Annual Report for Period: 11/2002 - 11/2003
Submitted on: 11/14/2003
Principal Investigator: Gragson, Theodore L.
Award ID: 0218001
Organization: U of Georgia Res Fdn Inc
Title:
LTER: Consequences of Land Use Change in the Southern Appalachian Mountains

Project Participants

Senior Personnel

Name: Gragson, Theodore
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Vose, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kloeppel, Brian
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Benfield, Fred
Worked for more than 160 Hours: No
Contribution to Project:

Name: Bolstad, Paul
Worked for more than 160 Hours: No
Contribution to Project:

Name: Clark, James
Worked for more than 160 Hours: No
Contribution to Project:

Name: Clinton, Barrie
Worked for more than 160 Hours: No
Contribution to Project:

Name: Coleman, David
Worked for more than 160 Hours: No
Contribution to Project:

Name: Elliott, Katherine
Worked for more than 160 Hours: No
Contribution to Project:

Name: Grossman, Gary
Worked for more than 160 Hours: No
Contribution to Project:

Name: Haines, Bruce

Worked for more than 160 Hours: No
Contribution to Project:

Name: Helfman, Gene
Worked for more than 160 Hours: No
Contribution to Project:

Name: Hendrick, Ron
Worked for more than 160 Hours: No
Contribution to Project:

Name: Hunter, Mark
Worked for more than 160 Hours: No
Contribution to Project:

Name: Knoepp, Jennifer
Worked for more than 160 Hours: No
Contribution to Project:

Name: Leigh, David
Worked for more than 160 Hours: No
Contribution to Project:

Name: Newman, David
Worked for more than 160 Hours: No
Contribution to Project:

Name: Pearson, Scott
Worked for more than 160 Hours: No
Contribution to Project:

Name: Pringle, Catherine
Worked for more than 160 Hours: No
Contribution to Project:

Name: Pulliam, Ron
Worked for more than 160 Hours: No
Contribution to Project:

Name: Reynolds, Barbara
Worked for more than 160 Hours: No
Contribution to Project:

Name: Riedel, Mark
Worked for more than 160 Hours: No
Contribution to Project:

Name: Swank, Wayne
Worked for more than 160 Hours: No
Contribution to Project:

Name: Turner, Monica
Worked for more than 160 Hours: No
Contribution to Project:

Name: Wallace, Bruce
Worked for more than 160 Hours: No
Contribution to Project:

Name: Wear, David
Worked for more than 160 Hours: No
Contribution to Project:

Name: Webster, Jack
Worked for more than 160 Hours: No
Contribution to Project:

Post-doc

Name: Cho, Seong.Hoon
Worked for more than 160 Hours: Yes
Contribution to Project:
In workgroup with David Wear and David Newman, support is NSF and USFS.

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Collins, Barrie
Worked for more than 160 Hours: Yes
Contribution to Project:
Coweeta information managers

Name: Stiner, Susan
Worked for more than 160 Hours: Yes
Contribution to Project:
Field technician and Schoolyard LTER coordinator

Name: Deal, Jim
Worked for more than 160 Hours: Yes
Contribution to Project:
Coweeta Analytical Lab technician

Name: Harper, Carol
Worked for more than 160 Hours: Yes
Contribution to Project:
Coweeta Analytical Laboratory technician

Other Participant

Research Experience for Undergraduates

Name: Pinner, Davis

Worked for more than 160 Hours: Yes

Contribution to Project:

Worked with Dr. Katherine J. Elliott (Coweeta Hydrologic Laboratory) on dendroecological reconstruction of the disturbance history of Coweeta Basin.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Name: Keyes, Hunter

Worked for more than 160 Hours: Yes

Contribution to Project:

Worked with Dr. Mark Hunter (University of Georgia) on the ecosystem effects of the hemlock wooly adelgid in the southern Appalachian region.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Name: Marcus, Kenneth

Worked for more than 160 Hours: Yes

Contribution to Project:

Worked with Dr. Jennifer Knoepp (Coweeta Hydrologic Laboratory) on the nutrient content and bulk density determination of coarse woody debris in the Coweeta Basin.

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Organizational Partners

Virginia Polytechnic Institute and State University

Duke University

UNIVERSITY OF MINNESOTA

Mars Hill College

University of North Carolina at Asheville

University of Wisconsin-Madison

Other Collaborators or Contacts

Jack Webster: The Lotic Intersite Nitrogen eXperiment (NSF) is a collaborative study of nitrogen cycling in streams involving simulation modeling, field tracer (15N) additions, and intersite comparison. The principal contact is Pat Mulholland of Oak Ridge National Laboratory. Additional collaborators include Prof. Alan Hildrew, Queen Mary and Westfield College, London; Prof. Horton Hobbs, Whittenburg College, Ohio; and Linda Ashkenas and Dan Soboda, of Oregon State University. Full information on this research collaboration is available at http://sparc.ecology.uga.edu/webdocs/linx/.

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Jim Vose: A collaboration with Dr. Larry Band, University of North Carolina-Chapel Hill and the Baltimore Ecosystem LTER, is directed at a cross-site comparison of streamflow and water quality. The research will use large scale models to examine contemporary and future impacts of land use change (i.e., development) on water resources. It will also examine scaling issues to determine how fine-scale disturbances (i.e., subwatershed level development or forest harvesting) integrate to influence large scale hydrologic responses.

Brian Kloeppel: Collaborations with Dr. Jacek Oleksyn, Poland Academy of Sciences at the Institute of Dendrology in Kornik, Poland and Dr. Adolf Korczyk, of the Poland Academy of Sciences at the Forest Research Institute in the Białowieża National Park in Białowieża, Poland to conduct international LTER studies in Poland (NSF). The studies use the natural 13C isotope signals in wood to determine the impact of historic (>300 years to present) changing CO2 regimes on water use efficiency. A related study compares the foliar natural 13C ratio of 12 populations of Norway spruce (Picea abies) along its native elevational gradient in the Tatra Mountains as well as in a 12-year-old common garden site from the same seed source to determine if water-use efficiency depends more on genetic or microsite factors.

