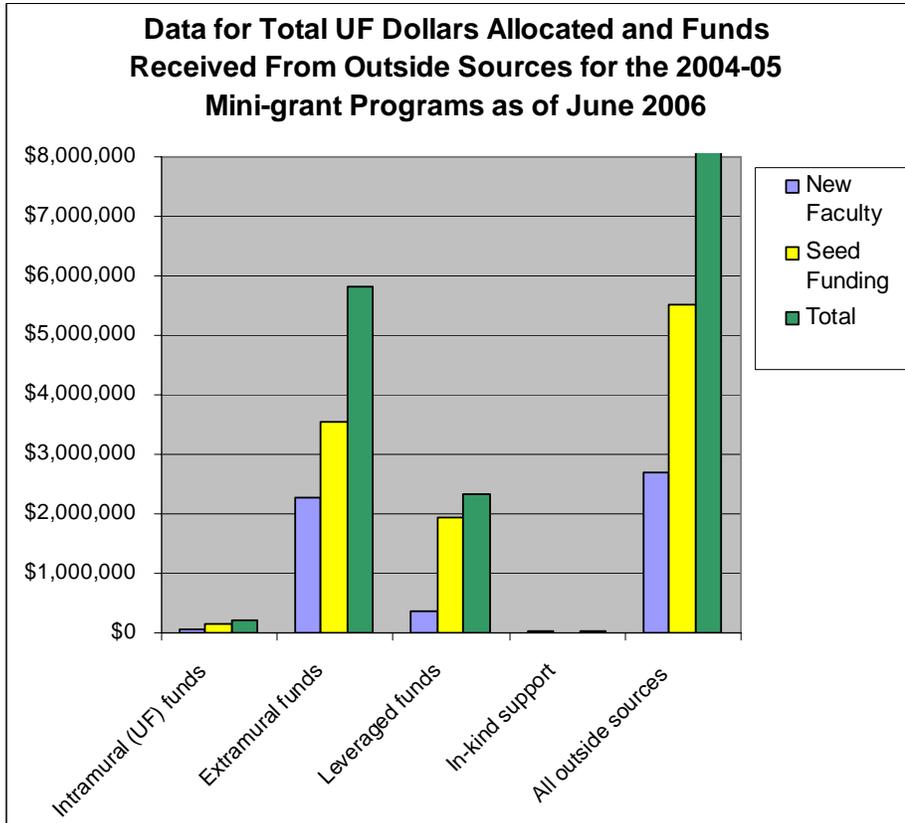


Table 1. Deliverables and Projects Resulting from FY 2004-2005 SNRE Mini-Grant Programs as of June 2006.

| | New Faculty Totals | Seed Funding Totals | Grand Totals |
|---|---------------------------|----------------------------|---------------------|
| # of Projects Funded | 10 | 6 | 16 |
| Collaborators | 36 | 82 | 118 |
| Internal | 15 | 61 | 76 |
| External | 21 | 21 | 42 |
| # of Depts. Represented | 16 | 22 | 38 |
| Publications | 16 | 7 | 23 |
| Peer review | 10 | 5 | 15 |
| Refereed | 1 | 0 | 1 |
| Extension | 2 | 2 | 4 |
| Abstract | 3 | 1 | 4 |
| Presentations | 7 | 5 | 12 |
| Local | 4 | 0 | 4 |
| State | 0 | 2 | 2 |
| National | 1 | 3 | 4 |
| International | 2 | 1 | 3 |
| Poster Presentations | 1 | 5 | 6 |
| Workshops/In-service Trainings | 1 | 0 | 1 |
| Grant Proposals | | | |
| Proposals Written | 15 | 19 | 34 |
| Total Amount Requested | \$3,218,611 | \$20,396,640 | \$23,615,251 |
| Proposals Funded | 8 | 8 | 16 |
| Pending | 7 | 5 | 12 |
| Total Grant Proposals Funded | \$2,278,214 | \$3,544,293 | \$5,822,507 |
| Leverage | \$375,500 | \$1,950,200 | \$2,325,700 |
| In-Kind Support | \$30,000 | \$15,000 | \$45,000 |
| Other Deliverables | | | |
| Educational Computer Programs | 2 | | 2 |
| Panel Session | 1 | | 1 |
| MOA with Universidade Federal of Uberlandia | 1 | | 1 |
| Support for International Undergraduate Students | 5 | | 5 |
| Preliminary Report for Registration of Archeological Site | 1 | | 1 |
| New Project | | 1 | 1 |
| Website | | 1 | 1 |
| Databases | | 2 | 2 |
| Bibliography | | 1 | 1 |
| Letters of Support to Continue Project | | 11 | 11 |
| Pamphlet | | 1 | 1 |
| *Total Funds from Outside Sources | \$2,683,714 | \$5,509,493 | \$8,193,207 |

*Total funds from outside sources include total grant proposals funded, leverage, and in-kind support.

SEED FUNDING GRANTS

1. Nanotechnology and the Environment: Assessing the Potential Impacts of Engineered Nanomaterials on Biota and Ecosystem Functions

Project Leader(s): Jean-Claude J. Bonzongo, Environmental Engineering Sciences

Collaborators: Dmitry Kopelevich, Chemical Engineering, and Gabriel Bitton, Environmental Engineering Sciences

Executive Summary

The goal of this project was to generate preliminary data that would support the development of proposals to be submitted to competitive federal funding programs. The objective of the study was to initiate an investigation on the potentially complex interplay between manufactured nanomaterials (MN) and the health of organisms and ecosystems, while the overall driving research hypothesis is based on the fact that chemical elements used in the production of MN could lead to environmental dysfunctions due to: (1) the potential toxicity of these elements and their derivatives; (2) the nanometer-sizes that make MN prone to bio-uptake/bioaccumulation, and (3) the large surface area which might lead MN to act as carriers/delivers of pollutants adsorbed onto them.

We conducted a limited number of preliminary experiments, focusing primarily on the modeling component of the proposed study. We found that based on their chemical composition and shape, MN can damage cell membranes, resulting in cytotoxicity. We also found that certain pollutants such as mercury (Hg) removed from waste streams on nanomaterials remain highly bioavailable, therefore, raising the issue of disposal of used nanomaterials. These obtained data were used for proposal development. Three different proposals were developed and submitted to: (i) NSF, (ii) USDA, and (iii) US-EPA, respectively. The proposal submitted to US-EPA has been selected for funding with a starting date in fall 2005, while the one submitted to NSF has been strongly recommended for resubmission.

Research and/or Outreach/Extension Needs

Since we received SNRE funds in departmental accounts in early spring 2005 only, a number of planned preliminary studies are still ongoing. These experiments are needed to obtain data that would strengthen our different proposal ideas.

Extramural Proposal(s) Submitted and Status

As stated above, four proposals have been submitted based on preliminary data obtained with SNRE seed funds. Information related to the status of these proposals is shown in Table 1 below. The non-funded proposals previously submitted to NSF and USDA will be revised and resubmitted in 2006.

Table 1.

| Funding Agency | Requested Amount | Status | Project Title |
|-----------------------|-------------------------|---------------------------|---|
| USDA | \$435,019 | declined | Engineered nanomaterials and food systems: Potential bioaccumulation and transfer through the food chain |
| NSF | \$160,000 | declined | Nanotechnology and the environment: Assessing the potential impact of engineered nanomaterials on biota and ecosystem functions |
| USEPA | \$400,000 | funded (\$375,000) | Assessing the environmental impacts of nanotechnology on organisms and ecosystems |
| USEPA | \$200,000 | pending | Engineered nanomaterials and food systems: Potential bioaccumulation and transfer through the food chain |

Deliverables Supported Entirely or in Part by this Grant

- Two papers have been submitted and are undergoing the review process.
- Resubmission of nonfunded proposals will occur as more data to support our current hypotheses become available.

Impacts/Outcomes

For these preliminary studies supported by SNRE, our investigation was focused on the transport of spherical nanoparticles represented by Lennard-Jones spheres of varying effective diameters. The energy parameter for the Lennard-Jones potential of interaction between the model nanoparticles and the lipid and water beads is chosen to mimic the hydrophobic properties of carbon-based MNs (such as fullerenes). The diameters and the masses of the considered particles are shown in Table 2.

| Name | Diameter (nm) | Mass (AMU) |
|----------------|---------------|------------|
| S ₁ | 0.470 | 324.9 |
| S ₂ | 0.676 | 672.0 |
| S ₃ | 0.882 | 1144.0 |
| S ₄ | 1.088 | 1741.0 |
| S ₅ | 1.294 | 2462.0 |
| S ₆ | 1.500 | 3309.0 |

Table 2. Physical properties of spherical nanoparticles considered in the MD simulations.

One of the main challenges in the investigation of the nanoparticle transport across the lipid bilayer is the long timescale of events of interest, which is not accessible by direct molecular dynamics simulations. Therefore, we employed the constrained simulations method (Marrink and Berendsen, 1994) which in our case consists of constraining the nanoparticle coordinate z normal to the bilayer surface. Measuring and integrating the average force required to constrain the particle at the prescribed depth within the bilayer allowed us to obtain the free energy for the permeation of the particle through the bilayer.

We have also initiated investigation using an alternative (kinetic) approach based on statistical analysis of a series of short-scale unconstrained MD simulations with judiciously chosen initial conditions. This approach will allow us to obtain additional *dynamic* information on the nanoparticle motion, such as the position-dependent diffusion coefficient of the nanoparticle within the bilayer, in addition to the free energy already obtained using the constrained simulation method. The knowledge of the free energy and the diffusion coefficient will allow us to develop a complete description of the nanoparticle transport using an effective stochastic Langevin equation for the nanoparticle diffusion across the lipid bilayer. The obtained Langevin equation will be solved to obtain the nanoparticle transport rates.

In order to gain detailed understanding of the mechanism of the nanoparticle transport, we developed codes to further analyze internal microstructure of the lipid bilayer and correlations between dynamics of the nanoparticle transport and the lipid dynamics. In particular, we are currently investigating local change in the lipid density and orientation in the neighborhood of the diffusing nanoparticle.

In addition to the studies of MN transport through a bilayer, we have initiated investigations of possible effects of chemical reactions induced by presence of MN on membrane integrity. For example, it is known that fullerenes cause the peroxidation reaction of phospholipids comprising the bilayer membrane (Foley et al., 2002) and it is hypothesized that these reactions can cause cytotoxicity due to membrane leakage (Sayes et al., 2004). In order to mimic effects of the peroxidation reactions during our preliminary studies, we replaced one of the oily hydrophobic beads in some of the lipid tails by a hydrophilic bead. The simulations were initiated starting at an equilibrium unperturbed bilayer configuration shown in Figure 1a. After we replaced the beads as discussed above, we performed the simulations for 100 ns. The results of these simulations for beads replaced in 50% and 100% of the lipids are shown in Figures 1b, 1c. It is

clearly seen that the bilayer microstructure quickly disintegrates that will lead to membrane leakage and possibly to cytotoxicity. Further investigations of these effects are planned in the near future.

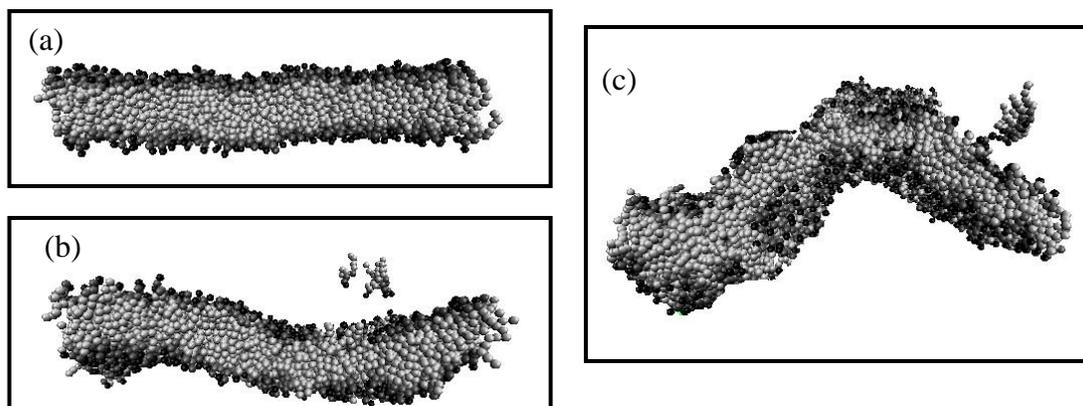


Figure 1. Model simulations to mimic the effects of lipid peroxidation reactions: (a) unperturbed equilibrium lipid bilayer. Figures (b) and (c) show the bilayer structure 100 ns after a hydrophobic bead was replaced by a hydrophilic bead in the tails of 50% and 100% of the lipids, respectively.

Finally, using mercury methylation and methyl mercury formation as a surrogate for bioavailability of Hg bound to TiO₂ nanoparticles, we were able to show that Hg-contaminated nanoparticles resulting from the removal of mercury from gas waste stream can not be disposed of without a risk of environmental contamination from mercury. Further studies are investigating the mobility of such particles in sedimentary environments.

