Coweeta LTER Program 2002 Annual Report
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Introduction

Coweeta LTER research focuses on studies along complex environmental gradients to examine the response to disturbance in a landscape perspective. We are examining the causes and consequences of land cover change in the southern Appalachians and are examining three linked components of the landscape: upland forests, riparian zones, and streams. In addition, the regional and socio-economic components of our research include a large scale (56,000 km^2) research approach to better understand the regional interactions of our ecosystems.

This report contains a brief update of these major research projects along with updates on data management and other LTER related research. In addition, we also include information on outreach, cross-site, and LTER/ILTER Network activities. We conclude with listings of publications and research grants related to our Coweeta LTER project.

Research Activities and Findings

Land-Use Change Regionalization Project

Our regionalization land-use change project, initiated with augmentation funding in 1994, has been a steady source of excitement for our site.

Aquatic Ecology Highlights

The aquatic research group has focused on a series of twenty-four sampling sites representing six replicated primarily forested and pasture sites in two different river drainage systems (Little Tennessee and French Broad). Fish and invertebrate quantity and diversity, along with water quality variables, have been sampled at each site over the past three field seasons and have yielded numerous interesting results. As more detailed data of the land cover history of the

area upstream of sample points has become available from GIS projects, additional analyses of the stream data have been possible. Results show that though significant differences exist in the species assemblages between primarily forested and agricultural drainage types, the history of the landscape may account for much of the difference between sites within each type of drainage. For example, terrestrial recovery from agricultural use may be relatively rapid, however recovery of stream fauna to their pre-disturbance species and population dynamics may take considerably longer (i.e. decades).

In 2000, we initiated a long-term (30 year) study on the predicted land-use change in stream ecosystems in the southern Appalachians. This study contains a set of stream study sites where half are predicted to undergo land cover change and the other half are predicted to have no significant change in land cover. Samplings of stream indices (e.g. water quality, fish populations, benthic invertebrates, stream morphology, riparian size and condition, etc.) were conducted in 2000 and will be conducted every five years until 2030. This research project is integrating social and economic predictive modeling with aquatic and riparian ecology.

Terrestrial Ecology Highlights

The terrestrial ecology research group has made progress on two main activities. First, Paul Bolstad, Co-PI on the project, has worked closely with all groups in the Regionalization project to distribute the wealth of digitized mapping and land cover products which his lab has produced. Paul is also a member of the three-person carbon cycling team, along with James Vose and Brian Kloeppel, who are quantifying the pools and fluxes of the carbon cycle across the complex southern Appalachian landscape. Three years of intense data collection and one year of summary and analysis have yielded relationships for the effect of slope position, aspect, temperature, and seasonal morphology on foliage, woody, soil, and litter carbon fluxes. These functional relationships, coupled with the more straightforward measurement of carbon pools for each of the above components now allow the development of a first generation carbon cycling model.

In addition to the carbon-cycling work, efforts by Scott Pearson, Ron Pulliam, and Monica Turner have focused on the diversity of species, both plant and bird populations, across the landscape in relation to land-use history. Jim Clark's lab has made a significant contribution to understanding the role of fire in land-use change by reconstructing the charcoal and pollen records from cores taken from 12 small bogs and ponds in North Carolina and Virginia. They were analyzed to determine the importance of fire and human disturbance in shaping presettlement and 20th century forests in the southern Appalachians. Prior to European settlement, low charcoal accumulations occurred, indicating low amounts of burning during the past 2000 years. However, charcoal peaks after European settlement suggest the presence of natural fires in forests. Furthermore, high charcoal concentrations occur at the transition between coniferous and deciduous forests of the Holocene and Pleistocene indicating a greater role of fire in these transitional forests.

Socio-Economic Highlights

Our socio-economic group has made significant progress on two fronts. First, an intense mapping and modeling project has digitized select areas from a five state southern Appalachian area. The database contains typical GIS layers such as slope, elevation, aspect, and land cover along with more socio-economic layers such as building density, population distribution, and road systems. These data have been summarized from sets of aerial photos and satellite imagery

from both the 1950's and the 1990's. This forty year time period change has then been used as a baseline, along with other socio-economic factors, to predicting future land use change with predictions of population and building distribution and land cover for the year 2030.