David Coleman: A collaboration with Dr. Barny Whitman, to develop an International workshop on the molecular basis of soil biodiversity with Dr. Chih-Yu Chiu, Academia Sinica, and Dr. Hen-Biau King, Taiwan Institute of Forestry Research. The conference will be held in Taipei on April 18-24, 2004, and will involve persons from six+ LTER sites as well as several foreign countries.

Activities and Findings

Research and Education Activities:

The major research activity in Year 1 was the organization of the research activities and initial compilation of information relative to the characterization of the socio-natural template (Initiative 1). Organizational aspects of this activity were carried out at our two regular meetings of the Coweeta LTER: the All-PI Winter 2003 Meeting (7-8 January), and the Summer 2003 Science Meeting (June 24-25). Full reports and presentations are available at: http://cwt33.ecology.uga.edu/science_meeting/archives.html. Following are highlights from these meetings.

The All-PI Winter meeting was organizational in nature since funding had just been received by the University of Georgia, and research accounts had not yet been established. The main outcome was the consensus on developing study plans for individual research themes as outlined in the proposal. The Summer Science Meeting convened all investigators and their students to report on the progress-to-date of their research activities or advances in planning their research. Six students prepared posters for the 1st Coweeta Student Poster competition with a prize to the winner in support of their research. This year's winner was Chris Frost with a poster entitled 'Frass from Canopy Herbivores Increases Soil Nitrogen, Carbon, and Nitrogen Export from Quercus rubra Mini-ecosystems.' We also had two invited presentations by researchers working in the region and/or on topics relevant to the Coweeta LTER program. J. Hilten presented on the 'All Taxa Biotic Inventory' at the Great Smoky Mountains National Park while B. Clinton and P. Gulusky described their rhododendron ecophysiology research.

There have been several interrelated research activities over the past year focused on improving the temporal sampling of our land use data: 1) increasing the spatial and categorical detail and accuracy of current and recent historical land use information; and 2) extending the time period of land use back to the late 17th century. The results from these activities will serve as the basis for testing a number of hypotheses on techniques (e.g., categorical detail/accuracy tradeoffs in multi-scale data, quantification of classification accuracy for high-resolution spatial data, mapping sub-canopy features on high-resolution data). It will also be used to establish the location and pattern of disturbance (a disaggregation of disturbance through time with the change from a primarily agricultural to a diversified service economy with related changes in riparian vegetation). Finally, anthropogenic disturbance trajectories will be derived that reveal, for example, the divergence in disturbance

regimes on public vs. private lands.

During summer 2003, the Coweeta LTER program sponsored three REU students. Davis C. Pinner worked with Dr. Katherine J. Elliott (Coweeta Hydrologic Laboratory) on dendroecological reconstruction of the disturbance history of Coweeta Basin. Hunter M. Keyes worked with Dr. Mark Hunter (University of Georgia) on the ecosystem effects of the hemlock wooly adelgid in the southern Appalachian region. Finally, Kenneth D. Marcus worked with Dr. Jennifer Knoepp (Coweeta Hydrologic Laboratory) on the nutrient content and bulk density determination of coarse woody debris in the Coweeta Basin.

Findings:

A unifying theme of both present and historic Coweeta LTER research is the quantification of ecological responses to natural and anthropogenic disturbance on levels ranging from the organism to the ecosystem. To build on our core research effort, we are undertaking a number of activities directed at cross-site and synthetic research. These activities are directly tied to our future efforts of constructing and validating explicit forecast scenarios on the response-trajectories of terrestrial and aquatic systems to natural and anthropogenic disturbance.

Training and Development:

In the Coweeta Schoolyard LTER initiative we are partnering with five instructors and approximately 65 students. The schools involved are: Sixth grade science classes at Macon County Middle School in Franklin, NC; High School environmental science students at Rabun Gap Nacoochee School in Rabun Gap, GA; and, Freshmen College level biology and chemistry classes at Southwestern Community College in Sylva, NC. Field work is conducted on school property study areas, the Coweeta Hydrologic Laboratory, and surrounding southern Appalachian study sites such as Joyce Kilmer Old Growth Memorial Forest. Data summary and discussions take place at Coweeta and the home institution of participating teachers and students. Data archives can be found at http://coweeta.ecology.uga.edu/webdocs/1/schoolyardlter.htm.

Outreach Activities:

Coweeta LTER scientists and staff conduct numerous tours for varied groups both on and off-site. Outreach activities this year were also carried out with The Macon County Historical Museum (Franklin, NC). Details of these activities follow.

Brian Kloeppel: In 2002, 58 groups and a total of 825 individuals including primary through college education classes, visiting scientists, and forest and watershed managers were provided educational and guided scientific tours (http://coweeta.ecology.uga.edu/webdocs/1/tours.html). These tours were led by a variety of scientists and staff at Coweeta Hydrologic Laboratory who specialize in the various topics presented. Depending on the need of each group, tours covered ecosystem function, vegetation management, stream biology, water quality and yield, and road construction and maintenance. In 2003 we also hosted several international science visitors: A group of six Japanese led by Dr. Hideaki Shibata, Associate Professor at Hokkaido University; a group of six French led by Ms. Dolores de Bortoli, Researcher at the Universite de Pau; Dr. Martin Sharman, Head of the Biodiversity Sector of the European Commission, Brussels; and Dr. Adolf Korczyk, Natural Forests Department Head of the Forest Research Institute of the Poland Academy of Sciences in the Białowieża National Park in Białowieża, Poland.

Bruce Haines: Conducted a field tour of the Coweeta Basin for the 88th Annual Meeting of the Ecological Society of American, held in Savannah (GA), August 2003. In asking the visitors, 'Are there any lessons, approaches, methods, or findings from the Coweeta Project that could help you better manage water, nutrients, vegetation, wild life and people back in your homeland?' Dr. Haines sought to encourage tour participants to become interested in landscape ecology.