Leveraging and/or Cost Sharing of SNRE Funds

SNRE funds were put forward in each of the three proposals we submitted. SNRE money was included as matching funds when appropriate, or simply as start-up funds used for generation of preliminary data.

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- Sayes, C. M., Fortner, J. D., Guo, W., Lyon, D., Boyd, A. M. Ausman, K. D., Tao, Y. J., Sitharaman, B., Wilson, L. J., Hughes, J. B., West, J. L., and Colvin, V. L. 2004. The differential cytotoxicity of water-soluble fullerenes. *Nano Lett.* 4, 1881-1887.

2. Biocontrol of Brazilian Peppertree with *Episimus utilis*: An Innovative Application of F₁ Sterility for Field Host Range Testing

Project Leader(s): James P. Cuda, Entomology and Nematology

Collaborators: William Overholt, Indian River Research and Education Center, UF IFAS; Jim Carpenter, USDA/ARS Crop Protection Laboratory; Stephanie Bloem, FAMU-USDA/ARS Center for Biological Control; Carl Gillis, Division of Plant Industry, FLDACS

Executive Summary

Brazilian peppertree, *Schinus terebinthifolius* Raddi (Anacardiaceae), is a non-native perennial woody plant that has become one of the most invasive weeds in Florida. It was introduced from South America as a landscape ornamental in the late 19th century, eventually escaped cultivation, and presently dominates entire ecosystems in central and south Florida, most notably within large areas of the Everglades. Brazilian peppertree readily invades disturbed sites and natural communities where it displaces native vegetation and alters biodiversity. It is a state listed prohibited plant and noxious weed, and is considered a Category I invasive natural areas weed by the Florida Exotic Pest Plant Council. Conservation organizations and land managers in south Florida consider the management of Brazilian peppertree a high priority because it poses a significant threat to regional Everglades restoration efforts authorized by the Comprehensive Everglades Restoration Plan (CERP). In 1994, several natural enemies of Brazilian peppertree were imported into a quarantine facility in Florida as candidates for classical biological control. One of these natural enemies was the leaf-rolling moth *Episimus utilis* Zimmerman (Lepidoptera: Tortricidae), which had been previously released in Hawaii in the 1950s (Yoshioka and Markin 1991, Martin et al. 2004).

Traditional laboratory no-choice and multiple-choice tests have shown that the host range of the insect is much broader than expected. However, laboratory testing can often overestimate host range, leading to the rejection of acceptable biocontrol candidates. The F₁ Sterile Insect Technique (F₁SIT) is being investigated as a novel approach for demonstrating host specificity. Using the F₁SIT, the leafrollers can be safely released temporarily for field host range testing. The advantage of this approach is that normal mating, host selection, and oviposition by irradiated female adults will occur under the actual field conditions the insects will encounter in south Florida. Larvae that eclose from eggs produced by the irradiated adults will be able to develop normally on appropriate test plants but the risk of permanent establishment of *E. utilis* will be acceptable because the F₁ generation adults will be unable to reproduce.

Research and/or Outreach/Extension Needs

Regarding research needs, additional time is needed to complete the project because of setbacks from equipment failures that occurred during this reporting period (see below), and an unexpected decline in the laboratory colony of *E. utilis*. Both problems have been rectified.

Extramural Proposal(s) Submitted and Status

In January 2004, a proposal titled “Biocontrol of Brazilian Peppertree in Florida with *Episimus utilis*: An Innovative Application of F₁ Sterility for Field Host Range Testing” was submitted to the USDA CSREES NRI Competitive Grants Program, Section 51.9 Biology of Weedy and Invasive Plants, for funding consideration. The proposal was not funded because preliminary data to support the research concept was lacking. The data from the current SNRE Seed Funding Grant will be incorporated into a revised version of the NRI proposal that will be resubmitted during the next granting cycle.

Deliverables Supported Entirely or in Part by this Grant

Publications

Cuda, J.P. J.C. Medal, D.H. Habeck, J.H. Pedrosa-Macedo and M. Vitorino. 1999 (revised 2005). Classical biological control of Brazilian peppertree (*Schinus terebinthifolius*) in Florida. <http://edis.at.ufl.edu/IN114>.

Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2005. Abstract (on-line version): Evaluating the F₁ sterile insect technique (F₁SIT) for field host range testing of the Brazilian peppertree natural enemy *Episimus utilis* (Lepidoptera: Tortricidae) (Poster). Entomological Society of America, Annual Meeting. Ft. Lauderdale, Fla; November 6-9.

Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2005. Extended Synopsis: Application of the F₁ Sterile Insect Technique (F₁SIT) for Field Host Range Testing of the Tortricid *Episimus utilis*, a Candidate for Classical Biological Control of Brazilian peppertree in Florida (Poster). FAO/IAEA International Conference on Area-Wide Control of Insect Pests: Integrating the Sterile Insect and Related Nuclear and other Techniques. Vienna, Austria; May 9-13.

Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2004. Abstract (on-line version): Application of the F₁ Sterile Insect Technique (F₁SIT) for Field Host Range Testing of the South American leafrolling tortricid *Episimus utilis*, a candidate for classical biological control of Brazilian peppertree in Florida (Poster). Entomological Society of America, Annual Meeting. Salt Lake City, UT; November 14-17.

Scoles, J.P. Cuda, and W. A. Overholt. 2005. How scientists obtain approval to release organisms for classical biological control of invasive weeds. <http://edis.at.ufl.edu/IN607>.

Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2006. Abstract: The F₁ Sterile Insect Technique (F₁SIT): A Novel Approach to Host Range Testing of the Tortricid *Episimus utilis*, A Natural Enemy of Brazilian Peppertree. Florida Exotic Pest Plant Council 21st Annual Symposium. Gainesville, Fla; April 24-26, 2006.

Presentations

- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2005. Evaluating the F₁ sterile insect technique (F₁SIT) for field host range testing of the Brazilian peppertree natural enemy *Episimus utilis* (Lepidoptera: Tortricidae) (Poster). Entomological Society of America, Annual Meeting. Ft. Lauderdale, Fla; November 6-9.
- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2005. Application of the F₁ Sterile Insect Technique (F₁SIT) for Field Host Range Testing of *Episimus utilis* Zimmerman (Lepidoptera: Tortricidae), a Candidate for Biological Control of Brazilian Peppertree. Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Research Coordination Meeting (RCM): Use of Nuclear Techniques for the Colonization and Production of Natural Enemies of Agricultural Insect Pests. Vienna, Austria; May 13-17.
- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2005. Application of the F₁ Sterile Insect Technique (F₁SIT) for Field Host Range Testing of the Tortricid *Episimus utilis*, a Candidate for Classical Biological Control of Brazilian peppertree in Florida (Poster). FAO/IAEA International Conference on Area-Wide Control of Insect Pests: Integrating the Sterile Insect and Related Nuclear and other Techniques. Vienna, Austria; May 9-13.
- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2004. Application of the F₁ Sterile Insect Technique (F₁SIT) for Field Host Range Testing of the South American leafrolling tortricid *Episimus utilis*, a candidate for classical biological control of Brazilian peppertree in Florida (Poster). Entomological Society of America, Annual Meeting. Salt Lake City, UT; November 14-17.
- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2006. The F₁ Sterile Insect Technique (F₁SIT): A Novel Approach to Host Range Testing of the Tortricid *Episimus utilis*, A Natural Enemy of Brazilian Peppertree. Florida Exotic Pest Plant Council 21st Annual Symposium. Gainesville, Fla; April 24-26.
- Moeri O.E., J.P. Cuda, W.A. Overholt, S. Bloem, and J.E. Carpenter. 2006. F₁SIT: Innovative Approach for Field Host Range Testing of the Brazilian Peppertree Natural Enemy *Episimus utilis* (Lepidoptera: Tortricidae) (Poster). IFAS Graduate Research Symposium. University of Florida. Gainesville, Fla; March 24, 2006.

Impacts/Outcomes

The first phase of experiments in the F₁ sterility study of *E. utilis* is still in progress. One of the problems was acquiring a sufficient number of adults of similar age to conduct the tests. While these issues were being addressed, a dosimetry analysis was conducted over an 8 hour period (500 min.) using Far West dosimetry film. The purpose of the dosimetry study was to determine the position in the irradiator where moths would receive uniform doses of radiation. Values for each position of the Far West film were averaged and then positioned into a dosimetry map

representing the Cs-137 irradiator (Fig. 1). These values are based on a monthly decay correction factor of 0.998. Differences between the levels of irradiation from the innermost to the outermost position of the vial were not statistically different (top mean = 6.8; top SD = 0.7) ($P > 0.05$, 1-WAY ANOVA) (SAS Institute 2000). However, levels of irradiation from the top to the bottom were significantly different (bottom mean = 7.2; bottom SD = 0.6) ($P < 0.05$, 1-WAY ANOVA) (SAS Institute 2000). To minimize the variance between the levels of irradiation due to vertical position within the canister, the canister will be positioned at the bottom of the irradiator (Fig. 2A, B).

Due to a shortage of similar aged emerging adults, single adult pairs were set up in wax paper chambers (Bloem et al. 1999) based on daily emergence patterns. During January and February 2005, the first phase of the F_1 study was initiated. However, no oviposition was observed in the treatments or the control, and the females were not mated. During this time period, colony production declined due to seasonal effects on the plants. Oviposition in waxed paper chambers was not observed until June 2005. Experiments for the first phase of the F_1 study were repeated again in June and July 2005 with similar results.

In August 2005, additional experiments were conducted using single pair matings of non-irradiated adults to determine the best material to be used in the experimental set-up of an oviposition chamber, including the replacement of a small disc of Brazilian peppertree leaflet with a disc of pistachio, *Pistacia vera* L., as an ovipositional cue (Table 1). Pistachio was used to replace Brazilian peppertree due to inconsistent oviposition results. Campello and Marsaioli (1975) found that the compounds obtained from the leaves and bark of Brazilian peppertree show a greater similarity to compounds isolated from *Pistacia* species than with those isolated from other species of *Schinus*. The pistachio seemed to produce comparable results with the presence of eggs in 4 out of 7 polypropylene sheet protector (C-LineProducts Inc., Mt. Prospect, IL) chambers versus 3 out of 7 waxed paper chambers with eggs. In the case of the polypropylene sheet protector chambers, an average of 32 ± 38 eggs was laid and the fertility rate was $99.6\% \pm 0.5\%$ (Table 1). For the waxed paper chambers, an average of 27 ± 41.8 eggs was laid and the fertility rate was $97.9\% \pm 0.5\%$ (Table 1). Both types of chamber material were suitable for oviposition. However, when set up for 2 intervals of 5 days (with 10 days being the normal adult life span), the moths in the waxed paper chambers had a better survival rate. Only 2 out of 7 (28.6%) of the polypropylene chambers were able to be set up for a second interval of 5 days, compared to 4 out of 7 (57.1%) of the waxed paper chambers. Based on the consistent oviposition with pistachio, the radiation biology study is currently being conducted with 5 pairs of moths per chamber with a disc of pistachio instead of Brazilian peppertree to maximize oviposition.

Preliminary results of testing two artificial diets for mass rearing *E. utilis* were completed. One of the diets is a Brazilian peppertree (BP) agar diet that includes freeze-dried Brazilian peppertree leaflets while the other artificial diet is a commercially-available Bio-Serv Lepidoptera diet. The Labconco FreeZone[®] 4.5 Liter Freeze Dryer, purchased with funding from this grant, was used in preparation of the BP diet. However, the vacuum pump of the freeze dryer was found to be defective, and delayed additional testing for a period of several months. A Labconco Purifier[®] Filtered PCR Enclosure was also obtained with funding from this grant, and was used to minimize contamination while transferring larvae to the two artificial diets.

The BP agar diet was previously tested in June 2005 and is currently being re-tested in addition to the Bio-Serv diet. The BP agar diet (June 2005) initially was tested with 13 third instar larvae of *E. utilis*. Six larvae were individually set up in small petri dishes, while the other 7 were individually set up in plastic diet cups. The larvae were observed daily to monitor survival, and the amount of frass produced was noted. Survival to pupation was 92% and survival to the adult stage was 69% (Fig. 3). The sex ratio was approximately 1:1 (M:F).

The BP agar diet and the Bio-Serv diet (September 2005) that are presently being tested were exposed to younger larvae (n=15 second instars). The larvae were each individually set up in plastic diet cups and observed in the same manner as previously described. To date, survival to pupation on the BP agar diet (September 2005) is 87%, while survival to the adult stage is 67% (Fig. 3). In contrast, larval survival to pupation was only 53% and survival to the adult stage was 7% on the Bio-Serv diet (September 2005) (Fig. 3). Pre-pupation mortality was only 13% for the BP agar diet compared to 47% for the Bio-Serv diet. Sex ratios for the emerged adults on the BP agar diet (September 2005) and the Bio-Serv diet (September 2005) were 1:1 and 1:3 (M:F), respectively.