Ted Gragson has also been performing an extensive census and population history of our regionalization study area and has found numerous interesting patterns. Rather than population growth and seasonal migration being strictly recent phenomena (from retiree and vacation home construction), they may be a repetition of a pattern set early in the population history of the Blue Ridge Mountains. A settlement history from 1790 to the present for the 42 counties in northern Georgia, western North Carolina, and southwestern Virginia comprising the cultural Blue Ridge has been developed from archival census records and other information.

Stream Ecology Projects

Research on southern Appalachian streams continues to be a diverse and productive aspect of the Coweeta LTER project involving 7 Co-PIs and at least 15 graduate students. Stream researchers focus on land-water interactions and in-stream processes, and how they are impacted by anthropogenic and other disturbances. Stream research has been integrated into most LTER project areas including gradient, regionalization, and riparian projects. In addition, several stream projects have been inspired by LTER, but are funded from other sources (see listing of Related Research Grants). These include fish diversity and sedimentation in the southern Appalachians (funded by USGS), the Lotic Intersite Nitrogen eXperiment {LINX} (NSF and Fulbright), a litter exclusion experiment (NSF), and a nutrient addition experiment (NSF).

In another series of studies, we examined the role of macrobiota in structuring the benthic communities of two low-order southern Appalachian streams, one draining intact forest (Ball Creek) and one draining pasture (Jones Creek). Fishes and crayfishes were excluded from areas of both streams using an electric exclusion technique; chlorophyll *a*, ash free dry mass (AFDM), and invertebrates were sampled over a 40-day period. In both streams, chlorophyll *a* and AFDM were higher in exclusion than control areas, although these trends were not consistently significant across all sampling dates. In Jones Creek, significantly more large (> 4 mm) aquatic insect larvae were found in exclusion than control areas, most likely due to exclusion treatments providing a refuge from macrobiotic predators. This refuge effect was also evident in Ball Creek, where exclusion treatments contained significantly more filterers. Results indicate that macrobiota influence the structure of southern Appalachian benthic communities by decreasing the amount of organic matter (algal and detrital) available for other consumers and by preferentially preying on certain sizes and taxa of invertebrates. Compared to some low-order tropical streams, however, macrobiotic influences are low. Weaker effects may be attributed to decreased abundance of macrobiota and increased influence of benthic insects in southern Appalachian streams.

Hillslope-Riparian Projects

In the six years following the vegetation cut and hurricane impacts, soil moisture decreased on the vegetation cut hillslope relative to the storm impact hillslope. Groundwater levels did not vary on either hillslope. For all seedlings measured, initial analysis showed little regeneration and high mortality in the control sites. *Acer rubrum* and *Liriodendron tulipifera* seedlings were found prevalent in the treatment removal quadrats while *Liriodendron tulipifera* and *Betula lenta* seedlings dominated the hurricane removal quadrats. Total soil respiration rates

were similar in the first year post-treatment, but then gradually increased in years two and three to 30% greater in the cut plot transects compared to the storm plot transects.

Monthly measurements of net N-mineralization along three transects in cut and storm plots showed moderate differences at 1 m, and as much as four times greater mineralization rates at 5 and 15 m above the stream on the storm slope. These differences were most pronounced in spring and early summer.

In the six years following hurricane and *Rhododendron* removal treatments, soilwater nutrient concentrations on the vegetation cut hillslope generally did not vary significantly, although a small increase in NO_3-N was seen in one plot on the vegetation cut slope. In contrast, nutrient concentrations on the storm impact hillslope showed marked changes. NO_3-N concentrations showed consistent increases of at least two orders in magnitude in all lysimeters on the storm impact hillslope. Marked and persistent changes were also seen in SO_4 (decrease), Ca (increase) and Mg (increase) in the soilwater. In groundwater, SO_4 showed no differential response following the vegetation removal and hurricane events. For other nutrients (NO_3-N, Ca and Mg), however, responses in groundwater were similar, although of lesser magnitude, to soilwater. Nutrient concentrations varied seasonally, with major changes occurring in summer and early autumn in both soilwater and groundwater.

Terrestrial Gradient and Canopy Gap Projects

The study of forested ecosystems over a complex environmental gradient was initiated in 1991 and has continued to generate many interesting results as well as several new studies that are currently underway. The gradient has five intensive plots, established from a relatively dry oak ecosystem to a mesic high elevation northern hardwoods ecosystem, as well as 20 extensive plots providing greater spatial coverage of these ecosystems across the Coweeta basin.