Ted Gragson: With the assistance of graduate students Meredith Devine and William Jurgelski, prepared a permanent museum exhibit entitled 'Chuttahsotee's Long Rifle and the Sand Town Cherokee.' The exhibit incorporates Coweeta LTER results on early white settlement in southern Appalachia and a unique pre-Civil War rifle manufactured in western North Carolina to tell a story of Indian-White land relations significant to local history.

Susan Murry: Susan is a Graduate Research Assistantship working in the Coweeta Information Management Laboratory, and with Barrie Collins (Coweeta Information Manager) she rendered a Native Garden plan for the Memory Lane Park, a small urban park in Franklin, NC adjacent to the Macon County History Museum. The rendered plan highlights native plants of Western North Carolina based on work at Coweeta and the region to create a place of repose as well as an educational exhibit that extends the museum's displays outdoors.

Journal Publications

Clark, James S.; Mohan, Jacqueline; Dietze, Michael; Ibanez, Inez, "Coexistence: How to identify trophic trade-offs.", Ecology, p. 17, vol. 84, (2003). Published

Coleman, David C.; Hunter Mark D.; Hutton, John; Pomeroy, Steven; Swift, Lloyd, Jr., "Soil respiration from four aggrading forested watersheds measured over a quarter century", Forest Ecology and Management, p. 247, vol. 157, (2002). Published

Hicks, Norman, G.; Pearson, Scott M., "Salamander diversity and abundance in forests with alternative land use histories in the Southern Blue Ridge Mountains", Forest Ecology and Management, p. 117, vol. 177, (2003). Published

HilleRisLambers, Janneke; Clark, James S.; Beckage, Brian, "Density-dependent mortality and the latitudinal gradient in species diversity", Nature, p. 732, vol. 417, (2002). Published

Hutchens, John, J., Jr.; Wallace, J. Bruce, "Ecosystem Linkages between Southern Appalachian Headwater Streams and Their Banks: Leaf Litter Breakdown and Invertebrate Assemblages", Ecosystems, p. 80, vol. 5, (2002). Published

Wyckoff, Peter H.; Clark, James S., "The relationship between growth and mortality for seven co-occurring tree species in the southern Appalachian Mountains", Journal of Ecology, p. 604, vol. 90, (2002). Published

Yeakley, J. Alan; Coleman, David C.; Haines, Bruce L.; Kloeppel, Brian, D.; Meyer, Judy L.; Swank, Wayne T.; Argo, Barry W.; Deal, James M.; Taylor, Sharon F., "Hillslope nutrient dynamics following upland riparian vegetation disturbance", Ecosystems, p. 154, vol. 6, (2003). Published

Books or Other One-time Publications

Kloeppel, Brian D., Clinton, Barton D.; Vose, James M.; Cooper, Aaron R., "Drought impacts on tree growth and mortality of southern Appalachian forests", (2003). Book, Published
Editor(s): David Greenland, Douglas G. Goodin, and Raymond C. Smith
Collection: Climate Variability and Ecosystem response at Long-Term Ecological Research Sites
Bibliography: pp. 43-55. Oxford: Oxford University Press

Web/Internet Site

URL(s):

http://coweeta.ecology.uga.edu

Description:

The Coweeta LTER program subscribes to the philosophy that the future of scientific research is tied to the free and efficient exchange of research and ideas in the scientific community. We have accordingly invested heavily in supporting emerging worldwide standards for research and GIS data and metadata, and the Coweeta LTER website was completely overhauled during Year 1 to reflect this approach. All information holdings were inventoried to determine that relevant parts (i.e., data, metadata, GPS, coverages, etc.) were complete; the missing information was either collected or key-coded. EML-compliant metadata was then developed for our tabular data legacy to provide machine-readable information for data harvesters. We simultaneously developed Coweeta Data Set Summaries to provide human-friendly metadata. The Coweeta Data Summaries incorporate the information contained in the EML-compliant metadata, but also provide access to geographic coordinates as well as data.

The single most important accomplishment of the overhaul of the Coweeta LTER website was the move to Open Source Software to develop a relational database management system. This provides complete access to the entire Coweeta data legacy in a recursive fashion from anywhere in our website. The architecture is based on MySQL and PHP. MySQL is a powerful, flexible and efficient database management system, while PHP is a CGI program with a built-in scripting language that dynamically accesses MySQL and outputs to an HTML browser. In contrast to a Google search that is static and only as good as the meta-tagging on individual web-pages, the Coweeta GLOBAL Data Search gives access to all holdings of any kind anywhere in the archives from anywhere on the site. First access to this search engine is available in the ?Data & Research? section of the Coweeta LTER homepage.

Other Specific Products

Product Type: Data or databases

Product Description:

The foremost reason for developing the Coweeta MySQL-PHP relational data management system was to give us complete control over our data legacy. The tabular data legacy now consists of nearly 200 data sets fully described and accessible according to the NSF LTER Type I and Type II criteria as implemented at Coweeta. Following are the most significant online resources available from the ?Data & Research? section of the Coweeta LTER homepage:
>>Publications - 1214 citations dating from 1928, 62 publications available online.
>>Thesis/Dissertations - 195 theses and dissertations online, dating from 1937.
>>Researcher's Biographical Sketches - formatted biographies of all 27 PIs.
>>Sample Archives - 93 collections featuring 17,000+ archived samples.
>>Species Lists I, GMNH Mammal/Amphibian Collection - 20,000+ vouchered specimens for southern Appalachia from 1905 onward held at the Georgia Museum of Natural History.
>>Species Lists II - Observed and collected species at Coweeta Hydrologic Laboratory.
>>Digital Elevation Model (DEM) Catalog - raster contour maps for the southern Appalachian study region.
>>Digital Raster Graphic (DRG) Catalog - DRGs for the southern Appalachian study region.
>>Digital Orthophoto Quadrangle (DOQ) Catalog - DOQs for the greater Coweeta area.
>>Demographics ? US Census block-level data for the southern Appalachian study region.
>>Monthly Climate Data (NOAA/NCDC) ? Geo- and temporally-referenced records for 123 stations in the southern Appalachian study region. (Daily climate data will soon also be available.)