Larvae that pupated in the two BP agar diets averaged 10-12 days to adult eclosion, while the duration of the pupal stage in the Bio-Serv Lepidoptera diet averaged around 12 days. The 10 to 12 day pupation period was comparable to that of larvae reared on potted BP plants, which was reported to be 12 days by Martin et al. (2004). Upon adult emergence in both diets, female and male adults will be paired and set up in an oviposition chamber. This chamber will be set up for 2 intervals of 5 days. Survival of the adults will be measured and compared to adults that have been reared on potted BP plants and set up in a similar manner. According to Martin et al. (2004), adults reared on potted BP plants survived on average 6.8 ± 0.8 days. The fertility of the eggs produced by the F₁ mated females (% egg hatch) also will be evaluated.

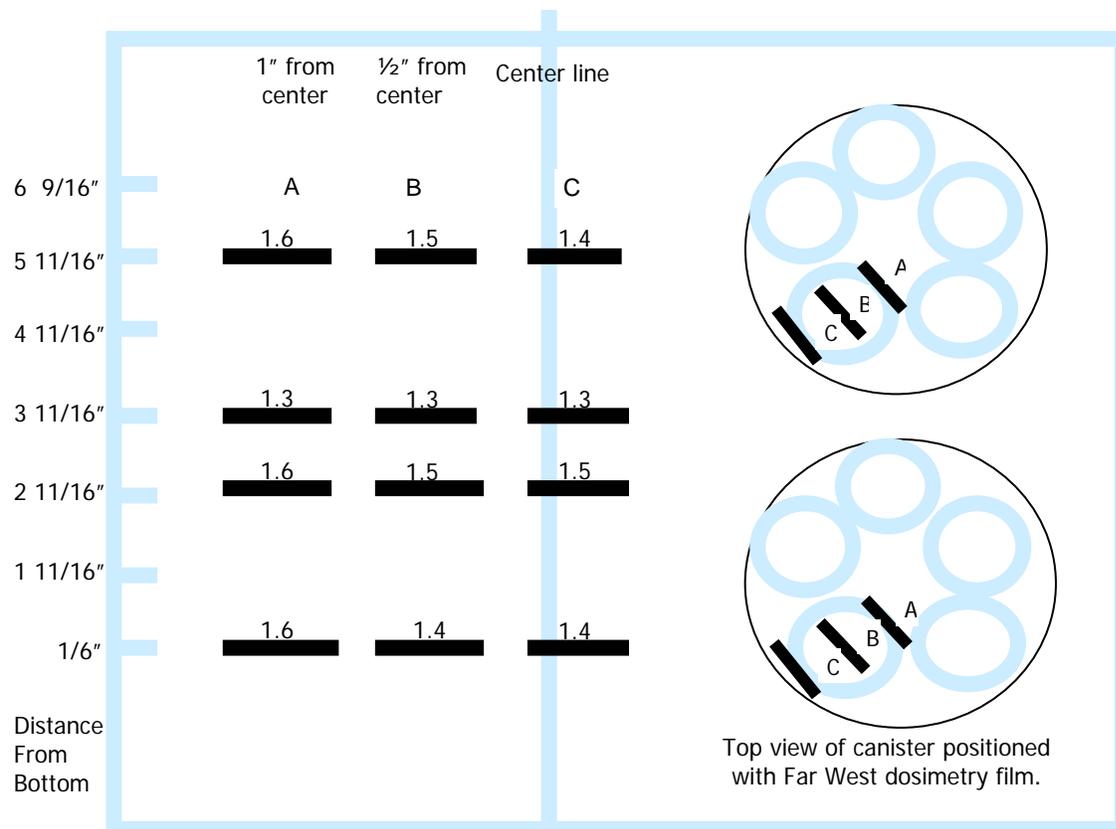


Figure 1. Dosimetry map of the Cs-137 irradiator based on 8 hrs (500 min.).



Figure 2A. Top view of irradiation canister. **Figure 2B.** Canisters used to irradiate moths

Table 1. Oviposition of Non-irradiated adults of *E. utilis* in 2 different types of chambers.

| Type of material | No. of chambers | No. of mated females | No. of eggs laid | No. of eggs hatched | Average fecundity | Percent fertility |
|------------------|-----------------|----------------------|------------------|---------------------|-------------------|-------------------|
| Polypropylene | 7 | 4 | 226 | 225 | 32.3 ± 38 | 99.6% ± 0.5% |
| Waxed Paper | 7 | 3 | 191 | 187 | 27.3 ± 41.8 | 97.9% ± 0.5% |

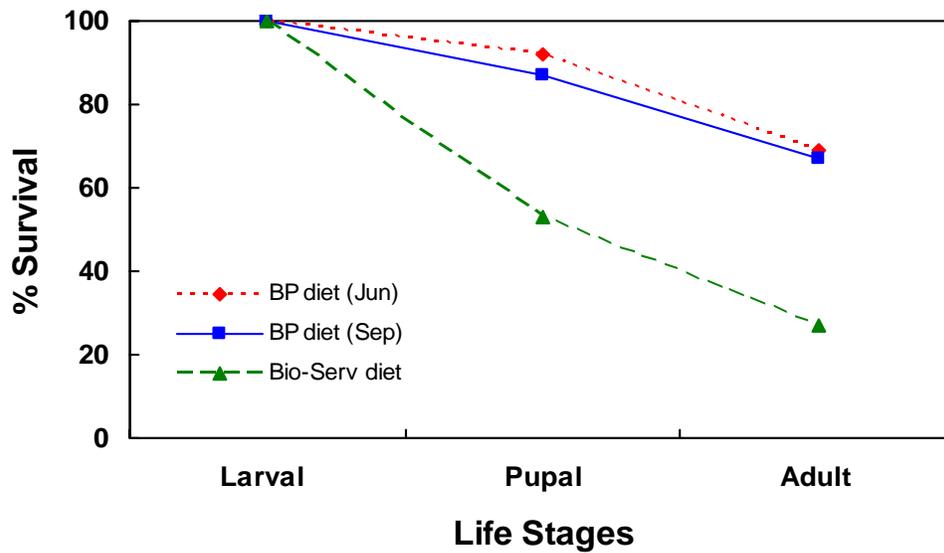


Figure 3. Larval development of *E. utilis* on two different artificial diets.

Leveraging and/or Cost Sharing of SNRE Funds

- USDA, CSREES, Southern Region IPM Center Enhancement Grant
Developing a sustainable management plan for Brazilian peppertree in Florida, July 2005.
Amount: \$ 25,349
- Dynamic Aviation, Travel Grant
Received for travel to FAO/IAEA International Conference on Area-Wide Control of Insect Pests: Integrating the Sterile Insect and Related Nuclear and other Techniques in Vienna, Austria May 9-13, 2005
Amount: \$ 2,000
- University of Florida, College of Agricultural and Life Sciences IFAS Travel Grant
Received for travel to the Annual ESA meeting in Salt Lake City, UT November 14-17, 2004
Amount: \$200
- Florida Entomological Society, Travel Grant
Received for travel to the Annual ESA meeting in Ft. Lauderdale, Fla. December 15-18, 2005
Amount: \$ 200.00

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3. Fostering Professional Development of Scientists and Engineers in Ecosystem Health and Sustainability

Project Leader(s): Doug Levey, Zoology; David Bloomquist, Civil and Coastal Engineering and University Center for Excellence in Teaching; Mary Jo Koroly, Medicine and Center for Precollegiate Education and Training; Ricardo Quintana, Alachua County Schools

Collaborators: Sandra Anusavice, Alachua County Schools; Mary Brown, Veterinary Medicine; Thomas Crisman; Environmental Engineering Sciences; Betty Dunckel, Florida Museum of Natural History; Louis Guillette, Zoology; Linda Jones, School of Teaching and Learning; Angela Lindner, Environmental Engineering Sciences; Wayne McCormack, Medicine; Martha Monroe, School of Forest Resources and Conservation; Martin Vala, Chemistry; Marta Wayne, Zoology

Executive Summary

The seed funding provided summer support for the PI, Doug Levey, to craft a GK-12 proposal for \$2 million to the National Science Foundation. The proposal is for continuation of SPICE (Science Partners in Inquiry-based Collaborative Education), a 3-year collaboration between UF (colleges of Engineering and Liberal Arts and Sciences) and the School Board of Alachua County. SPICE was in its last year of funding when the SNRE mini-grant provided support for writing the proposal to renew it. The proposal for renewal was fully funded -- \$2 million for 5 years. The success of the proposal hinged on the effectiveness of SPICE's plan for institutionalization (i.e., its viability after NSF funding expires). Forging a path towards institutionalization and writing the proposal required many collaborators and many commitments of financial support from deans and other high-level administrators at UF. All parties were enthusiastic about SPICE and provided what I requested of them.

Research and/or Outreach/Extension Needs

SPICE is an outreach program in which graduate students in the STEM disciplines (Science, Technology, Engineering, and Math) are trained in inquiry-based learning techniques and placed in Gainesville middle schools that have high proportions of underprivileged children.

Extramural Proposal(s) Submitted and Status

A proposal titled "Science Partners in Inquiry-based Collaborative Education II (SPICE II)" was submitted to NSF in early June 2005. The proposal for renewal was fully funded -- \$2 million for 5 years.

Deliverables Supported Entirely or in Part by this Grant

Writing the proposal was an intensive, one-month project. I have no other deliverables to report other than the proposal and all of its accompanying letters of support from 11 administrators at

UF and the School Board of Alachua County. The presentations I made about SPICE were all one-on-one during this period.

Leveraging and/or Cost Sharing of SNRE Funds

I received no additional funds to support my grant writing efforts during the month I was supported by the SNRE Seed Grant. However, I was able to use SNRE support of SPICE (not support of me, per se) to leverage promises of significant fellowship support from COE, CLAS, CALS, VetMed, and the Provost. This institutional funding amounts to >\$100,000 per year for as long as SPICE remains active. Details are provided in the Budget Justification section of the proposal. The proposal has provided a \$2 million return for an SNRE investment of approximately \$10,000.

New Projects Resulting from this Grant

The proposed project is a continuation and expansion of SPICE.

4. Support for Preparation of the NSF Proposal: “Development of a Hydrologic Observatory in the Suwannee River Watershed”

Project Leader(s): Jonathan Martin, Geological Sciences; Wendy Graham, Agricultural and Biological Engineering; Joseph Delfino, Environmental Engineering Sciences

Collaborators: Peter Sheng and Clint Slatton, Civil and Coastal Engineering; Jasmeet Judge and Rafael Munoz-Carpena, Agricultural and Biological Engineering; Mike Annable and Jim Heaney, Environmental Engineering Sciences; Tom Frazier, Bill Lindberg, and Ed Philips, Fisheries and Aquatic Sciences; Jim Jawitz, Ramesh Reddy, Jim Sickman, and Sabine Grunwald, Soil and Water Science; Mike Binford, Geography; Liz Sreaton, Geological Sciences; and Eric Triplett, Microbiology

The SNRE Seed Grant funds were used to support two research staffs for the 6 months between January and June 2005. These were Matt Cohen (Research Assistant Scientist in Soil and Water Science/SNRE) and Kathleen McKee (Staff Scientist and Information Manager for the HO in Agricultural and Biological Engineering).

Executive Summary

We have used funds from the SNRE mini-grant program to position UF as a leader of a large multi-institution research group working towards submission of a proposal to NSF to create a Hydrologic Observatory (HO) in the Suwannee River watershed. Over the past several years, NSF has been developing plans to construct up to five hydrologic observatories throughout the United States at an approximate cost of \$25 million each. Each observatory is envisioned as a network of research stations within a single watershed, focused on the problems and opportunities for research, teaching, and extension at the scale of large river basins. NSF planned to issue a request for proposals through the Hydrology Program (Geosciences) for the observatories in late 2005, but this request has now been postponed for several years while NSF coordinates a similar effort with engineering programs.

In response to the planned RFP, we selected the Suwannee River watershed as an excellent candidate for the observatory. To develop the proposal, we formed a team of researchers from several colleges and departments at UF, as well as other academic institutions and research organizations across Florida and Georgia. As a direct result of the SNRE funding, significant progress has been made towards several objectives, including collation and organization of existing data for the Suwannee Basin, developing research objectives for large, basin-scale scientific inquiry and forming the collaborative linkages among UF, other research institutions, federal and state agencies, and other watershed groups including the Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI). This progress situated UF as the statewide leader of the Suwannee River Hydrologic Observatory and one of approximately ten groups working nationally toward developing observatory science. Regardless of the delay in the major observatory proposal, SNRE funds were instrumental in the development and submission of four other proposals (one declined, three pending) to various NSF programs. The preparation

of these proposals has continued the momentum toward building a Suwannee River Hydrologic Observatory among faculty in the UF group. The SNRE funds have allowed UF to become a nationally recognized leader of observatory science.