Several new studies established on the gradient plots include a 15-year small log (bolt) study established by James Vose and D.A. Crossley. During the course of the study, including nine commonly transplanted species on all sites, periodic biomass sampling along with gas flux measurements are being conducted. Two-year results indicate surprisingly high decomposition at the high elevation northern hardwoods site, the site expected to exhibit the lowest decomposition rates. This same site exhibits unexpectedly high soil nitrogen mineralization. In a second set of studies, the area of the gradient plots is being enlarged from 20 x 40 m to 80 x 80 m in an effort to map and model single and multiple tree gap dynamics. Seed rain, seed bank dynamics, seedling dynamics, and overstory survival and growth have already being quantified. This last component will allow a complete analysis of all life stages of the vegetation across the complex gradient. The larger plots have also been used to map and quantify coarse woody debris on the gradient plots.

A recent publication from our terrestrial gradient project focuses on soil invertebrates. Previous studies have suggested that herbivory in forest canopies can influence forest floor processes such as nutrient cycling and decomposition. We studied the response of litter decomposition to a moisture/productivity gradient with manipulations of the effects of canopy herbivory. Litterbags containing *Quercus rubra* L. and *Acer rubrum* L. litter were placed at three elevations along the gradient and sampled monthly for two years. Microarthropods, nematodes, and litter mass loss responses to the productivity gradient were measured. Mass loss was greater at the middle and high elevation sites in both years and was correlated with increased numbers of oribatid mites per gram of litter. The abundance of all the above microarthropods (of which oribatids were the most common) was also greater on the middle and high elevation sites and

greater on two- year -old litter than on one- year- old litter. Experimental additions of frass to plots on the low and middle elevation sites led to an increase in Collembola abundance in litterbags from those plots. Results from these studies suggest not only significant influences of elevation on litter decomposition and soil fauna abundance, but direct links between canopy herbivory and responses in population densities of forest floor biota.

Reference: Response of Soil Invertebrates to Forest Canopy Inputs Along a Productivity Gradient (Reynolds, Crossley, and Hunter, Pedobiologia *in press*).

Our artificially induced forest gap project is nearing completion of the first phase of work. This replicated study conducted on high and low elevation forest sites has monitored the microclimate, seedling dynamics, physiology, and N mineralization of both rhododendron and non-rhododendron study sites. Results show that the impact of rhododendron was highly detrimental to seedling establishment and growth. Several investigators have now established forest gap plots resulting from hurricane Opal that impacted Coweeta on 05 October 95. This progression to more and widespread plots will allow us to investigate the gap dynamics across a larger geographic area and elevational gradient of the Coweeta Basin.

Data and GIS Management

The information management system of the Coweeta Long-term Ecological Research Program is designed to support the scientific efforts of all associated investigators as well as our obligations to the wider research and educational communities.

The Coweeta LTER Program represents an interdisciplinary research effort that builds from our studies and data on environmental gradients and natural disturbance toward a comprehensive understanding of the spatial, temporal, and decision-making components of land use and land-use change in the southern Appalachian Mountains. The collaborative, multidisciplinary research teams associated with this effort depend on a scientific information system that not only archives data and information, but also foster its use. Our web-interface (http://coweeta.ecology.uga.edu) is the access portal to data, metadata, and information on long-term research in the Southern Appalachian Mountains that is physically distributed from the University of Georgia campus in Athens to the Coweeta Hydrologic Laboratory in Otto, North Carolina.

Coweeta LTER Program researchers and their students are similarly distributed since they are located at seven institutions around the country. To meet our emerging needs as a region-based research project and in anticipation of the information demands of the proposed research, we reorganized the staff and objectives of the Coweeta Informatics Center (CIC) at the University of Georgia in the fourth quarter of 2001 and hired Barrie Collins as the Coweeta LTER Information/GIS Manager. He brings over a decade of senior-level experience working with ESRI and ERDAS softwares, and integrating spatial and attribute databases so they are maximally responsive to users. He will be assisted in the renewal by Ron Rouhani on a part-time basis who served for several years as the Coweeta LTER Information Manager and has extensive programming skills in building structured SQL databases for personnel and ecological data.

Our informatics platform is a network of Sun SPARC (UNIX) and NT workstations, that serve as the backbone to communicating data, information and knowledge across spatial, temporal and disciplinary boundaries. Eighty-one data sets and their associated metadata are downloadable. We are also developing general purpose databases for the entire study region that will be available for download through our Internet Map server (see below). Our website also includes a dynamic scheduling calendar for dorm rooms at Coweeta, and making reservations on project equipment and vehicles. Finally, we make available online our LTER proposals, annual research summaries, a searchable bibliography, diverse other information and will soon be providing full-text research articles.