Sharing Information:

The relational data structure allows us to assemble, manage and dynamically deliver via the Coweeta website many types of information including species lists, biographical sketches, and a comprehensive bibliography of publications, thesis and dissertations that we are in the process of converting to downloadable PDFs.

Contributions

Contributions within Discipline:

While the principal discipline of the Coweeta LTER research is ecosystem ecology, the 27 investigators span a wide gamut of contributory subdisciplines. Publications this year contributed to our understanding of many key ecological concerns: trophic trade-offs; aboveground biomass and nutrient accumulation; an optimal foraging model for drift-feeding stream minnows; salamander diversity and abundance; density-dependent mortality and the latitudinal gradient in species diversity; leaf litter breakdown and invertebrate assemblages; retention of soluble organic nutrients in a forested ecosystem; seasonal respiration of foliage, fine roots, and woody tissues in relation to growth, tissue N, and photosynthesis; and hillslope nutrient dynamics following vegetation disturbance.

Contributions to Other Disciplines:

Our contributions are not limited to ecosystem ecology, but penetrate other science disciplines as well. David Leigh is applying geomorphological techniques to the 'Hazards Project' that will document the response trajectory of streams to changing land use patterns in southern Appalachia over the next 30 years. In the process he is comparing two widely used yet divergent physical stream survey parameters û USGS and USEPA û to develop a standardized methodology for use in the Appalachian Highlands. Seong Cho along with David Wear and David Newman are conducting an economic analysis of the site-specific factors of land development in the French Broad and Little Tennessee River Basins. In the process, they are advancing the nascent field of spatial econometrics.

Contributions to Human Resource Development:

Although already noted in other categories, the Coweeta LTER program provides numerous opportunities for the development of human resources. We have three post-doctoral fellows working on research projects in the southern Appalachian study region. There are 31 graduate students, both M.S. and Ph.D. level, assisting with, participating in, or conducting their own research in the Coweeta LTER program. Finally, with NSF supplemental funds to the Coweeta LTER program we sponsored three REU students in summer 2003. Following are three additional contributions to the development of human resources.

James Clark will run a 2004 summer school with NSF funding on statisical computation, which is a direct outgrowth of his Coweeta LTER research on trophic dynamics, density-dependent growth and mortality of Appalachian tree species. Students will work in groups guided by the course instructors; they will select data sets for analysis, develop models, write and execute code, produce predictive distributions, and write case studies for publication as a volume. Topics to be covered in the course include: principles of Bayesian inference; graphical modeling for complex processes; hierarchical modeling; data, process, and parameter models; the Gibbs sampling framework; robustness and sensitivity to stage-wise specification; and model adequacy/validation/model selection.

Brian Kloeppel & Susan Steiner direct the Coweeta Schoolyard LTER program that provides exposure to science and technology for students and teachers from grade school through college. As part of this effort, they direct and organize on and off-site data collection and discussion in association with ongoing Coweeta LTER studies. These efforts contribute to the needs of students at all levels, as well as the needs of visiting

scientists of all kinds, ecosystem managers, and the public at large.

Phaedra Scarborough, a student researcher working with Dr. Kitti Reynolds, learned basic microarthropod taxonomy in sorting microarthropods from Coweeta soil samples. She also participates in the decision-making of setting up new off-site research plots associated with experiments on climate and site controls of forest form and function (a component of Coweeta LTER Research Initiative 2).

Contributions to Resources for Research and Education:

One of the most significant contributions in the first year of the Coweeta LTER research cycle is the development of a true relational archive for our data legacy. Not only is this a critical component to the success of our activities in the years to come, but it is a significant contribution to the infrastructure for research and education. Not to be overlooked, however, are the complete renovation of the Analytical Laboratory and the Residence, and the construction of the Conference Center at the Coweeta Hydrologic Laboratory. This achievement was made possible by funds and inter-institutional collaborations by the USFS, the NSF, and the University of Georgia. The facilities meet the day-to-day research, communication, and residential needs of Coweeta investigators and students, as well as many other research collaborators. In some of the most practical ways imaginable, these three facilities make the Coweeta LTER program possible.

Contributions Beyond Science and Engineering:

Understanding the causes and consequences of land-use change is a critical research challenge at both national and global scales. Our current research addresses ecological and socioeconomic aspects of land-use change while continuing our studies of environmental gradients and natural disturbance regimes. This will produce a comprehensive understanding of ecological dynamics in the southern Appalachian Mountains and make possible the development of reliable forecasts of its future ecological state. Such forecasts offer the opportunity to formulate policies and management objectives with increased chances of success.

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Unobligated funds: less than 20 percent of current funds

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Coweeta LTER Year 1 (Nov 2002-Oct 2003) Annual Report
NSF Award DEB-0218001
Consequences of Land Use Change in the Southern Appalachian Mountains
Submitted October 25, 2003

Introduction

This report covers Year 1 (November 2002-October 2003) activities on the Coweeta LTER program in the following four categories: Participants, Activities & Findings, Products, and Contributions. The Coweeta LTER Program has evolved since 1980 from a site-based to a site- and region-based project examining the effects of disturbance and environmental gradients on biogeochemical cycling, and the underlying watershed ecosystem processes that regulate and respond to those cycles. The objective for the proposed 2002-2008 research is to advance scientific understanding of the spatial, temporal, and decision-making components of land use and land-use change in the southern Appalachian Mountains over the last 200 years, and forecast patterns 30 years into the future. To accomplish this task, we will address the ecological and socioeconomic aspects of land-use change while continuing long-term studies of environmental gradients and natural disturbance regimes.

1. Participants: Who has been involved?

Participants in the Coweeta LTER program include a large number of individuals from numerous State and Federal institutions. By virtue of the expertise of the individuals involved and the nature of the research itself, numerous collaborators and contacts have also been established.