Extramural Proposal(s) Submitted and Status

The primary objective of applying for SNRE seed funds was to allow flexible and pre-emptive data compilation, networking, and proposal development. While we engaged in these activities (and more), the lack of an RFP for the observatory has prevented us from preparing a proposal specifically for the Suwannee River Hydrologic Observatory. In exchange for a major RFP for observatories, however, NSF is now approaching the HO proposal process as a series of smaller grants that will lead to a more rigorous science plan for the observatories, and ultimately to the RFP for observatories. We have embraced this directive by leveraging the work completed as part of this mini-grant into submission of four proposals. The following is a list of proposals from UF that have directly resulted from mini-grant support of the observatory planning effort:

- **Funded**
 - NSF Earth Science – Engineering Declaration (Wendy Graham PI, co-PI’s Jon Martin, Joe Delfino, Clint Slatton, Matt Cohen, and Ray Thomas) *Design and demonstration of a distributed sensor array for predicting water flow and nitrate flux in the Santa Fe Basin*, National Science Foundation, \$360,000 co-PI
- **Not Funded**
 - NSF Cyber-Infrastructure (with CUAHSI national network, Wendy Graham co-PI) – *Develop and standardize tools for integration and presentation of digital hydrologic data among the CUAHSI community*. \$10,000 (UF portion only)
- **Pending**
 - NSF Earth Science - Instrumentation and Facilities (Clint Slatton and Matt Cohen) – *Develop new tools for the assessment of fine scale spatial variability in soil hydraulic properties using laser mapping and soil spectroscopy*. \$350,000.
 - NSF Earth Science – Carbon and Water Cycle (Jon Martin, PI, co-PI’s, Jim Sickman, Andy Zimmerman, Wendy Graham, Jean-Claude Bonzongo; Senior Investigators, Joe Delfino, Tom Frazier, Matt Cohen) *Influence of Hydrologic Variability on Carbon Processing and Fluxes in an Organic Carbon and Carbonate Rich Watershed*, Suwannee River Florida, National Science Foundation, \$2,407,910.

Deliverables Supported Entirely or in Part by this Grant

The following list highlights some of the activities, presentation, and materials that have been created in the effort toward formation of the Suwannee River Hydrologic Observatory:

- **Presentations**
 - Upper Suwannee River Watershed Initiative (Tifton, GA, March 2005)
 - Suwannee Basin Interagency Alliance (Folkston, GA, June 2005)
 - Hydrologic Information System (HIS) meeting (Austin, TX, March 2005)
- Educational Materials describing the potential of the Suwannee River as a hydrologic observatory:

- Poster
- Pamphlet
- Website <http://suwanneeho.ifas.ufl.edu>:
 - Describing the concept of a hydrologic observatory
 - Organizational tool for subcommittees on different aspects of the HO development
 - Important tool to showcase successful data collection efforts and high level of commitment the HO team had to a Suwannee River Basin observatory.
 - Data portal (under development)
- Bibliography
 - Annotated bibliography of literature relevant to comprehensive study of the Suwannee River Basin (over 500 entries)
- Geodatabase
 - Spatial database characterizing the natural resources of the Suwannee River basin containing data collected from multiple governmental organizations (many are described in the website). This geodatabase is now being enhanced and maintained by the UF Water Institute.

Impacts/Outcomes

- Research
 - Improved understanding of data sources, availability, reliability, delivery
 - Improved understanding of critical data requirements for digital watershed, including methods for integrating spatial and temporal data, archiving and summarizing data, and delivering data to end-users
 - Improved understanding of water quality and quantity issues in the Suwannee River basin (e.g., peak flows, nitrate concentrations, DO concentrations).
- Extension
 - Elevated awareness of water research at UF both within national research groups (CUAHSI) and funding agencies (NSF), and within government agencies and institutions (USGS, Suwannee River Water Management District, Suwannee River Partnership, Florida Geological Survey, USDA-ARS researchers in Georgia).
 - Coordination among researchers at UF, USF, UCF, UNF, UGA, OSU, FSU, FAMU, and Princeton.

Leveraging and/or Cost Sharing of SNRE Funds

Leveraged funds from Progress Energy for initiation of UF's Water Institute. These funds include two grants:

- Water Institute Planning and Implementation Grant: \$50,000
- Progress Energy Endowment for the University of Florida Water Institute: \$1,200,000

5. ROADIES: An Interdisciplinary Approach to Modeling the Impacts of Infrastructure Connectivity on the Resilience of Social-Ecological Systems

Project Leader(s): Stephen Perz, Sociology; Grenville Barnes, School of Forest Resources and Conservation; Graeme Cumming, Wildlife Ecology and Conservation; Jane Southworth, Geography

Collaborators: More than 10 faculty and 20 graduate students.
See <http://www.wec.ufl.edu/faculty/cummingg/roadies/roadies.htm>
Click on “Members” for a full listing.

Executive Summary

This project was partially funded (\$5263 out of the requested \$30,000), so from among the activities we proposed, we chose to support meta-data collection and synthesis. We conducted meta-data collection for two study sites, North Florida and the “MAP” region of the southwestern Amazon. These were the study sites in our grant proposal to the NSF Human and Social Dynamics (HSD) program, which has been funded at a level of about \$650,000 for 3.5 years.

Research and/or Outreach/Extension Needs

This grant supported activities for the development of a proposal to examine road impacts on the resilience of social-ecological systems. Resilience has rarely been evaluated empirically, but our recent work and a comparative design may afford a means for doing that. In our case, the proposal sought to compare the resilience of social-ecological systems to new road infrastructure, at low and high levels of road connectivity. This allows for an empirical treatment of road impacts, a highly complex problem with policy implications, via the application of fairly abstract theory in data collection at multiple study sites. The “Roadies” group at UF is well-suited to address this problem, for the group consists of faculty and graduate students who have regularly met for four years to work on these issues. The proposal to NSF draws on a recent collaborative paper on the measurement of resilience, which provides the theoretical core of our proposal and motivates specific forms of data collection and modeling.

Extramural Proposal(s) Submitted and Status

We submitted a proposal titled “AOC: Infrastructure Change, Human Agency, and Resilience in Social-Ecological Systems” to NSF’s FY2005 competition in the Human and Social Dynamics Program. Perz (Sociology) was PI, with Barnes (Forestry), Cumming (Wildlife), and Southworth (Geography) as co-PIs. The proposed project had a 3-year lifespan and a total budget of about \$745,000. NSF responded in July indicating an interest in supporting the proposal, but with a maximum budget of \$650,000. Based on comments by reviewers, the program officer also requested a change in project scope, by dropping the North Florida site and expanding the focus on the southwestern Amazon from the Brazilian state of Acre to the entire “MAP” region. We drafted a new project summary, revised the budget, wrote questionnaires, received IRB approval, and passed the revised project through DSR to NSF, who has since funded the proposal. The

project will begin this year; our first report to NSF is due on December 1. The revised project lifetime is 3.5 years.

Deliverables Supported Entirely or in Part by this Grant

While working on the NSF proposal, the PI (Perz) was also serving as PI on another proposal involving road impacts in the MAP region. This second proposal has a project budget with total costs of approximately \$1 million, and involved much more collaborative development with university faculty in the MAP region. The proposal has nearly \$600,000 in cost-sharing and matching contributions, and was submitted to the Inter-American Institute for Global Change Research (IAI) in March. IAI will announce their funding decisions in October. If funded, this project alongside the NSF HSD project will allow for considerable collaborative research over the next 5 years on road impacts on social and ecological processes in the MAP region.

Aside from the IAI proposal, meta-data collection has proceeded, primarily for the MAP site. We purchased storage drives to back up the meta-data information. We also developed a relational database to store and query our meta-data. We plan to put that database on the web for Roadies members and collaborators at MAP universities to use. This will facilitate collection, documentation, and sharing of data among collaborators interested in issues related to road impacts in the MAP region, including students at UF.

Impacts/Outcomes

The NSF HSD project, the prospect of an IAI project, and the database will all have impacts on research and training at UF and elsewhere concerning road impacts on social-ecological systems. The NSF HSD project will advance our knowledge about road impacts theoretically, by examining in detail the effects of changing connectivity on system resilience. We will be gathering spatial data to observe gradients in road impacts, and our data collection will include the use of baseline information from past research, extend over time during the project lifetime, and even go into the future via spatially explicit simulation modeling and scenario planning. In the process, the HSD project will in effect constitute an empirical experiment to see how well the concept of resilience allows us to manage the multiple effects of roads. The HSD project will also provide a basis for advancing spatio-temporal modeling of regional change in a way that allows for decision-making on the basis of whether social-ecological systems can retain their identities in the face of system shocks brought by new roads.

The IAI project, if funded, will provide considerable resources to MAP universities for equipment purchases, student support, and cross-border and interdisciplinary networking among researchers in the region. MAP is biologically and socially diverse but needs considerable capacity building for scientific research that can be put to work in the region's grassroots movement for participatory environmental planning. The IAI project would not only provide a series of experiences for collaboration among universities in MAP, but would also help train many students there in research and connecting with local communities in order to collaboratively plan for road impacts. This rather applied project would thus complement the more theoretical focus of the HSD project.

Leveraging and/or Cost Sharing of SNRE Funds

While the HSD project has no official cost sharing, the Department of Sociology has agreed to fund an additional graduate research assistant as part of the HSD project. The project co-PIs and MAP consultants will also be contributing more time than they will be paid for in that project.

The IAI proposal has nearly \$600,000 in documented cost-sharing and contributions from other projects. We note that SNRE stands among the UF units who have agreed to contribute funds to the IAI proposal if it is funded.

New Projects Resulting from this Grant

The IAI project is a potential addition. It is important to recognize that both of these proposals in effect call for the creation and fortification of cross-national and interdisciplinary research networks, for road impacts are multidimensional. It is our goal to produce additional proposals, including those led by MAP university faculty, in the near future.

A new proposal, “Experiments in Environmental Governance in the MAP Region: Madre de Dios, Peru, Acre, Brazil, Pando, Bolivia,” has stemmed from the SNRE mini-grant. This proposal was submitted to USAID (Amazon Basin Conservation Initiative) on April 19, 2006 with a proposed budget of \$8.7 million.

6. Molecular Biology of Arsenic Reduction, Detoxification, and Hyperaccumulation in *Pteris vittata*. (Progress Report for Year 1)

Project Leader(s): Bala Rathinasabapathi, Horticultural Sciences

Collaborators: Lena Ma, Soil and Water Science

Executive Summary

Progress Report for Dec. 2004 to June 2005.

Arsenic is of great environmental concern due to its extensive contamination and carcinogenic toxicity. *Pteris vittata*, the first known arsenic hyperaccumulator, was discovered by the Co-PI's research team and reported in *Nature* (Ma et al., 2001). This discovery led to the idea that phytoextraction, a plant-based green technology, may become a reality as a cost-effective and environment-friendly method to clean up arsenic-contaminated sites. However, before *P. vittata* can be successfully used, it is paramount to first understand the underlying mechanisms of its arsenic hyperaccumulation. Also, the basic science in and of this fern is of great interest because of its unique and unknown mechanisms of arsenic detoxification. Realizing the importance of this research, the PI and Co-PI have begun an active collaboration to initiate a research program to elucidate the mechanisms of arsenic detoxification in *P. vittata*. The PI and Co-PI have generated preliminary data enough to develop a few manuscripts for publication and to be used in grant proposals to federal funding agencies.

Extramural Proposal(s) Submitted and Status

The data generated will be used as preliminary data in grant proposals to federal funding agencies. The proposed work and these tools are required to convince peer reviewers that we will be able to accomplish characterizing more genes involved in arsenic hyperaccumulation in *P. vittata*. This will also make us competitive compared to other world teams that have entered into this area. Currently our competition includes teams in Purdue University; University of California, La Jolla; University of Georgia; and Rothamstead Experimental Station, England. Apparently, understanding the mechanisms of arsenic detoxification by *P. vittata* has become a hot topic for many research teams worldwide.

Deliverables Supported Entirely or in Part by this Grant

Rathinasabapathi, B., Wu, S. and Ma L. Identification of *Pteris vittata* cDNAs for arsenic resistance genes using a microbial expression cloning strategy. *Manuscript in preparation for Plant Molecular Biology*.

Rathinasabapathi B, Ma L. Functional genomics and proteomics of the arsenic hyperaccumulator fern *Pteris vittata*. *Grant proposal to be submitted to the National Science Foundation (July 2005)*.

Impacts/Outcomes

The goal is to develop molecular biology resources on *Pteris vittata* that could be used to create novel data for a compelling federal research grant. Two objectives of this proposal were as follows:

1. To develop cDNA libraries of *Pteris vittata*
2. To screen for arsenate reductase cDNAs using a microbial mutant complementation strategy.

Objective 1

We proposed to prepare two expression cDNA libraries in the fronds of *P. vittata*, one from plants exposed to arsenate and one from the control with no arsenate in the growing medium, in lambda TriplEx2 (BD Biosciences, Mt. View, CA) vector using their custom library service. We made total RNA from *P. vittata* frond tissue for this purpose. Even though the quality of the RNA was good based on our gel and spectrophotometric analyses, no cDNA could be synthesized due to inhibitors present in the RNA preparation. Hence, we optimized the RNA isolation technique to get the best quality RNA. By inclusion of a Plant RNA Isolation Aid, a proprietary product from Ambion, we significantly improved the quality of RNA. Because of the extra effort into optimizing RNA isolation procedures, we made only one cDNA library (from fronds of plants exposed to 200 ppm arsenate for one week) instead of two as proposed.