Physical samples including voucher specimens of plants and animals along with soil samples are an invaluable resource for future researchers. Plant vouchers and soil samples are presently archived at the Coweeta Hydrologic Laboratory, with the list of items available on our website. Animal vouchers (including fish, herps, small mammals, and arthropods) are archived at the Georgia Museum of Natural History (GMNH) in Athens where they are available to all researchers through standard GMNH policies. The Coweeta LTER Program has archived over 38,956 specimens of plant, animals, and soils.

Barrie Collins is presently coordinating the effort of several assistants in documenting and locating historical and ongoing research sites in both the Coweeta Basin and the region; metatagging information to facilitate and expedite search and retrieval operations; and developing web-accessible products that respond to the varied levels of need and expertise of our site users (researcher and visitor alike). As Barrie Collins completes the first steps of the CIC reorganization, he will begin a second phase directed at facilitating the exchange of information specific to the research objectives of our renewal proposal, and linking some of our empirical models with voucher information in a prototype spatial display.

Collaborative Efforts. We have worked toward developing and implementing an informatics platform that not only builds from our necessities as an independent research project, but from the needs of the larger community of LTER researchers and public users. We have benefited in solving technical issues and building information capital from our collaborations with the H.J. Andrews LTER (Theresa Valentine; Don Henshaw), the San Diego Supercomputer Center (Tony Fountain; Chaitan Baru; Peter Arzberger), and the Central Arizona-Phoenix LTER (Peter McCartney). More recently we began a close collaboration with the information management and GIS centers of the Georgia Coastal LTER, which like the Coweeta LTER is also based at the University of Georgia Athens campus. This collaboration will allow both sites to pool knowledge resources toward developing a mature information management system, and through our common commitment make it possible for researchers to carry out plot-to-regional science in tangible ways from the Blue Ridge peaks of North Carolina to the Atlantic coast of Georgia.

Our Approach to Information Management. Much of our recent information management efforts have been in building a solid infrastructure that supports our current and proposed research program. From the premise that information management should make data readily available to those who seek it, Coweeta has invested heavily in personnel and equipment. This is because web technologies, GIS, and advanced database systems are potentially the most effective way to both organize and serve data, and maintain the level of communication necessary between Coweeta researchers, LTER network researchers, and fellow researchers across a wide span of disciplines. Most data management tasks are accomplished with the SAS data-warehousing

engine, while the SAS/ASSIST module allows easy creation and updating of data sets, generating QA/QC procedures, and interactive analysis of data sets.

Geographic Information Systems. Our GIS (geographic information system) is built around software standards in the field: ESRI's ARC/INFO and ARC/VIEW, and the ERDAS Image package for digital image analysis. Spatial information is provided as fully projected GIS files (ERDAS IMAGINE and ESRI ARC/Info), mid-level GIS (ARC/View), and exportable files for transfer to other software packages. Through our highly customized Internet Mapper, we make it possible for individuals to access and manipulate GIS data with no GIS software or GIS experience. This system was officially launched on January 31, 2002, and provides tangible evidence of the Coweeta LTER Programs commitment to making data publicly available. The Internet Mapping Tool will allow visitors to the Coweeta LTER website to access maps and their supporting attribute information through Internet Explorer or Netscape, without any additional software or GIS experience. The first datasets are now online and hosted as an Internet Map, while the schema and rationale for the system is available in the DataBits Newsletter (http://www.lternet.edu/documents/Newsletters/DataBits/00fall).

Coweeta LTER Outreach Activities

Our research site has participated in a number of outreach activities during the past year.

First, Coweeta personnel have continued to dedicate part of their time to lead tours for a variety of scientists, resource managers, and students to present and discuss research conducted at Coweeta. This past year we provided tours for over 1100 people with topics ranging from climate network operation, to watershed ecology, to terrestrial gradient research, to the impacts of hurricane Opal in October 1995 on our steep mountain terrain.

Second, our site has again been fortunate to receive Research Experience for Undergraduate (REU) positions. This past year, student research focused on fish populations, rhododendron and laurel biomass, and nitrogen distribution and the impact of land use history on small mammals and herbaceous plants.