What people have worked on the project and what other organizations are involved as partners?
A total of 27 investigators from eight institutions worked on the Coweeta LTER program as listed on the following table.

Participant	Institution	Role
Fred Benfield	Virginia Tech	Investigator
Paul Bolstad	U Minnesota	Investigator
James Clark	Duke U	Investigator
Barrie Clinton	USDA-USFS	Investigator
David Coleman	U Georgia	Investigator
Katherine Elliott	USDA-USFS	Investigator
Ted Gragson	U Georgia	Principal Investigator
Gary Grossman	U Georgia	Investigator
Bruce Haines	U Georgia	Investigator
Gene Helfman	U Georgia	Investigator
Ron Hendrick	U Georgia	Investigator
Mark Hunter	U Georgia	Investigator
Brian Kloeppel	U Georgia	CoPrincipal Investigator
Jennifer Knoepp	USDA-USFS	Investigator
David Leigh	U Georgia	Investigator
David Newman	U Georgia	Investigator
Scott Pearson	Mars Hill	Investigator

Catherine Pringle	U Georgia	Investigator
Ron Pulliam	U Georgia	Investigator
Barbara Reynolds	UNC Asheville	Investigator
Mark Riedel	USDA-USFS	Investigator
Wayne Swank	USDA-USFS	Investigator
Monica Turner	U Wisconsin	Investigator
James Vose	USDA-USFS	CoPrincipal Investigator
Bruce Wallace	U Georgia	Investigator
David Wear	USDA-USFS	Investigator
Jack Webster	Virginia Tech	Investigator

Working directly with these investigators are 31 graduate students, both M.S. and Ph.D., and three post-doctoral fellows. One of the post-doctoral fellows and approximately half of the graduate students are supported by Coweeta LTER funds; for the students, this means they also receive tuition grants-in-aid from their home institution. The balance of graduate students while engaged in Coweeta LTER activities, are supported by other funds. There are four full-time technicians affiliated with the Coweeta LTER program; three are based at the Coweeta Hydrologic Laboratory in Otto and one at the University of Georgia campus in Athens. Finally, we sponsored three REU students during summer 2003, and worked with 20 undergraduate students involved as summer or fall interns, or hourly lab and field assistants during the school year.

Have you had other collaborators or contacts? Either by leveraging the Coweeta LTER project resources – data, personnel, infrastructure – participants on the Coweeta LTER have established several important collaborations. These include:

Jack Webster: The Lotic Intersite Nitrogen eXperiment (NSF) is a collaborative study of nitrogen cycling in streams involving simulation modeling, field tracer (^{15}N) additions, and intersite comparison. The principal contact is Pat Mulholland of Oak Ridge National Laboratory. Additional collaborators include Prof. Alan Hildrew, Queen Mary and Westfield College, London; Prof. Horton Hobbs, Whittenburg College, Ohio; and Linda Ashkenas and Dan Soboda, of Oregon State University. Full information on this research collaboration is available at http://sparc.ecology.uga.edu/webdocs/linx/.

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determine how fine-scale disturbances (i.e., subwatershed level development or forest harvesting) integrate to influence large scale hydrologic responses.

Brian Kloeppel: Collaborations with Dr. Jacek Oleksyn, Poland Academy of Sciences at the Institute of Dendrology in Kornik, Poland and Dr. Adolf Korczyk, of the Poland Academy of Sciences at the Forest Research Institute in the Białowieża National Park in Białowieża, Poland to conduct international LTER studies in Poland (NSF). The studies use the natural ^{13}C isotope signals in wood to determine the impact of historic (>300 years to present) changing CO_2 regimes on water use efficiency. A related study compares the foliar natural ^{13}C ratio of 12 populations of Norway spruce (*Picea abies*) along its native elevational gradient in the Tatra Mountains as well as in a 12-year-old common garden site from the same seed source to determine if water-use efficiency depends more on genetic or microsite factors.

David Coleman: A collaboration with Dr. Barny Whitman, to develop an International workshop on the molecular basis of soil biodiversity with Dr. Chih-Yu Chiu, Academia Sinica, and Dr. Hen-Biau King, Taiwan Institute of Forestry Research. The conference will be held in Taipei on April 18-24, 2004, and will involve persons from six+ LTER sites as well as several foreign countries.

2. Activities and Findings: What have you done & what have you learned?

The guiding hypothesis for the Coweeta LTER is that the frequency, intensity, and extent of land use represents human decision-making in response to socioeconomic and biogeophysical conditions with consequences that cascade through ecosystems. The research activities are organized into three initiatives: (1) characterization of the socio-natural template, (2) ecosystem responses to the socio-natural template, and (3) forecasting ecosystem responses to changes in the socio-natural template. As the first year of a significantly reorganized project, most effort has been on activities to enable the research so that findings are still limited.

What were your major research and education activities? The major research activity in Year 1 was the organization of the research activities and initial compilation of information relative to the characterization of the socio-natural template (Initiative 1). Organizational aspects of this activity were carried out at our two regular meetings of the Coweeta LTER: the All-PI Winter 2003 Meeting (7-8 January), and the Summer 2003 Science Meeting (June 24-25). Full reports and presentations are available at: http://cwt33.ecology.uga.edu/science_meeting/archives.html. Following are highlights from these meetings.

The All-PI Winter meeting was organizational in nature since funding had just been received by the University of Georgia, and research accounts had not yet been established. The main outcome was the consensus on developing study plans for individual research themes as outlined in the proposal. The Summer Science Meeting convened all investigators and their students to report on the progress-to-date of their research activities or advances in planning their research. Six students prepared posters for the 1st Coweeta Student Poster competition with a prize to the winner in support of their research. This year's winner was Chris Frost with a poster entitled "Frass from Canopy Herbivores Increases Soil Nitrogen, Carbon, and Nitrogen Export from *Quercus rubra* Mini-ecosystems." We also had two invited presentations by researchers working in the region and/or on topics relevant to the Coweeta LTER program. J. Hilten

presented on the "All Taxa Biotic Inventory" at the Great Smoky Mountains National Park while B. Clinton and P. Gulusky described their rhododendron ecophysiology research.