The cDNA library was of high quality with 1×10^7 pfu per ml and the total volume was 1.6 ml. This library has the cDNA inserts unidirectionally in fusion with lacZ and OmpA protein coding sequences under the control of an IPTG-inducible promoter. The library was excised to create phagemids that could be used to transform into *Escherichia coli*. An analysis of 15 randomly picked clones had a size range of 0.73 Kb to 2.97 Kb.

We have successfully achieved objective 1 and have tested protocols to achieve the second objective. We have identified seven *P. vittata* cDNA clones that confer arsenic resistance in bacteria when expressed. However, these clones need to be sequenced and further characterized. Hence, funding for the second year is critical to achieve that goal.

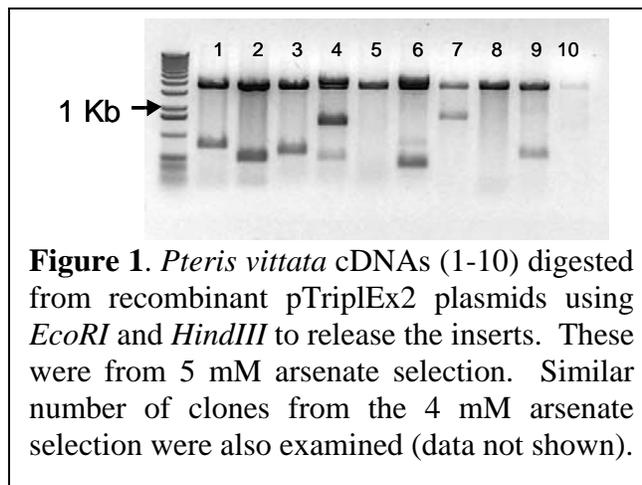
Objective 2

In *P. vittata*, arsenic is mainly concentrated in the fronds mostly as As(III), a form suitable for complexing with thiol ligands. Reduction of As(V) is observed in excised fronds, suggesting that the site of reduction is in the fronds (Tu et al., 2004). We hypothesized enzymatic reduction of As(V) to As(III) in *P. vittata* fronds. We proposed to identify the putative arsenate reductase cDNA by complementing phagemids into an arsenate reductase deficient mutant *E. coli* strain WC3110 (Mukhopadhyay and Rosen, 1998).

For this purpose, the phagemids were excised from the cDNA library. Prior to testing complementation of the mutant, we tested whether expression of *P. vittata* cDNAs in *E. coli* BM25.3 and XL-1 Blue will confer arsenic resistance to the strains. In one screen, following transformation with phagemids, we selected the *E. coli* BM25.3 at 4 mM and 5 mM sodium arsenate in a liquid medium for 24 h. The cells were then plated on a non-selective medium.

Restriction digestion analysis of plasmid DNA from these clones identified the inserts to be between 0.5 and 1.0 kb (Figure 1).

Five clones each from 5 mM and 4 mM arsenate selections were sequenced. One of them was identified to be a full length cDNA for cytosolic triose phosphate isomerase, a glycolytic enzyme known to be inhibited by arsenate in many organisms. This result validates that enzymes targeted by arsenic and could confer arsenic resistance upon overexpression, can be identified using this strategy. Further research is currently in progress in our laboratories to characterize these clones.



In a variation of this procedure, the fern library phagemids were transformed into *E. coli* XL1 Blue. Following screening 1.5×10^4 colonies on 2.5 mM sodium arsenate in the medium, seven arsenate-resistant colonies were identified. Sequencing and characterization of these seven cDNA clones will be the objective for the second year's goal in this grant. During this period we will also attempt complementing *E. coli* mutant deficient in arsenate reductase.

Leveraging and/or Cost Sharing of SNRE Funds

This is the first year of a two-year project.

References

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7. Quantifying Dissolved Organic Matter Sources to Surface Waters in the St. Johns River Basin Using Radiocarbon Dating

Project Leader(s): James O. Sickman, Soil and Water Science

Collaborators: Ted Schuur, Botany; Ramesh Reddy, Soil and Water Science; and Millard Fisher, St. Johns River Water Management District

Executive Summary

Much of the upper St. Johns River (USJR) is considered impaired by the Florida Department of Environmental Protection (FDEP) due to low dissolved oxygen (DO) levels. Organic substrates fueling excessive biological oxygen demand (BOD) can derive from both internal and external sources. Radiocarbon dating of isolates of dissolved organic matter (DOM) provides a powerful tool for resolving sources of DOM. A pilot study was conducted during 2005 to collect data on the age of DOM in the upper St. Johns River. The objectives of the study were to establish that enough variation in radiocarbon ages exists for the technique to work in Florida rivers and to attract extramural funding for a larger project. Two proposals relating to the SNRE SFG funded project were submitted, and one was funded in the amount of \$48,700 by the lower St. Johns River Water Management District. An extensive negotiation for a two-year study of DOM in the lower St. Johns River for 2005-2007 was awarded for \$95,284, bringing the total SJRWMD funds to \$131,522. The other proposal was submitted to USDA National Research Initiative (with a proposed budget of \$397,876), and while reviews were favorable, the study was not funded (a resubmission is planned for the 2005-2006 USDA NRI call).

Research and/or Outreach/Extension Needs

Much of the upper St. Johns River (USJR) is considered impaired by the Florida Department of Environmental Protection (FDEP) due to low dissolved oxygen (DO) levels. Organic substrates fueling excessive biological oxygen demand (BOD) can derive from both internal and external sources. The classical paradigm links anthropogenic nutrient inputs of nitrogen (N) and phosphorus (P) to increased algal blooms followed by die-offs and subsequent low DO due to microbial decomposition processes. However, water quality data collected from the USJR indicates weak and inconsistent relationships between N&P and DO. Poor correlations also exist between phytoplankton biomass (Chl a) and DO in the USJR suggesting that autochthonous carbon production may not be the primary cause of high BOD in the river. We hypothesize that dissolved organic matter (DOM) from watershed sources is a primary cause for high rates of respiration in the river. If so, then planned Total Maximum Daily Load (TMDL) for nutrients promulgated by FDEP and the U.S. EPA may not prevent low DO in the USJR. This allochthonous DOM may originate from carbon-rich peat soils within the watershed that have undergone oxidation due to draining; expansion of wetland restoration may increase allochthonous DOM inputs to the river in the future.

We received SNRE SFG funds to collect baseline data on the radiocarbon and stable-isotopic composition of DOM in the USJR Basin. These data are necessary to demonstrate to funding agencies that we have a tool to trace DOM sources that will help answer management questions

they have about high BOD levels, DOM sources to the St. Johns River, and impacts of urbanization on carbon cycling in the river. The isotopic data are being used to generate site-specific hypotheses on sources of DOM involved in BOD and DBP formation which will help us attract funding from local water management districts, USDA, and in the future, NSF.

Extramural Proposal(s) Submitted and Status

The following proposals were prepared in relation to the SNRE SFG grant received by J.O. Sickman

- Deliverable 1: Proposal submitted to USDA National Research Initiative, Watershed Processes and Water Resources RFA (Funding Opportunity Number 090304-001). In response to this solicitation, a proposal was submitted on March 1, 2005, titled “Watershed Processes and Water Resources RFP. Influence of Hydro-period and Redox on the Quality of Dissolved Organic Matter Leached from Agricultural/Restored Peatlands: Consequences for Aquatic Foodwebs and Human Health.” J.O. Sickman was the lead PI and A. Zimmerman (Geological Sciences, University of Florida) was co-PI. The total request for the 3-year study was \$397,876. One hundred forty proposals were received in this competition, and 14 were funded. We learned that the UF proposal was not funded, but it was categorized as medium to high importance. The review comments were favorable enough to warrant a resubmission in the 2005 NRI competition.
- Deliverable 2: Submitted proposal to the St. Johns River Water Management District. On February 15, 2005 a Request for Qualifications (RFQ) was issued by the St. Johns Water Management District for teams of ecologists and biogeochemists to assist the district in studying the dynamics of aquatic organic matter in the lower SJR. J.O. Sickman took the lead on writing and submitting an RFQ response to the St. Johns River Water Management District titled: “Assessment of Water Quality Impacts Resulting from Development-Driven Changes in Aquatic Organic Matter Composition. Phase I: Methods Evaluation.” The UF team led by Sickman was awarded the multi-year study. In the 2004-2005 fiscal year, UF received a \$48,700 fixed-cost contract from the District to analyze 25 water samples from the lower St. Johns River for radiocarbon, bioavailability, and other biochemical characteristics. An additional \$92,584 was received as an extension of this work, totaling \$131,544 in funds from SJRWMD.

Deliverables Supported Entirely or in Part by this Grant

A summary of the funded SNRE SFG project titled “Riverine organic matter” was presented at a lecture delivered to the lower St. Johns River Water Management District on January 13, 2005 in Palatka, Florida.

Data collected on radiocarbon ages in the upper St. Johns River will be combined with similar measurements being made in the lower St. Johns River in a manuscript to be submitted to Water Resources Research titled “Radiocarbon age of dissolved organic matter in a sub-tropical river: Implications for sources of biological oxygen demand in the St. Johns River, Florida, USA.”

An additional grant proposal has been submitted to the Suwannee River Watershed in request of \$2.4 million.

Impacts/Outcomes

This work is enhancing knowledge of organic matter sources to rivers of north Florida. With these data, management agencies can better evaluate the impacts of ongoing urbanization on water quality and aquatic ecosystems. This work is also being used as part of a PhD program in the Soil and Water Science Department (Chunhao Xu).

Leveraging and/or Cost Sharing of SNRE Funds

Funds provided by SNRE SFG have been leveraged to acquire funding of \$131,544 from the lower St. Johns River Water Management District.

New Projects Resulting from this Grant

A new project titled: “Assessment of Water Quality Impacts Resulting from Development-Driven Changes in Aquatic Organic Matter Composition. Phase I: Methods Evaluation” has been funded by the lower St. Johns River Water Management District. This project will run from July 1, 2005 through September 30, 2007.

NEW FACULTY SUPPORT GRANTS

1. The Development of Virtual Teaching Collections for the Natural Sciences

Project Leader(s): Marc A. Branham, Entomology and Nematology

Collaborators: Eugenio Nearn, Entomology and Nematology

Executive Summary

In December of 2004, I was awarded a New Faculty Support Grant (\$5,000) for the project “The Development of Virtual Teaching Collections for the Natural Sciences.” Since that time, I have purchased the computer hardware and software to generate the product we promised to deliver: a prototype virtual teaching collection focused on “The Invisible Invertebrate World” that would be directed toward a K-12 audience. This collection will feature 360° rotateable 3-D images of specimens and high-resolution close-up “pop-ups” of their distinguishing features for students to study. The collection would be available on CD in both English and Spanish.

Objectives and Rationale

A basic understanding of the natural sciences is necessary for students (and the general public) to appreciate the natural world and the value of scientific research into its systems. The study of such subjects like biodiversity, classification, and taxonomy are taught most easily (and also most easily appreciated) through the study of specimen collections. While many of us were exposed to live moths, grasshoppers and fireflies as children, many children today, especially in inner cities, have an extremely limited exposure to the natural world. Additionally, the vast majority of living organisms are small enough to require a microscope to be examined in any detail. Unfortunately, most primary schools lack microscopes of any kind while high schools and many colleges generally lack ready access to high quality microscopes and light sources necessary to see morphological variation requisite to the study of biodiversity and classification of select organisms. There is also a lack of high quality specimens available for students to observe, and many students today have ethical concerns about killing organisms solely to study them. There is thus an obvious need for the development of virtual teaching collections for natural science education. Such collections would address all of these concerns, while providing students of all ages, all cultures, and from many differing geographic regions access to high quality digital images of quality biological specimens for viewing on their computer. In addition, the proposed virtual collection would not only show students which morphological characters are useful in the classification of each organism in the collection, but would also provide classroom and on-line instructors with testing materials.

Deliverables Supported Entirely or in Part by this Grant

In order to create a virtual teaching collection prototype, we have developed “The Invisible Invertebrate World” for K-12 students, specifically focusing on (a) exposing students to the “invisible” biodiversity of the invertebrate world around them, an introduction to the major

invertebrate lineages, (b) presenting differences in morphology that help group them taxonomically, and (c) exposing students to an array of invertebrate lifestyles through highlighting the habitats and feeding modes of each invertebrate pictured on the deliverable. The “Invisible Invertebrate World” virtual collection consists of 360° rotateable 3-D images of 20 specimens, representing 9 phyla and 16 classes (from sponges to Chordates), along with high resolution images on 48 “pop-up” screens showing the characteristics that group these organisms into the classification scheme currently being used by zoologists. Each copy of “The Invisible Invertebrate World” is burned to a CD and will be available in both English and Spanish.

Leveraging of and/or Cost Sharing of SNRE Funds

Our ultimate goal is to use “The Invisible Invertebrate World” virtual collection as a prototype deliverable for a much larger project, “The Virtual Insect Collection.” We will submit a Higher Education Challenge Grant proposal (due January 2007) to fund the construction of a virtual insect collection, which will greatly enhance the teaching of entomology and has already created much interest among both instructors and students alike, across multiple programs.