Third, the Coweeta LTER program has pursued all NSF Schoolyard LTER initiatives to build upon our long term commitment to K-12 education. This past year we have had five teachers, 8 research staff, and over 50 students involved in Schoolyard LTER projects.

Cross-Site Research Projects

There are several cross-site research projects involving the Coweeta LTER site. The first project is a cross-site study by Liam Heneghan, Dave Coleman, Xiaoming Zou, Dac Crossley, and Bruce Haines at the University of Georgia. They are studying microarthropod regulations of microbial populations involved in leaf litter decomposition in sites in Puerto Rico, Costa Rica, and Coweeta. Cross-site litter decomposition is being compared along with a quantification of the abiotic and biotic agents affecting this decomposition. This study has already produced several publications listed at the end of this annual report.

The second project is NSF funded and concentrates on fine and coarse root growth and dynamics across a series of sites, both LTER and non-LTER, that is coordinated by Ronald Hendrick at the University of Georgia for the Coweeta sampling. The Coweeta site is located on a Terrestrial Gradient project study site and has benefited from the eight years of baseline information already available on the microclimate, soil solution chemistry, throughfall and litter

inputs, and large viewing rhizotrons. The minirhizotrons for this study were installed at Coweeta in September 1996 and the first observations were recorded in spring 1997.

Third, the Mulholland et al. LINX2 project is a cross-site experiment involving several LTER sites. We will use field experiments to determine the rates and factors controlling nitrate uptake and retention in relatively pristine streams and in streams that have been altered by agriculture or urban development and have elevated nitrate levels. These experiments will allow us to test a variety of hypotheses dealing with the impacts of human disturbances on streams, including effects on channel morphology, hydraulics, biological activity, and N retention. At each of eight sites distributed across diverse biomes throughout the U.S., we will perform tracer-level ^{15}N-nitrate addition experiments to trace the fate of nitrate in nine streams: 3 reference, 3 agricultural and 3 urban streams (for a total of 72 streams across all sites). Each experiment will consist of a 24-h addition of ^{15}N-nitrate and longitudinally distributed measurements of ^{15}N in water and in various benthic organic matter pools to determine *in-situ* rates of nitrification, assimilatory uptake of nitrate, and denitrification in each stream. We will use our experimental results to develop a general, process-based model of nitrate retention in stream reaches. We then will extend our results to much larger spatial scales by combining our stream model with GIS-based information on hydrography and land use to predict nitrate retention in 5th or 6th order river basins at each of the eight study sites.

Fourth, Jennifer Knoepp (Coweeta) and Lindsay Boring (Joseph W. Jones Ecological Research Center) are studying the use of nitrogen isotope ratios to determine forest disturbance history and nitrogen inputs and utilization. Changes in nitrogen availability often occur following site disturbance by either cutting or burning (Bormann and Likens 1967). On some sites, these changes are due in part to an increase in populations of nitrogen fixing plant species. This occurs in a diverse range of ecosystems including southern Appalachian hardwood forests and longleaf pine/wiregrass savannahs (Boring et al. 1988; Hendricks and Boring 1999). The fixation of atmospheric nitrogen results in the formation of plant material with a stable nitrogen isotope ratio signature (δ^{15}N) similar to atmospheric nitrogen. The δ^{15}N signature of plant available nitrogen in the soil is the product of the plant material added to the soil as well as alterations that occur due to biological soil nitrogen transformation processes. We will characterize the N isotope ratios in current site foliage, tree rings collected with increment cores, and soil organic matter through the soil profile, to identify changes in nitrogen fixation and nitrogen uptake patterns on forested sites disturbed by fire and cutting.

LTER/ILTER Network Activities

We have participated in several LTER and ILTER network activities outside of the regular coordinating committee meetings attended by our site administrators and the annual information management meetings attended by our computer and management staff.

First, Dave Coleman, Coweeta Co-Lead PI, has been chairman of the LTER Publications Committee that is advising on all LTER publications, including the LTER synthesis volumes series, being published by Oxford University Press. He stepped down from that position in June 2002.

Second, Brian Kloeppel participated in the September 1998 Poland ILTER trip with Jim Gosz. Brian was then awarded a grant for cross-site research in Poland and has made research excursions to Poland in 2000, 2001, and 2002. One manuscript has been submitted and two manuscripts are in preparation from this research. Brian also participated in the April 2001

Central and Eastern European Regional ILTER Meeting in Prague, Czech Republic and will be participating in the same annual meeting to be held in Zvolen, Slovak Republic in August 2002.