There have been several interrelated research activities over the past year focused on improving the temporal sampling of our land use data: 1) increasing the spatial and categorical detail and accuracy of current and recent historical land use information; and 2) extending the time period of land use back to the late 17th century. The results from these activities will serve as the basis for testing a number of hypotheses on techniques (e.g., categorical detail/accuracy tradeoffs in multi-scale data, quantification of classification accuracy for high-resolution spatial data, mapping sub-canopy features on high-resolution data). It will also be used to establish the location and pattern of disturbance (a disaggregation of disturbance through time with the change from a primarily agricultural to a diversified service economy with related changes in riparian vegetation). Finally, anthropogenic disturbance trajectories will be derived that reveal, for example, the divergence in disturbance regimes on public vs. private lands.

During summer 2003, the Coweeta LTER program sponsored three REU students. **Davis C. Pinner** worked with Dr. Katherine J. Elliott (Coweeta Hydrologic Laboratory) on dendroecological reconstruction of the disturbance history of Coweeta Basin. **Hunter M. Keyes** worked with Dr. Mark Hunter (University of Georgia) on the ecosystem effects of the hemlock wooly adelgid in the southern Appalachian region. Finally, **Kenneth D. Marcus** worked with Dr. Jennifer Knoepp (Coweeta Hydrologic Laboratory) on the nutrient content and bulk density determination of coarse woody debris in the Coweeta Basin.

What are your major findings from these activities? A unifying theme of both present and historic Coweeta LTER research is the quantification of ecological responses to natural and anthropogenic disturbance on levels ranging from the organism to the ecosystem. To build on our core research effort, we are undertaking a number of activities directed at cross-site and synthetic research. These activities are directly tied to our future efforts of constructing and validating explicit forecast scenarios on the response-trajectories of terrestrial and aquatic systems to natural and anthropogenic disturbance. Synthesis and cross-site comparison projects supported with supplemental NSF funds include:

- *Mark Hunter* who is conducing long-term monitoring of hemlock stands for woolly adelgid infestation.
- *Katherine Elliott* who is directing dendroecological research in the southern Appalachian mountains.
- *David Leigh* who is benchmarking "Hazard Sites" in the Little Tennessee and French Broad drainages.
- *Brian Kloeppel* who is bringing archived data sets on-line as part of our effort to convert all our holdings to a relational data structure compliant with EML.
- *Ted Gragson* who is comparing long-term land use trajectories between southern Appalachia and the southern Pyrenees.

What opportunities for training and development has the project helped provide? In the Coweeta Schoolyard LTER initiative we are partnering with five instructors and approximately 65 students. The schools involved are: Sixth grade science classes at Macon County Middle School in Franklin, NC; High School environmental science students at Rabun Gap Nacoochee

School in Rabun Gap, GA; and, Freshmen College level biology and chemistry classes at Southwestern Community College in Sylva, NC. Field work is conducted on school property study areas, the Coweeta Hydrologic Laboratory, and surrounding southern Appalachian study sites such as Joyce Kilmer Old Growth Memorial Forest. Data summary and discussions take place at Coweeta and the home institution of participating teachers and students. Data archives can be found at http://coweeta.ecology.uga.edu/webdocs/1/schoolyardlter.htm.

What outreach activities have you undertaken? Coweeta LTER scientists and staff conduct numerous tours for varied groups both on and off-site. Outreach activities this year were also carried out with The Macon County Historical Museum (Franklin, NC). Details of these activities follow.

Brian Kloeppel: In 2002, 58 groups and a total of 825 individuals including primary through college education classes, visiting scientists, and forest and watershed managers were provided educational and guided scientific tours (http://coweeta.ecology.uga.edu/webdocs/1/tours.html). These tours were led by a variety of scientists and staff at Coweeta Hydrologic Laboratory who specialize in the various topics presented. Depending on the need of each group, tours covered ecosystem function, vegetation management, stream biology, water quality and yield, and road construction and maintenance. In 2003 we also hosted several international science visitors: A group of six Japanese led by Dr. Hideaki Shibata, Associate Professor at Hokkaido University; a group of six French led by Ms. Dolores de Bortoli, Researcher at the Universite de Pau; Dr. Martin Sharman, Head of the Biodiversity Sector of the European Commission, Brussels; and Dr. Adolf Korczyk, Natural Forests Department Head of the Forest Research Institute of the Poland Academy of Sciences in the Białowieża National Park in Białowieża, Poland.

Bruce Haines: Conducted a field tour of the Coweeta Basin for the 88th Annual Meeting of the Ecological Society of American, held in Savannah (GA), August 2003. In asking the visitors, "Are there any lessons, approaches, methods, or findings from the Coweeta Project that could help you better manage water, nutrients, vegetation, wild life and people back in your homeland?" Dr. Haines sought to encourage tour participants to become interested in landscape ecology.

Ted Gragson: With the assistance of graduate students Meredith Devine and William Jurgelski, prepared a permanent museum exhibit entitled "Chuttahsotee's Long Rifle and the Sand Town Cherokee." The exhibit incorporates Coweeta LTER results on early white settlement in southern Appalachia and a unique pre-Civil War rifle manufactured in western North Carolina to tell a story of Indian-White land relations significant to local history.

Susan Murry: Susan is a Graduate Research Assistantship working in the Coweeta Information Management Laboratory, and with Barrie Collins (Coweeta Information Manager) she rendered a Native Garden plan for the Memory Lane Park, a small urban park in Franklin, NC adjacent to the Macon County History Museum. The rendered plan highlights native plants of Western North Carolina based on work at Coweeta and the region to create a place of repose as well as an educational exhibit that extends the museum's displays outdoors.

3. Products: What has the project produced?

As in the past, the greatest single achievement of individuals involved with the Coweeta LTER program is the significant number of publications. This year we have also developed significant web-accessible databases.