Five public primary and secondary schools in the Gainesville area (Trenton Elementary, Trenton, Fla; Terwilliger Elementary, Gainesville, Fla; Lincoln Middle School, Gainesville, Fla; Talbot Elementary School, Gainesville, Fla; Littlewood Elementary, Gainesville, Fla.) have participated in outreach activities provided by our department (Entomology) in the past. Each of these schools has communicated interest in receiving additional materials, activities, and presentations relating to life science and entomology. These five schools will be the first to receive CD copies of “The Invisible Invertebrate World.” The expected delivery date of this material is mid-October 2005, for the use in teaching life science in the fall of 2005. We will be asking instructors who incorporate the virtual collection into their class to evaluate its use as a teaching device and to report suggestions for its use in the classroom across various grade levels. Standardized evaluation forms are currently being produced.

I believe that the production and evaluation of a prototype virtual teaching collection such as ours will make us competitive for garnering funds like those awarded through Higher Education Challenge Grants.

New Projects Resulting from this Grant

A new project that we hope will result from our virtual invertebrate collection is the construction of a virtual insect collection that accurately and effectively covers the known diversity of the Class Insecta (all the described orders and many of the families common to the United States), as well as detailed high resolution photographs of the morphological characters that are used to distinguish them. Wouldn't it be wonderful if a student studying the natural sciences could have a comprehensive virtual collection right on their laptop computer or pocket PC as a resource for learning wherever they are.

2. Growth Management, Sustainability, and Community Well-Being in Rural Florida: A Pilot Study

Project Leader(s): M.A. Brennan, Family, Youth, and Community Sciences

Collaborators: Jade Marcus, Amanda Holzworth, Brianne McCarthy, Gloria Curry, M. Swisher, and T. Stein, Family, Youth, and Community Sciences

Executive Summary

This pilot study was designed to explore the real and perceived impacts of growth pressure on rural community well-being and to look at ways in which local communities can positively contribute to sustainable/responsible natural resource usage and planning. To achieve this goal, case studies of four Florida communities facing growth pressures were conducted. These case studies consisted of a mixed methods research framework and provide a clear overview of factors shaping community well-being and local responses to increasing growth. A variety of issues were identified through this research. Among the most pressing that were noted by local informants were as follows: (1) a need for infrastructure to grow at rate of growth, includes water, roads, schools, community services, waste management, mass transit; (2) a need for increased affordable/workforce housing; (3) a need for local wages to increase due to increasing cost of living; (4) a need to consider and manage the environmental effects (land, animals, waterways) of growth and development; (5) need for preservation, ‘smart growth’, conservation, and sustainable efforts to balance growth and natural resource demands; and (6) a need for a broad based community contribution to planning, regulation, and development.

Research and/or Outreach/Extension Needs

The data collected from key informant interviews confirmed and enhanced the descriptive statistics gathered prior to fieldwork. Interviews shed light on the complexity and variety of issues facing the four counties. While all locations had their own unique issues, there were several common facts related to growth that emerged. Summarizing, the most prevalent issues identified were:

- the need for infrastructure expansion at rate of growth, which includes water management, roads, schools, community services, waste management and mass transit;
- the need for affordable/workforce housing;
- the need to increase jobs and wages to match increasing cost of living;
- the need to mitigate environmental effects on land, animals and waterways; and
- the need to moderate the ongoing debate between preservation (“smart growth”) and conservation.

Extramural Proposal(s) Submitted and Status

A proposal was submitted to the USDA National Research Initiative (NRI) program in February, with a proposed budget of \$159,000. A decision will be made in June/July of 2006.

Deliverables Supported Entirely or in Part by this Grant

Several deliverables are in process. Included are one article to be submitted for refereed journal publication and two EDIS extension publications.

The possibility also exists for several presentations/workshops to be conducted in St. Johns County.

Impacts/Outcomes

This pilot study provided a detailed insight into the county level responses to growth pressures in four Florida locations that are representative of the diversity within the state. Included were a greater understanding of predominant concerns, needs, and issues facing Florida communities. Also included is a better understanding of the role that local groups, citizen coalitions, and others can play in enhancing local decision making.

From these findings, extension agents and local officials will be provided with a better understanding of local concerns and capacities for self-help development strategies. This information will serve to enhance existing extension training/outreach materials, local planning, and other efforts designed to foster sustainable development.

This pilot study will also set the stage for more in-depth research which will assess a wider range of public voices. Included are county or community wide surveys of local residents to determine their interests, concerns, and issues related to local well-being.

New Projects Resulting from this Grant

Meetings have taken place in St. Johns County, and plans are under way to explore possible uses of this data and to develop large-scale research projects based on these findings in St. Johns and St. Lucie counties.

3. Seed Predation and Herbivory in Neotropical Savannas: Are There Demographic Consequences for Plants?

Project Leader(s): Emilio M. Bruna, Wildlife Ecology and Conservation and The Center for Latin American Studies

Collaborators: Heraldo Vasconcelos and Glein Monteiro de Araújo Institute of Biology, Universidade Federal de Uberlândia, Brazil

Executive Summary

We are conducting the first comprehensive investigation of how top-down effects, specifically granivory and herbivory, interact with variation in soil fertility to influence plant community structure in Neotropical savannas. We used funding from the SNRE New Faculty Support Program to conduct preliminary surveys of small mammal abundance and diversity at the Panga Ecological Reserve, a 409 ha reserve of *Cerrado* in south-central Brazil administered by the University Federal de Uberlândia. To date, in 16,480 trap nights we captured a total of 53 individuals from 4 putative genera (identification currently in progress). These ongoing collection efforts, in concert with seed removal experiments conducted by one of our students, led us to tentatively conclude that small mammals are found at low abundance in our field sites and are exerting limited seed predation pressure. Instead, leaf-cutter ants (*Atta* sp.) appear to be the principal seed predators.

Research and/or Outreach/Extension Needs

Savannas are one of the most widespread ecosystems in the tropics, occupying 65% of Africa, 60% of Australia, and 45% of South America. Throughout much of South America the savanna biome is called the *Cerrado*, and at 2 million km² it is second only to Amazonia in total land area. It is also one of the most threatened ecosystems in South America, due in part to habitat fragmentation, agricultural conversion, and the alteration of fire regimes.

A fundamental goal of ecological research is disentangling the factors that structure plant communities. One of the principal paradigms that has been used to address this question is “top-down vs. bottom-up,” in which primary control is thought to be exerted either by resources (i.e., bottom-up) or consumers of plants and their predators (i.e., top-down). Decades of research have demonstrated that plant communities in African and Asian savannas are regulated by a combination of pervasive top-down and bottom-up effects. In contrast, simultaneous investigations of top-down and bottom-up drivers have rarely been conducted in the *Cerrado*. As a result, little is known regarding the relative importance of different mechanisms that structure these diverse and threatened plant communities. These data are needed for the development of effective conservation and management plans.

Deliverables Supported Entirely or in Part by this Grant

Grant proposal funded by the National Science Foundation:

“U.S.-Brazil Collaborative Research: Seed predation and herbivory in Neotropical savannas:

Are there demographic consequences for plants?" (Grant OISE-0437369; \$25,012 funded of requested \$36,225).

Collaborative agreement between UF-IFAS-WEC and the Institute of Biology, Universidade Federal of Uberlândia:

The objective of this collaborative agreement is to provide opportunities for international scholarship related to the ecology and conservation of Neotropical ecosystems. Additional information is available at <http://international.ifas.ufl.edu/coopuuberlandia.html>

Contributed poster presentation at the 2005 Meeting of the Association for Tropical Biology and Conservation (Uberlândia, Brazil):

Ferreira, A. V., H. L. Vasconcelos, and E. M. Bruna. "Granivory by ants, rodents, and birds in a woodland savanna (*cerrado*) in central Brazil."

Provided complete or partial support to five undergraduate research interns from the Universidade Federal de Uberlândia (Alana Vaz Ferreira, Alan Nilo da Costa, Cauê Thomé Lopes, Polyanna Custódio Duarte, Estefane Leoncini Siqueria).

New Projects Resulting from this Grant

Observations during field work led to the development of a new project investigating the consequences of anthropogenic nitrogen deposition on Cerrado plant demography and ecosystem ecology. This new research project is the subject of a proposal currently under review by NSF's Minority Career Advancement Award Program ("Linking ecosystem and population ecology: How does nitrogen deposition influence plant demography in Neotropical savannas?" E. Bruna PI; \$174, 499).

4. The Role of Soil Nitrogen in Plant Litter Decomposition

Project Leader(s): Michelle C. Mack, Botany

Collaborators: Paul Grogan, Queen's University, Canada; and Syndonia Bret Harte, University of Alaska, Fairbanks

Executive Summary

Although soil and plant litter nitrogen (N) concentrations are often invoked as controls over litter decomposition rates, we have a relatively limited understanding of the gross N cycling mechanisms that determine the relationship between N availability and decomposition rates. Funds from this grant supported the initiation of a study to test a new method for tracking gross N fluxes between decomposing plant litter and soil using enriched and natural abundance N isotope tracers. Initial results suggest that this method produces a mass balance of N fluxes, and thus has potential for addressing the controlling role of gross N fluxes in plant litter decomposition. Initial planning from this study was used to write a larger proposal subsequently funded by NSF.

Research and/or Outreach/Extension Needs

Soil nitrogen (N) availability controls the decomposition of plant litter in two ways. First, it affects the quality or relative decomposability of litter through effects on plant growth and allocation. Second, it may directly limit the activity of decomposers. Because the carbon (C) to N ratio of litter is usually higher than that of bacteria and fungi, these decomposers must immobilize N from the soil solution in order to use C in plant litter for metabolic activity and growth. Although the latter observation has been used to support the idea that increases in soil N availability should increase rates of decomposition, studies where N has been directly added to litter have produced variable and often contradictory results.

Interpretation of these results has been hampered by the difficulty of measuring N immobilization onto decomposing litter. Most studies have measured the net loss of N from litter over time, which confounds two concurrent processes: the release of plant N from litter to the soil, and the uptake of soil N onto litter. Measurements of N immobilization may be crucial to predicting when and where soil nutrients limit decomposer activity, and to understanding the relative importance of litter quality and soil N availability for litter decomposition.

My general objective is to develop a mechanistic understanding of how interactions between soil available N and plant litter quality affect decomposition. With the requested funding, I began a pilot experiment to test a novel method for measuring total N immobilization and loss during decomposition. Leaf litter from four plant species varying in quality and experimentally enriched in ¹⁵N are currently decomposing in the Natural Areas Teaching Lab at the University of Florida. Tracing the dilution of leaf litter N isotope ratios over time will enable measurement of the total amount of plant N lost from litter, and estimation of the amount of soil N immobilized onto litter as it decomposes. I collected the first time point from this experiment in August 2005. Initial results show that I can effectively calculate N mass balance with this technique. There are five more sampling times for this experiment, which will end in May 2006.

New Projects Resulting from this Grant

In January 2005, I submitted a proposal to NSF Division of Environmental Biology that included this technique, titled “Collaborative research on snow-shrub interactions in Alaskan and Canadian tundra and their potential for positive feedbacks to vegetation and climate change.” This proposal was funded for \$195,966 in May 2005 (NSF DEB 0516041).

5. An Investigation of Anthropogenic Soils in the Upper Amazon: Stratigraphic and Temporal Variability and Cultural Context

Project Leader(s): Augusto Oyuela-Caycedo, Anthropology

Collaborators: Andrew Zimmerman, Cultura Nacional del Peru; Gino Ceccarelli Pinedo, Regional Instituto Nacional de Cultura of Iquitos; Renee Bonzani, University of Kentucky. The director of the graduate program of the Universidad de la Amazonia Peruana (UNAP) has been working on the development of a master's degree program on protected areas in collaboration with the TCD. This collaboration will make feasible the logistic Geology; Santiago Rivas and Monica Panaifo, Instituto de support needed by the school of graduate studies of the UNAP in the future.

Executive Summary

The funding was used in the preliminary stage of a long-term project on the origins and formation processes of black soils (*terra pretas*) in the archaeological past of the Upper Amazon Basin. A preliminary survey was conducted on the road from Iquitos to Nauta, Peru, which allowed for the identification of multiple sites with dark earths. The fieldwork was conducted during the months of June and July of 2005. The survey resulted in the location of several sites of interest in understanding the formation and context of *terra pretas*. Coring and test cut excavation was performed in one of these sites that will undergo further study. In upcoming fieldwork, we will focus on a more intensive examination of the variation of human occupation and impact on the environment in the Upper Amazon. The archaeological site was named Quistococha or LQ-001. This is the first site located in the Upper Amazon with human occupation associated to *terra pretas*. It is also the first evidence of a new culture previously unknown in the Amazonian basin. The excavations conducted give evidence of pottery and carbonized botanical remains that are in the process of classification. The tentative identifications include fragments of avocado (cf. *Persea* sp., Lauraceae), of aHai (cf. *Euterpe* sp., Palmae), and of milpe-sillo (cf. *Oenocarpus* sp., Palmae). The avocado remains are the first hard evidence of its introduction and cultivation in the Amazon in the context of *terra pretas*. The soils are currently under study. Four radiocarbon dates fix the occupation of the site between 500 BC and 700 AD, indicative of the earliest human occupation in this part of the Upper Amazon discovered up to now.