Third, Ted Gragson has received a supplement to initiate ILTER in France. The research will focus on social interactions and impacts on ecosystems.

Fourth, James Vose and Wayne Swank are continuing collaborative research on watershed-scale studies with colleagues at The University of Istanbul. In 2003, Coweeta will host Dr. Yusef Serengil for a one-year postdoctoral research project.

Fifth, Brian Kloeppel has lead authored, along with three co-authors, a chapter in the Greenland et al. LTER Climate Variability book that is currently in press. The chapter focuses on the effects of recent drought on the growth and mortality of southern Appalachian forests.

Sixth, Wayne Swank continues to cooperate with Professors Fred Worrall and Tim Burt at Durham University on time series analysis for Coweeta stream chemistry, runoff, and precipitation. This effort has resulted in four published/in review manuscripts.

Seventh, Dr. Manuel Maass, Institute of Ecology in Morelia, Mexico, spent a nine-month sabbatical at Coweeta in 2002 to continue cooperative research on forested watersheds with James Vose and Wayne Swank.

Eighth, Coweeta has fully participated in the ClimDB and HydroDB LTER Network activities to centrally locate and document long-term climate and hydrologic data for both the internal and external LTER communities. This effort was led by Lloyd Swift, Julie Moore, and Barrie Collins at Coweeta.

Ninth, Brian Kloeppel (Coweeta LTER) and Mark Harmon (Andrews LTER) have a co-authored book chapter in preparation for the Fahey and Knapp (co-editors) LTER Net Primary Productivity volume. The compiled chapter outlines are being presented to the publisher representative at the Annual ESA Meeting in Tucson, AZ in August 2002.

Publications of the Coweeta LTER Project (2001 - present)

Please link below to the searchable Coweeta LTER Online Bibliography to locate citations and abstracts of publications. As of 09 August 2002, we have 57 publications from 2001 to present. These citations have also been entered online for the electronically submitted annual report to NSF.

http://coweeta.ecology.uga.edu/webdocs/1/publications.html

Coweeta LTER Related Research Grants (Active in 2001-2002)
Excludes 1996-2002 Coweeta LTER grant from NSF (DEB 96-32854) for $6,030,489
(27 grants total for $10,813,409 representing 9 funding agencies)
Compilation as of 09 August 2002 by Brian D. Kloeppel

Bolstad, P.V., P.B. Reich, and J.M. Vose. Acclimation/adaptation of leaf respiration in eastern deciduous forests: a biome-wide study. Funded by National Science Foundation - Ecological Studies / Ecosystems for $375,000 from 1999 to 2001.

Bolstad, P.V., J.M. Vose, D.M. Wear, and M.S. Riedel. Land use, carbon, and water in the Southeastern Uplands. Funded by the National Aeronautics and Space Administration for $290,000 from 2002 to 2004.

Coleman, D.C. and B.D. Kloeppel. Equipment supplement proposal for the Coweeta LTER program (DEB-96-32854). Funded by National Science Foundation for $25,000 from 2000-2001.

Coleman, D.C., T.L. Gragson, B.D. Kloeppel, and B. Collins. Supplemental proposal for establishing/enhancing on-line access to long-term hydrologic and environmental data from the Coweeta LTER Program. Funded by the National Science Foundation for $8,000 from 2002 to 2003.

Hunter, M.D. Top-down and bottom-up effects on herbivores: nutrient availability and the trophic interactions of insects on oak. Funded by National Science Foundation for $70,000 from 1999 to 2001.

Hunter, M.D., M.D. Lowman, and T.D. Schowalter. Canopy herbivory and soil processes in a temperate and tropical forest. Funded by National Science Foundation for $300,000 from 1999 to 2002.

Kloeppel, B.D. and D.C. Coleman. Communications and technology facilities improvement to the LTER program at Coweeta Hydrologic Laboratory. Funded by National Science Foundation for $290,000 from 1999 to 2004.

Kloeppel, B.D. and D.C. Coleman. Carbon and water dynamics in mature and old growth forests in Poland and the United States. Funded by National Science Foundation - International Programs for $14,667 from 1999 to 2002.

Kloeppel, B.D. and D.C. Coleman. Dormitory renovation and expansion at Coweeta Hydrologic Laboratory. Funded by National Science Foundation - Field Station and Marine Laboratories for $198,000 from 1999 to 2001.