What have you published as a result of this work? Over the past year, Coweeta investigators and their students have published 31 journal articles and/or book chapters, two M.S. theses and two Ph.D. dissertations. Following are some of the most salient publications; a complete listing is available at http://cwt33.ecology.uga.edu/coweeta_publications.php.

Clark, James S.; Mohan, Jacqueline; Dietze, Michael; Ibanez, Inez. Coexistence: How to identify trophic trade-offs. *Ecology* 84(1): 17-31.

Coleman, David C.; Hunter Mark D.; Hutton, John; Pomeroy, Steven; Swift, Lloyd, Jr. 2002. Soil respiration from four aggrading forested watersheds measured over a quarter century. *Forest Ecology and Management* 157: 247-253.

Elliott, Katherine, J.; Boring, Lindsay, R.; Swank, Wayne, T. 2002. Aboveground biomass and nutrient accumulation 20 years after clear-cutting a southern Appalachian watershed. *Canadian Journal of Forest Research* 32: 667-683.

Grossman, G.D.; Rincon, P.A.; Farr, M.D.; Ratajczak, R.E. Jr. 2002. A new optimal foraging model predicts habitat use by drift-feeding stream minnows. *Ecology of Freshwater Fish* 11: 2-10.

Hicks, Norman, G.; Pearson, Scott M. 2003. Salamander diversity and abundance in forests with alternative land use histories in the Southern Blue Ridge Mountains. *Forest Ecology and Management* 177: 117-130.

HilleRisLambers, Janneke; Clark, James S.; Beckage, Brian. 2002. Density-dependent mortality and the latitudinal gradient in species diversity. *Nature* 417: 732-735.

Hutchens, John, J., Jr.; Wallace, J. Bruce. 2002. Ecosystem Linkages between Southern Appalachian Headwater Streams and Their Banks: Leaf Litter Breakdown and Invertebrate Assemblages. *Ecosystems* 5: 80-91.

Kloeppel, Brian D., Clinton, Barton D.; Vose, James M.; Cooper, Aaron R. 2003. Drought impacts on tree growth and mortality of southern Appalachian forests. In *Climate Variability and Ecosystem response at Long-Term Ecological Research Sites*, David Greenland, Douglas G. Goodin, and Raymond C. Smith, Eds. Pp. 43-55. Oxford: Oxford University Press.

Qualls, R.G.; Haines, B.L.; Swank, W.T.; Tyler, S.W. 2002. Retention of soluble organic nutrients by a forested ecosystem. *Biogeochemistry* 61: 135-171.

Turner, Monica G., Collins, Scott L.; Lugo, Ariel E., Magnuson, John J., Rupp, T. Scott, Swanson, Frederick. 2003. Disturbance dynamics and ecological response: The contribution of long-term ecological research. *BioScience* 53(1): 46-56.

Vose, James M.; Ryan, Michael G. 2002. Seasonal respiration of foliage, fine roots, and woody tissues in relation to growth, tissue N, and photosynthesis. *Global Change Biology* 8: 182-193.

Wyckoff, Peter H.; Clark, James S. 2002. The relationship between growth and mortality for seven co-occurring tree species in the southern Appalachian Mountains. *Journal of Ecology* 90: 604-615.

Yeakley, J. Alan; Coleman, David C.; Haines, Bruce L.; Kloeppel, Brian, D.; Meyer, Judy L.; Swank, Wayne T.; Argo, Barry W.; Deal, James M.; Taylor, Sharon F. 2003. Hillslope nutrient dynamics following upland riparian vegetation disturbance. *Ecosystems* 6(2): 154-167.

What Web site(s) or other Internet site(s) reflect this project? The Coweeta LTER program subscribes to the philosophy that the future of scientific research is tied to the free and efficient exchange of research and ideas in the scientific community. We have accordingly invested heavily in supporting emerging worldwide standards for research and GIS data and metadata, and the Coweeta LTER website (http://coweeta.ecology.uga.edu) was completely overhauled during Year 1 to reflect this approach. All information holdings were inventoried to determine that relevant parts (i.e., data, metadata, GPS, coverages, etc.) were complete; the missing information was either collected or key-coded. EML-compliant metadata was then developed for our tabular data legacy to provide machine-readable information for data harvesters. We simultaneously developed Coweeta Data Set Summaries to provide human-friendly metadata. The Coweeta Data Summaries incorporate the information contained in the EML-compliant metadata, but also provide access to geographic coordinates as well as data. An example can be found at http://cwt33.ecology.uga.edu/summaries/summary1005. For our GIS data legacy we adhere to the Federal Geographic Data Committee (FGDC) Geospatial Standards format (http://cwt33.ecology.uga.edu/fgdc_overview.html).

The single most important accomplishment of the overhaul of the Coweeta LTER website was the move to Open Source Software to develop a relational database management system. This provides complete access to the entire Coweeta data legacy in a recursive fashion from anywhere in our website. The architecture is based on MySQL and PHP. MySQL is a powerful, flexible and efficient database management system, while PHP is a CGI program with a built-in scripting language that dynamically accesses MySQL and outputs to an HTML browser. In contrast to a Google search that is static and only as good as the meta-tagging on individual web-pages, the Coweeta GLOBAL Data Search gives access to all holdings of any kind anywhere in the archives from anywhere on the site. First access to this search engine is available in the "Data & Research" section of the Coweeta LTER homepage, http://coweeta.ecology.uga.edu/webdocs/1/index.htm.

What other specific products have you developed? The foremost reason for developing the Coweeta MySQL-PHP relational data management system was to give us complete control over our data legacy. The tabular data legacy now consists of nearly 200 data sets fully described and accessible according to the NSF LTER Type I and Type II criteria as implemented at Coweeta (http://coweeta.ecology.uga.edu/webdocs/3/static/datapolicies.html). However, the relational data structure also allowed us to assemble, manage and deliver many other types of information including species lists, biographical sketches, and a comprehensive bibliography of publications, thesis and dissertations that we are in the process of converting to downloadable PDFs. Following are the most significant online resources available from the "Data & Research" section of the Coweeta LTER homepage:

- Publications - 1214 citations dating from 1928, 62 publications available online.
- Thesis/Dissertations - 195 theses and dissertations online, dating from 1937.
- Researcher's Biographical Sketches - formatted biographies of all 27 PIs.