Research and/or Outreach/Extension Needs

This first phase of the project facilitated the development of network connections with the Universidad de la Amazonia Peruana (UNAP) and the Instituto Nacional de Cultura (INC). We are now in the process of an agreement of collaboration with both institutions to develop long term and interdisciplinary research to study the historical ecology of the area between Iquitos and Nauta, where evidence of *terra pretas* was found. The next stage of this project is the excavation of the area of Quistococha. Excavation will be conducted in area e and a detailed study of the soil variation and use of the *terra pretas* will be completed. In order to do this we hope to be able to count on the collaboration of the UNAP and the INC. As part of this collaboration with UF, a

summer field school (six weeks, May – June 2007) is being developed to train undergraduate students in archaeology with the purpose of giving them experience in working in the tropical forest of the Amazon. It will be helpful to conduct this field school with the support of SNRE and the Department of Anthropology.

Deliverables Supported Entirely or in Part by this Grant

An article was submitted for publication in collaboration with the Peruvian archaeologists to a journal published by the Universidad de San Marco. The article's first authors are the Peruvian archaeologists. This order of authorship was done in the spirit of reinforcing the institutional collaboration with Peru. I am in the process of preparing a proposal for National Geographic and NSF with the results derived from the research. A paper on the research was also accepted and will be presented at the Society for American Archaeology Annual Meetings in Puerto Rico (April 2006). Another paper on the *terra pretas* will be presented at the symposium of dark earths in July of 2007 in collaboration with a graduate student from Geology, Pamela Hartman, who is analyzing the soils under the supervision of Dr. Zimmerman.

The research results also generated a preliminary report that has been submitted by our Peruvian collaborators to the INC for the registration of the archaeological site of Quistococha as national patrimony of Peru. This nomination is based on its significance in terms of being the first archaeological site reported in that part of the Amazon with associations to *terra pretas*. This registration will enforce the legal protection of the site allowing for its future intensive research.

Leveraging and/or Cost Sharing of SNRE Funds

The research costs were also covered by a supplementary humanities enhancement grant obtained from the College of Liberal Arts and Sciences to support the PI.

New Projects Resulting from this Grant

In the summer of 2007, a field school in Quistococha will be held. Collaborative research on the relationship between climate change and the formation of *terra pretas* will occur. Continuation of the survey of the region between Iquitos and Nauta will be accomplished with support from NSF and the National Geographic Society.

December 7, 2005



General view of Quistococha



The site of Quistococha



Profile of terra preta Quistococha

6. Increased Productivity of Forest Plantations to Conserve Native Forests

Project Leader(s): Gary Peter, School of Forest Resources and Conservation

Collaborators: M. Kirst, and T. Martin, School of Forest Resources and Conservation; Jerry Tuskan and Steve Difazio, Oak Ridge National Laboratory

Executive Summary

The project funds supported two separate areas of research. First was my week long trip to help annotate the Poplar genome at the DOE's Joint Genomes Institute (JGI). This trip should lead to my being an author on the genome sequence publication. Also it better positioned me to apply for funds to work on poplar trees, something I had not previously done. A proposal was submitted and awarded to research carbon allocation and partitioning in poplars. Moreover, the tools for genome analysis that I learned about at the JGI have helped me begin new bioinformatic approaches to the study of the vascular cambium. The second area of research supported by this award was the measurement of standing tree stiffness in breeding populations of slash pine established by the UF cooperative forest genetics research program. This work is currently being written for publication.

Research and/or Outreach/Extension Needs

To meet growing demands for wood from a declining forest land base the productivity of select intensively managed planted forests will need to continue to increase. The forests in the US south already produce more industrial wood than any other country in the world, in large part because forest productivity research has been implemented effectively across large areas in the region. While farming or silvicultural practices and genetic improvement have both been responsible for large advances in productivity, gains from silvicultural research are starting to slow, in part due to their cost. Genetic improvement efforts on the other hand are in their infancy and hold great potential to substantially increase productivity of forest lands. For example, accelerating growth rates will shorten rotation ages permitting smaller land areas to sustainably meet growing demand. Tailoring trees to specific applications such as solidwood, pulp, paper, and bioenergy will further enhance productivity.

Deliverables Supported Entirely or in Part by this Grant

- Grant proposals funded
 - Consortium for Plant Biotechnology Research/Genes for Improved Wood Quality PI: G. Peter (requested \$230,000; funded for two years \$206,000 total).
 - DOE: Office of Science/ Genomic Mechanisms of Carbon Allocation and Partitioning in Poplar PI: M. Kirst, Co-PI's T. Martin, G. Peter (fully funded for three years for \$1.09 million total).

- Refereed and non-refereed publications
 - Complete Sequence and Annotation of the Poplar Genome (in preparation), Breeding for Improved Growth and Corewood Stiffness in Slash Pine (submitted)

Leveraging and/or Cost Sharing of SNRE Funds

IFAS 0.1 FTE & CALS-Undergraduate summer internship program

New Projects Resulting from this Grant

DOE: Office of Science/Genomic Mechanisms of Carbon Allocation and Partitioning in Poplar
PI: M. Kirst, Co-PI's T. Martin, G. Peter

CFGRP: In Tree Methods for Selection of Pine Germplasm with Superior Stiffness for Solidwood Products

7. The Age of Carbon Fluxes from Arctic Tundra: Detecting Ecosystem Change with a Geochemical Tool

Project Leader(s): Ted Schuur, Botany

Collaborators: James Sickman, Soil and Water Science; Jason Vogel, Koushik Dutta, Hanna Lee, and Laura Gutierrez, Botany

Executive Summary

Up to 450 Pg of soil carbon (C) has accumulated in high latitude ecosystems after the retreat of the last major ice sheets. This soil C has until now been protected from decomposition in part by cold temperatures, waterlogging, and permafrost. Climate models predict that with increasing atmospheric CO₂ concentrations the strongest warming will occur in high latitude ecosystems, and direct evidence suggests that the warming has begun. Recent studies also suggest that these ecosystems may no longer be accumulating C, and in some cases may be losing stored C to the atmosphere. However, we do not know if observed net C flux to the atmosphere represents the loss of recently fixed C or loss of these large old Holocene C stores. Sustained and significant transfers of C to the atmosphere that could cause a significant positive feedback to climate change must come from old C, which forms the bulk of the soil pool. Radiocarbon ($\Delta^{14}\text{C}$) measurements of ecosystem respiration now provide the means to address these uncertainties. We asked the question: “*Is old C that comprises the bulk of the soil organic matter pool released in response to thawing of permafrost?*” We addressed this question by using a combination of field and laboratory experiments to measure ¹⁴C/¹²C isotope ratios in soil organic matter (SOM) soil respiration, and dissolved organic carbon (DOC) in tundra ecosystems. The objective of these proposed measurements was to develop a mechanistic understanding of the SOM sources contributing to C losses following permafrost thawing. We used a tundra field site near Healy, Alaska in the foothills of the Alaska Range. Field measurements centered on a natural experiment where permafrost has been observed to warm and melt over the past several decades. This area represented a gradient of sites each with a different degree of change due to permafrost thawing. As such, this area is unique for addressing questions at the time and spatial scales relevant for change in arctic ecosystems. We used this natural gradient as a case study of the effect of permafrost thawing on the release of old soil C, and quantified fluxes and isotopic composition of CO₂ respired and leached from this ecosystem. In summary, high latitude soils may act as a significant positive feedback to climate change if the old C that forms the bulk of the soil pool is respired to the atmosphere following permafrost thaw. This old C, when lost to the atmosphere, is detectable in the $\Delta^{14}\text{C}$ of CO₂ respired from the ecosystem.

Research and/or Outreach/Extension Needs

Up to 450 Pg (billion tons) of soil carbon (C) has accumulated in high latitude ecosystems after the retreat of the last major ice sheets. This soil C has until now been protected from decomposition in part by cold temperatures and permafrost. Climate models predict that with increasing atmospheric CO₂ concentrations the strongest warming will occur in high latitude ecosystems, and direct evidence suggests that the warming and permafrost melting has already begun. Changes in these northern latitude C pools have been hypothesized as one of the most

likely positive feedbacks between ecosystems and the atmosphere that will act to quickly accelerate global climate change in the near future. Climate change and positive feedbacks to the global carbon cycle are critically important national and international issues.

Deliverables Supported Entirely or in Part by this Grant

The data generated by this grant was used to produce as preliminary data for a full research proposal, for publications, and for presentations.

- Submitted Grants
See below.
- Published Abstracts
Vogel, J.G., E.A.G. Schuur, and G. Crummer. 2005. Permafrost thawing and vegetation change: Impacts on the carbon dynamics of arctic tundra. *Bulletin of the Ecological Society of America*.

Schuur, E.A.G., K. Dutta, and J.G. Vogel. 2004. Permafrost melting and the age of carbon respired from arctic tundra. American Geophysical Union meetings.
- Other Presentations
Ecology Group Meeting, Department of Botany, January 2005
- Peer Reviewed Papers
Schuur, E.A.G., K.G. Crummer, J.G. Vogel, and M.C. Mack. Plant productivity and biomass in areas of permafrost thawing. In preparation.

Schuur, E.A.G., J.G. Vogel, K. Dutta. Ecosystem respiration of old carbon from tussock tundra in response to climate change. In preparation.

Leveraging and/or Cost Sharing of SNRE Funds

This SNRE New Faculty Support Grant was leveraged by three grants:

2004-2005 NSF Geosciences Carbon Cycle: “REU Supplement: “Collaborative Research: Climate Controls Over Ecosystem Respiration: Using Isotopes to Determine the Sources and Age of Respired Carbon” \$5,000; PI: Schuur (UF).

2004-2006 NSF Division of Environmental Biology Long Term Ecological Research Program “Alaska’s Changing Boreal Forest: Resilience and Vulnerability: 2004 Bonanza Creek LTER Renewal Proposal” \$10,000 (UF budget); co-PI Schuur (UF).

2002-2005 NASA New Investigator Award: “The Response of Soil Carbon to Permafrost Melting in High Latitude Ecosystems: Using Radiocarbon to Detect the Effects of Climate Change” \$358,000; PI: Schuur (UF)

New Projects Resulting from this Grant

This SNRE New Faculty Support Grant contributed to two new proposals that were funded:

2005-2008 NSF DEB Ecosystems: “The Carbon Balance of Arctic Tundra in Response to Permafrost Thawing: Using Radiocarbon to Detect the Loss of Old Carbon” \$550,000; PI: Schuur (UF), co-PI: Sickman (UF).

2005-2006 US National Parks: “Development of Monitoring Techniques to Detect Change in Carbon Cycling in Relation to Thermokarst in National Parks and Preserves” \$11,750 (UF budget); PI: Schuur (UF).

8. Interactions among Protected Areas, Agricultural Change, and Biodiversity in East Africa

Project Leader(s): Jane Southworth, Geography and Land Use and Environmental Change Institute (LUECI)

Collaborators: A. Goldman and M. Binford, Geography; C. Chapman and L. Chapman, Zoology, McGill University; T. McCabe, Anthropology, University of Colorado; and P. Leslie, Anthropology, University of North Carolina Chapel Hill.

Executive Summary

Protected areas, including parks, remain the main mode of purposeful biodiversity conservation in most of the world today. Surrounding these areas throughout the developing world are landscapes that, while still containing considerable biodiversity, also have rapidly growing human populations. The domesticated portions of these landscapes are zones of dynamic change in demography, land use, and land cover, and are characterized by biological and socio-political risks not usually found elsewhere. In most of these areas, agriculture is already or is rapidly becoming the main land use. The interactions between agriculture and biodiversity – often viewed with mutual enmity by researchers and proponents of each – are particularly intense in East Africa, where agriculture remains the predominant livelihood activity, while population growth rates have been among the highest in the world, and the number and extent of protected areas has been increasing, driven by national and international interest groups. In East Africa and elsewhere, the areas surrounding parks comprise an extremely important, but inadequately studied, category of landscapes in which the interactions among protected areas, agricultural systems, and biodiversity are critical to the future of all three. This proposed research will be undertaken in an area surrounding a park in western Uganda, Kibale National Park, and will be linked into research being undertaken in northern Tanzania, in Tarangire National Park. Kibale National Park (KNP, 766 km²), located in western Uganda near the foothills of the Ruwenzori Mountains, is one of few remaining mid-altitude rain forests in East Africa, and it represents one of the best studied forest sites in Africa. Although primarily forested, the park includes woodlands, savannas, and wetlands. The range of habitats in the park, as well as intermittent historic human occupation and alteration of land cover have also affected the park's ecological diversity; however, little to no research has taken place beyond the park's borders.