Kloeppel, B.D. and D.C. Coleman. Education supplement to the Coweeta LTER Program (NSF Grant DEB-96-32854). Funded by National Science Foundation for $30,000 from 2000-2001.

Kloeppel, B.D. and D.C. Coleman. Education and equipment supplement to the Coweeta LTER Program (DEB-96-32854). Funded by National Science Foundation for $55,000 from 2001-2002.

Kloeppel, B.D., D.C. Coleman, and J.M. Vose. Analytical laboratory equipment at Coweeta Hydrologic Laboratory. National Science Foundation - Field Station and Marine Laboratories for $60,063 from 2000 to 2001.

Knoepp, J.D. and L.R. Boring. Use of nitrogen isotope ratios to determine forest disturbance history and nitrogen inputs and utilization. Funded by USDA Forest Service—Southern Research Station and Joseph W. Jones Ecological Research Center for $10,000 from 2002 to 2003.

Mulholland, P.J., B.J. Peterson, S. Hamilton, J.L. Tank, R. Hall, C.N. Dahm, W. Dodds, S. Findlay, S.V. Gregory, N.B. Grimm, S. Johnson, W. McDowell, J.L. Meyer, G. Poole, H.M. Valett, and J.R. Webster. Nitrate uptake and retention in streams: Mechanisms and effects of human disturbance from stream reaches to landscapes. Funded by the National Science Foundation for $3,000,000 from September 2001 to August 2006.

Nilsen, E.T., O.K. Miller, and B.D. Clinton. Probing the mechanisms by which subcanopy evergreen shrubs inhibit tree seedling recruitment. Funded by USDA-NRI-CSRS for $485,000 from September 1999 to August 2003.

Pulliam, H.R. Habitat suitability and the distribution of species. Funded by National Science Foundation for $240,285 from June 2000 to December 2003.

Reynolds, B.C. et al. Variability in decomposition and microarthropod communities in recently restored and intact plant communities. Funded by the North Carolina Department of Transportation for $3,895 from 2002 to 2004.

Rosemond, A.D., J.B. Wallace, K. Suberkropp, and P.J. Mulholland. Nutrient effects on a detritus-based ecosystem. Funded by National Science Foundation for $700,000 from January 1999 to December 2002.

Swank, W.T. and J.M. Vose. Estimating effectiveness of groundwater removal in fast-growing cottonwoods planted for phytoremediation of trichloroethylene. Funded by US Department of Defense, Wright-Patterson Air Force Base for $191,000 from 1991-2001.

Valett, H.M., J.R. Webster, P.J. Mulholland, C.N. Dahm, P.V. Unnikrishna, and C.G. Peterson. Nitrate retention in headwater stream: influences of riparian vegetation, metabolism, and subsurface properties. Funded by National Science Foundation for $1,120,000 from April 1999 to March 2002.

Vose, J.M. Distinguishing groundwater vs. surface water uptake in phreatophytes. Funded by US Department of Defense, Wright-Patterson Air Force Base for $75,000 from 2000-2001.

Vose, J.M. Quantifying transpiration of native overstory vegetation. Funded by the Department of Defense, Charleston Airforce Base for $98,000 from 2000 to 2002.

Vose, J.M., K.J. Elliott, T.L. Gragson, and W. Covington. Integrative assessment of the historical role and contemporary uses of prescribed fire in southern Appalachian ecosystems. Funded by the Joint Fire Science Program (Departments of Interior and Agriculture) for $291,499 from 2003 to 2005.

Vose, J.M. and C.D. Geron. Assessing nitrogen cycling mechanisms to evaluate riparian zone restoration effectiveness. Funded by US-EPA Ecosystem Restoration Competitive Grants Program for $486,000 from 2000-2003.

Vose, J.M. and R. Mickler. Impacts of prescribed fire and wildfire on water quality. Funded by the USDA Forest Service National Fire Plan for $1,300,000 from 2002 to 2006.

Vose, J.M. and W.T. Swank. Determining sensitivity of Class I Wilderness Areas to acidic deposition: case studies of the Joyce Kilmer and Slickrock Wilderness Areas. Funded by National Forest Systems for $90,000 from 1999-2001.

Wallace, J.B., J.L. Meyer, K. Suberkropp, and J.R. Webster. Consequences of detrital complexity for ecosystem function. Funded by the National Science Foundation for $1,007,000 from August 2002 to July 2006.