- Sample Archives - 93 collections featuring 17,000+ archived samples.
- Species Lists I, GMNH Mammal/Amphibian Collection - 20,000+ vouchered specimens for southern Appalachia from 1905 onward held at the Georgia Museum of Natural History.
- Species Lists II - Observed and collected species at Coweeta Hydrologic Laboratory.
- Digital Elevation Model (DEM) Catalog - raster contour maps for the southern Appalachian study region.
- Digital Raster Graphic (DRG) Catalog - DRGs for the southern Appalachian study region.
- Digital Orthophoto Quadrangle (DOQ) Catalog - DOQs for the greater Coweeta area.
- Demographics – US Census block-level data for the southern Appalachian study region.
- Monthly Climate Data (NOAA/NCDC) – Geo- and temporally-referenced records for 123 stations in the southern Appalachian study region. (Daily climate data will soon also be available.)

4. Contributions: How has the project contributed?

The 1996-2002 Coweeta research effort revealed surprisingly strong effects of land-use history on the current state of terrestrial and aquatic ecosystems in the southern Appalachian Mountains. Natural disturbances and human land use interact with steep environmental gradients to produce complex spatial patterns and temporal dynamics at the individual, population, community, ecosystem, and landscape levels. This research positioned us for significant advances in the scientific understanding of the spatial, temporal, and decision-making components of land use and land-use change in the southern Appalachian Mountains during 2002-2008. Particular contributions not already mentioned above are noted next.

To the development of the principal discipline(s) of the project? While the principal discipline of the Coweeta LTER research is ecosystem ecology, the 27 investigators span a wide gamut of contributory subdisciplines. Publications this year contributed to our understanding of many key ecological concerns: trophic trade-offs; aboveground biomass and nutrient accumulation; an optimal foraging model for drift-feeding stream minnows; salamander diversity and abundance; density-dependent mortality and the latitudinal gradient in species diversity; leaf litter breakdown and invertebrate assemblages; retention of soluble organic nutrients in a forested ecosystem; seasonal respiration of foliage, fine roots, and woody tissues in relation to growth, tissue N, and photosynthesis; and hillslope nutrient dynamics following vegetation disturbance.

To other disciplines of science or engineering? Our contributions are not limited to ecosystem ecology, but penetrate other science disciplines as well. David Leigh is applying geomorphological techniques to the "Hazards Project" that will document the response trajectory of streams to changing land use patterns in southern Appalachia over the next 30 years. In the process he is comparing two widely used yet divergent physical stream survey parameters – USGS and USEPA – to develop a standardized methodology for use in the Appalachian Highlands. Seong Cho along with David Wear and David Newman are conducting an economic analysis of the site-specific factors of land development in the French Broad and Little Tennessee River Basins. In the process, they are advancing the nascent field of spatial econometrics.

To the development of human resources? Although already noted in other categories, the Coweeta LTER program provides numerous opportunities for the development of human resources. We have three post-doctoral fellows working on research projects in the southern Appalachian study region. There are 31 graduate students, both M.S. and Ph.D. level, assisting with, participating in, or conducting their own research in the Coweeta LTER program. Finally, with NSF supplemental funds to the Coweeta LTER program we sponsored three REU students in summer 2003. Following are three additional contributions to the development of human resources.

James Clark will run a 2004 summer school with NSF funding on statisical computation, which is a direct outgrowth of his Coweeta LTER research on trophic dynamics, density-dependent growth and mortality of Appalachian tree species. Students will work in groups guided by the course instructors; they will select data sets for analysis, develop models, write and execute code, produce predictive distributions, and write case studies for publication as a volume. Topics to be covered in the course include: principles of Bayesian inference; graphical modeling for complex processes; hierarchical modeling; data, process, and parameter models; the Gibbs sampling framework; robustness and sensitivity to stage-wise specification; and model adequacy/validation/model selection.

Brian Kloeppel & Susan Steiner direct the Coweeta Schoolyard LTER program that provides exposure to science and technology for students and teachers from grade school through college. As part of this effort, they direct and organize on and off-site data collection and discussion in association with ongoing Coweeta LTER studies. These efforts contribute to the needs of students at all levels, as well as the needs of visiting scientists of all kinds, ecosystem managers, and the public at large.

Phaedra Scarborough, a student researcher working with Dr. Kitti Reynolds, learned basic microarthropod taxonomy in sorting microarthropods from Coweeta soil samples. She also participates in the decision-making of setting up new off-site research plots associated with experiments on climate and site controls of forest form and function (a component of Coweeta LTER Research Initiative 2).

To physical, institutional, and information resources that form the infrastructure for research and education? One of the most significant contributions in the first year of the Coweeta LTER research cycle is the development of a true relational archive for our data legacy. Not only is this a critical component to the success of our activities in the years to come, but it is a significant contribution to the infrastructure for research and education. Not to be overlooked, however, are the complete renovation of the Analytical Laboratory and the Residence, and the construction of the Conference Center at the Coweeta Hydrologic Laboratory. This achievement was made possible by funds and inter-institutional collaborations by the USFS, the NSF, and the University of Georgia. The facilities meet the day-to-day research, communication, and residential needs of Coweeta investigators and students, as well as many other research collaborators. In some of the most practical ways imaginable, these three facilities make the Coweeta LTER program possible.

To the public welfare beyond science and engineering? Understanding the causes and consequences of land-use change is a critical research challenge at both national and global

scales. Our current research addresses ecological and socioeconomic aspects of land-use change while continuing our studies of environmental gradients and natural disturbance regimes. This will produce a comprehensive understanding of ecological dynamics in the southern Appalachian Mountains and make possible the development of reliable forecasts of its future ecological state. Such forecasts offer the opportunity to formulate policies and management objectives with increased chances of success.