This research is designed as an interdisciplinary collaboration among social, biological, and physical scientists from the U.S. and these two countries, of which I was a part of. The study focuses on two interrelated research issues: (1) how does the presence of a park affect the land use and livelihoods of people surrounding the park; and (2) how do the extent, pattern, and type of agricultural land use affect biodiversity in areas surrounding the parks? These interactions will be examined at present and with respect to land cover change over the past 25 years through social science research, biological sampling, and analysis of satellite imagery. I am leading the satellite imagery analysis. This is one of few studies designed from the outset as a comparative multi-site and interdisciplinary examination of interactions of changing land use with the presence of protected areas and wild biodiversity in human-managed landscapes. The

comparisons among sites will be important in assessing both the generalizability of relationships identified at any one site and the validity of the two broad propositions listed above. In order to apply for and obtain such funding initial analysis must be conducted to prove the validity and feasibility of such a study. This is what I did with this SNRE New Faculty Support Grant, in terms of summer data collection. I will be presenting initial results in Germany in October at a human dimension (IHDP) conference, and our first group research paper should be submitted by December of this year, addressing landscape level changes in land cover and land use, along with patterns of fragmentation in the landscape surrounding the park, 1985-2005 (Southworth lead author).

Deliverables Supported Entirely or in Part by this Grant

- Presentations
 - International Human Dimensions Program (IHDP) Meeting, Bonn, Germany, October 2005:

I am an organizer of a panel session on the use of remote sensing in human dimensions research. I will be presenting preliminary results from summer 2005: “Footsteps on the land: detecting and analyzing change within a continuous landscape framework in and around Kibale National Park, Uganda.” Authors: Southworth, Jane, M. Binford, A. Goldman, E. Binford, C. Chapman, L. Chapman, J. Hartter
 - AAGs March 2006:

I am the organizer of multiple sessions on the theme of “Linking Social and Ecological Research,” and will be presenting my Africa research from Summer 2005 here on the use of *Superpixels* as linking agents (to be submitted Oct. 13).
 - Two seminars on campus will be given this fall on the topic of my summer research, one to SNRE and one to Botany.
- Research Papers
 - Research Papers in Progress (2)
 1. Land Cover, Land Use Change, and Landscape Fragmentation in and around Kibale National Park Uganda. Authors: Southworth et al., to be submitted to GeoForum by December 2005.
 2. Changes in forest biomass and quality within Kibale National Park: Implications of continuous versus discrete approaches to land change science. Authors: Joel Harrter, Jane Southworth et al., Submission Spring 2006 to IJRS or Applied Geography.

New Projects Resulting from this Grant

NSF - Resubmission for more money on this same topic. We had initial budget cuts by NSF of 60% so it really became a small grant. We will now try to complete the topics initially planned and add new areas we had not considered before. Due date: January 15, 2006, Geography & Regional Science Program, NSF. PI, Dr. Abe Goldman; Co-PI, Jane Southworth.

New submission to NOAA, NASA, or NSF Climate Program looking at shifting climate patterns and implications for the future survival of the park. The park is completely islandized; therefore, climate change (already in evidence) will have severe ramifications for species present and for the future of this park. PI, Jane Southworth; Co-PI's, Lauren and Colin Chapman and Dr. Mike Binford. Target submission: Spring 2006.

9. Belizean Maya Medicinal Plant Ethnoecology

Project Leader(s): Richard Stepp, Anthropology

Collaborators: Filibero Penados, Tumul K'in Center of Learning, Blue Creek, Belize; and Dawn Dean, Maya Mountain Research Center, University of Belize

Executive Summary

This SNRE New Faculty Support Grant funded preliminary research on the relationship between cultural knowledge and use of medicinal plants in relation to the biophysical environment and in a comparative perspective. The research took place in Southern Belize with Mopan and Q'eqchi' Maya communities. Approximately 16,000 Mopan and Q'eqchi' Maya inhabit the region (GOB 2001). Many communities have high rates of monolingual Mayan speakers, generally ranging from 40-80% of the population (TMCC 1997). The two Mayan sociolinguistic groups live in similar environments, although the Mopan tend to live at slightly higher elevation. Likewise, subsistence practices are similar. Yet the two languages are not mutually intelligible. Southern Belize, until recently, has experienced little economic development and remained relatively isolated. The recent paving of a highway from the capital to the Toledo district center of Punta Gorda is rapidly accelerating processes of change. Despite recent changes, however, the plant diversity of Southern Belize remains high, comprising at least 3,400 species of vascular plants (Balick et al. 2000). A substantial amount of this flora is employed for medicinal uses by the Mopan and Q'eqchi' Maya. The work led to the first stage of a comprehensive database that will allow long-term research and follow up to track processes of ethnobotanical loss and persistence. Also, the development of this comprehensive database allows for cross-cultural comparison over time.

Research and/or Outreach/Extension Needs

The World Health Organization estimates that two-thirds of the world's populations rely on plant based medicines for their primary health care (Farnsworth et al 1985). However, to date there are relatively few *comprehensive* studies of medical ethnofloras. As a result, there has been little research on the interaction between cultural knowledge and use of medicinal plants in relation to the biophysical environment and in a comparative perspective. By placing medical ethnobotany within both an ecological and comparative framework it becomes possible to relate botanical knowledge (ethnobotany) to ecological knowledge (ethnoecology). Ethnoecology is an interdisciplinary sub-field of anthropology that looks at indigenous cognitive perceptions of divisions in the biological world and how human behavior relates to these perceptions (Frechione, Posey and Da Silva 1989). This approach allows for a fuller understanding of human-environmental relations by contextualizing human behavior within local perceptions of the environments.

There are also significant applied aspects of the research. The research will provide data that might be used to suggest improved management of the resource in the context of increasing development and change in Southern Belize. It also has the potential to make recommendations to governmental and non-governmental organizations working on sustainable resource

initiatives. Because the vast majority of the world's population is reliant on plant based medicines (Farnsworth et al. 1985), it is crucial to understand the cultural relationships with these resources. This will help to ensure the continued survival of local healing practices. Medicinal plant conservation is a relatively new endeavor (Sheldon, Balick and Laird 1997). Up until 1960 only a single plant species was known to have gone extinct due to human action. However, today over 20,000 plant species are endangered (Wilson 1993, Tyler 1996). This does not include the number of plants in danger of local extirpation, a problem that has widespread implications for local peoples reliant on traditional plant medicine for their primary health care.

Finally, social scientists interested in environmental knowledge are concerned that much of this knowledge is rapidly changing or being lost (Nabhan 1998; Maffi 2001). Yet without baseline data we are forced to rely on anecdotal evidence. Creating a comprehensive database will allow long-term research and follow up to track processes of ethnobotanical loss and persistence. Also, the development of a comprehensive database and a standardized methodology allows for cross-cultural comparison.

Deliverables Supported Entirely or in Part by this Grant

- Extramural Funding and Deliverables

pending NSF CAREER-“Comparative Ethnobotany of the Mopan and Q'eqchi' Maya to Build Theory and Method in Research and Education”: PI \$458,150

funded National Science Foundation BCS-0529888 \$ 24,987
 “Exploratory Research On Medical Ethnobotany of the Mopan and Q'eqchi' Maya”: PI

- Conference Presentations

Stepp, J.R. 2005. Global and Regional Assessment of Biocultural Diversity through GIS. Annual Meetings of the Society for Economic Botany. Ft. Worth, Texas. 6/7/05.

Stepp, J.R. and L. Maffi. 2005. Gaps and Needs in Biocultural Diversity Research Workshop. Gainesville, Fla. 4/21-4/22.

- Research Articles in Progress

Stepp, J.R. Highland Maya Medicinal Plant Habitat Preferences. *Human Organization*.

Stepp, J.R. Reported Distribution of Tzeltal Medicinal Plants. *Economic Botany*.

Stepp, J.R. Non-use of Primary Forest for Medicinal Plants by Highland Maya. *Conservation Biology*.

Stepp, J.R. Tzeltal Maya Ethnoepidemiology. *Medical Anthropology Quarterly*.

Stepp, J.R. Botanical Ethnography of the Most Utilized Highland Maya Medicinal Plants. *Journal of Ethnobiology and Ethnomedicine*.

New Projects Resulting from this Grant

This pilot research is expected to lead towards synergistic activities for long-term research and funding. Additionally, it will provide opportunities for SNRE graduate students to conduct research by developing contacts with local NGO's and communities. There are currently two SNRE MS students conducting research in Belize. Since the conclusion of the project, I received funding from the National Science Foundation to continue the work. I am also exploring the possibility of receiving funding from a private foundation.

10. An Investigation of Peruvian Black Soil (*Terra preta*): Chemical Variability and Mechanisms of Organic Carbon Preservation

Project Leader(s): Andrew R. Zimmerman, Geological Sciences

Collaborators: Augusto Oyuela-Caycedo, Anthropology

Executive Summary

'*Terra preta*' or 'black earths' are small areas of fertile anthropogenic soils found within the Amazon watershed and possibly other tropical regions. While surrounded by soils generally too infertile to support agriculture, terra preta are rich in organic matter and other nutrients and can be sustainably cultivated. Thus far, these soils have mainly been identified in the Brazilian Amazon.

With support wholly from the SNRE (New Faculty Support Grant), the PI's traveled to Iquitos, Peru in July 2005 and located, characterized, and collected new black soil formations. Fifty individual samples were collected from four vertical soil profiles with dark earth strata, from a horizontal transect of soils from Iquitos to Nauta (40 km), and from Lake Quistacocha. These samples were collected in duplicate and both shipped and hand-carried to Gainesville. These findings expand the geographic and cultural range of *terra preta* that have been examined.

The terra preta formations, themselves, are within two stratigraphical horizons within a quartz sand terrace, and have abundant ceramic materials of a unique anthropological origin. They have been ¹⁴C dated as calendar age BCE 547 to AD 780 (Cal BP 2497 to 1433) and are some of the oldest anthropological materials found in the Eastern Amazon.

Chemical and physical analysis of the soils is still in early stages. Early results indicate that organic carbon and nitrogen and nutrient elements (P, K, Ca) are present in concentrations higher than surrounding soils, but are quite low compared to terra preta found in other locations. Analysis of abundant charcoal fragments found within the soils is also beginning. Early results indicate the presence of nanopores, which may be linked to organic matter preservation in these soils and related to the soils' fertility. A graduate student has recently been recruited (through SNRE) to continue initial data collection and will be involved in proposal preparation.

Research and/or Outreach/Extension Needs

While in Iquitos, we had meetings with members of the Instituto Nacional de Cultura (Gino Ceccarelli Berdales) and the biology faculty (Roberto Pezo Diaz, Dr. James Albert and Dr. Logio Verdi Olivares) and dean (Dr. Janeth Braga Vela) of Universidad Nacional de la Amazonia Peruana (UNAP). Letters of collaboration agreement were drawn up between these parties.

This research will help to build the academic relationships between the University of Florida and the Universidad Nacional de la Amazonia Peruana (UNAP), Iquitos. We want to expand the collaboration to help enhance the human resource capacity of the UNAP through educational training beyond the undergraduate formation. We hope to be able to offer two Peruvian scien-

tists (Freddy Espinoza Campos, a microbiologist and Santiago Rivas, an anthropologist) fellowships to attend graduate school at UF to work on various aspects of this project. In addition, the utilization of ancient *terra preta* soils or the generation of new *terra preta* soils has the potential of significantly improving the relationship between human populations and the environment, thus lessening our impact on the Amazon basin.

Deliverables Supported Entirely or in Part by this Grant

The data generated by this grant will be used as preliminary data for a full research proposal, for publications, and for presentations.

- **Grant Proposals Submitted**

Collaborative Research: The geochemical signature of black carbon and its organic matter preservation potential. NSF Geobiology Program Investigators: Co-P.I's Zimmerman, A.R. and Mitra, S. (In preparation, estimated \$200,000).

An Inquiry into Black Soil (*Terra Preta*) Formation in the Upper Amazon River Drainage (Transect Nauta-Iquitos): An Anthropological and Geochemical Collaboration. Heinz grant program in Latin American archeology, \$8000 (over 1 year) Co-PI's: Oyuela-Caycedo A., Zimmerman A.R.

- **Published Abstracts**

Formation of Dark Earth Soils in Western Amazonia, Iquitos, Peru. A. Zimmerman and A. Oyuela-Caycedo, 18th World Congress of Soil Science, Philadelphia., Pa., July 9-15, 2006

- **Presentations**

An investigation of black soil (Terra preta) in Western Amazonia - Anthropological archaeology and geochemical initial results. UF-School of Natural Resources and the Environment seminar series. Feb. 7, 2006

Formation of Dark Earth Soils in Western Amazonia, Iquitos, Peru. A. Zimmerman and A. Oyuela-Caycedo, 18th World Congress of Soil Science, Philadelphia., Pa., July 9-15, 2006

- **Peer Reviewed Papers**

Santiago, R., Oyuela-Caycedo, A., and R. Zimmerman (submitted). The development of religion in relation to the changing environmental conditions of the northern Andes and the northwest Amazon. Boletn de Estudios Amazonicos of Universidad Nacional Mayor de San Marcos.