Thursday 06 January 2000
Location: Meeting Hall, The Mountain Retreat and Learning Center, near Highlands, NC

Presentation Equipment: Please note that a slide projector, overhead projector, and digital projector will be available for use throughout the meeting.

10:00 **Introductions, Logistics, and Opening Remarks** (Coleman, Kloeppel, and Jenny Stein - Representative from The Mountain)
Introductions: Kathy Flowers - Clerk/Typist, Coweeta Hydrologic Laboratory
Frank van Manen - Univ. of Tennessee Southern Appalachian Assessment (unable to attend)
William McLarney - Representing Tennessee Valley Authority
Pat Mulholland - Oak Ridge National Lab (unable to attend)
John Pickering - Great Smoky Mountain National Park Biotic Inventory
Elizabeth Reitz and Elizabeth McGhee - Director and Zoology Collection Manager, UGA Natural History Museum
Robert Turner - Southern Appalachian Man and the Biosphere (SAMAB)
Robert Wyatt - Director, Highlands Biological Station

10:30 **New Initiatives from NSF** (Coleman, Kloeppel, others???)
BON: Biological Observatory Network
NEON: National Environmental Observation Network

Guest Presentations

11:15 Highland Biological Station Research Interests (Wyatt)

11:30 UGA Museum of Natural History Research Interests (Reitz)

11:45 Tennessee Valley Authority Ecological Research Interests (McLarney)

12:00 Southern Appalachian Man and the Biosphere (SAMAB) (Turner)

12:15 Great Smoky Mountain National Park Biotic Inventory (Pickering)

12:30 Lunch at the The Mountain dining hall

Information/GIS Management

1:30 Coweeta LTER Information Management: Updates, Challenges, and Issues (Rouhani)

1:50 Coweeta LTER GIS Management: Hazard Index Project and Updates (Gardiner)

Thursday 06 January 2000
Location: Meeting Hall, The Mountain Retreat and Learning Center, near Highlands, NC

2:10 Break

2:30 Group Discussion: BON and NEON Initiatives
Where do we go from here?????
Plans, assignments, etc.

New Research Project Introductions

3:30 New and Proposed Socio-economic Research (Gragson)

3:45 Socio-economic Research Project Summary (Newman)

4:00 Group Visit to Highlands Biological Station (Wyatt)
The purpose is to view facilities and to evaluate potential collaborative research.

5:30 Social before and after dinner with wine, beer, soft drinks, etc.

6:00 Dinner at The Mountain dining hall
Graduate Student Discussion: All Scientists Meeting, Communications, etc. (Madson)

7:00 Poster Session in Meeting Room with Refreshments

Posters:

Bonito, G. and B. Haines. Nitrogen Mineralization in Soils of Northern Hardwoods and Oak Pine Stands

McTammany, M.E., E.F. Benfield, E.P. Gardiner, and P.V. Bolstad. Stream Recovery from Agriculture: observations from preliminary stream surveys.

Reynolds, B.C., M.D. Hunter and D.A. Crossley, Jr. Litter Decomposition and Microarthropod Abundance along an Elevation Gradient in Western North Carolina.

Schofield, K., E. Rossi, C. Pringle, and J. Meyer. Analysis of Food Web Dynamics in Streams Draining Forested, Residential, and Industrial Landscapes.

Scott, M.C. and G.S. Helfman. Land Use, Stream Habitat Alteration, and Fishes: new directions for inquiry.

Sutherland, A., J. Meyer, and E. Gardiner. Effects of Land Use on Sediment Transport and Fish Assemblage Structure in Southern Appalachian Streams.

Zuckerman, M. and D. Coleman. Litter decomposition and nutrient dynamics in urbanized riparian zones of the Southern Appalachians

Friday 07 January 2000
Location: Meeting Hall, The Mountain Retreat and Learning Center, near Highlands, NC

7:00 Early Morning Hike For Those Interested (Kloeppel)
There are several short, but interesting trails around The Mountain property.

8:00 Breakfast at The Mountain dining hall

8:45 Opening Remarks and Reminders (Coleman)
a) Update about All Scientists Meeting in August 2000 in Snowbird, UT
b) Dates for mid-year science meeting in Athens, GA (12-13 June 2000)

9:00 Coweeta Facilities Update (Kloeppel)

New Research Project Introductions (continued)

9:15 Forest Gap Research (Clark)

9:30 Cross-Site DIRT Research (Coleman and Knoepp)

9:45 Functional Diversity Research, Coweeta Large-Scale Watershed Manipulations (Vose)

10:00 Cross-Site Litter Aquatic/Terrestrial Decomposition Research (Hunter/Pringle/Coleman)

10:15 Breakout Groups:
Forest Gap Studies (Clark)
Aquatic Studies (Webster)
Regionalization Studies (Gragson)
Riparian Studies (Yeakley)
Terrestrial Studies (Knoepp)

11:15 Reassemble as a Group and Report Back from Breakout Groups

12:00 Discussion of 2002-2008 University of Georgia Lead PI

12:30 Lunch at the The Mountain dining hall

Co-PIs Not Attending (staff and students filling in):
Grossman, Hendrick, Turner, and Wear

Coweeta LTER Co-Principal Investigator Research Summaries

Fred Benfield (benfield@vt.edu)

Long-term studies of leaf breakdown in Big Hurricane Branch, Benfield & Webster

Jack Webster and Jack Waide performed leaf breakdown studies in Big Hurricane Branch prior to, during, and following the experimental clear-cut of WS7. Since then, Jack, I and our students have done 3 additional leaf breakdown studies at approximately 5-year intervals and we began a 4th in December 1999. The latter 3 and present study included comparable sites in Hugh White Creek as well. We have measured breakdown rates for a variety of species but the one used in all studies to date is rhododendron (Fig 1). Except during 1986-87 (a severe drought year), leaf breakdown rates have been consistently higher for all species in years since the clear-cut. Rates have also been consistently higher in BHB than in HWC for the years both have been studied. We presented these results at an international conference in Austria in September 1999. A paper will be published in the Internat. Rev. Hydrobiol. and the data will become part of the stream chapter in the forthcoming WS7 book.

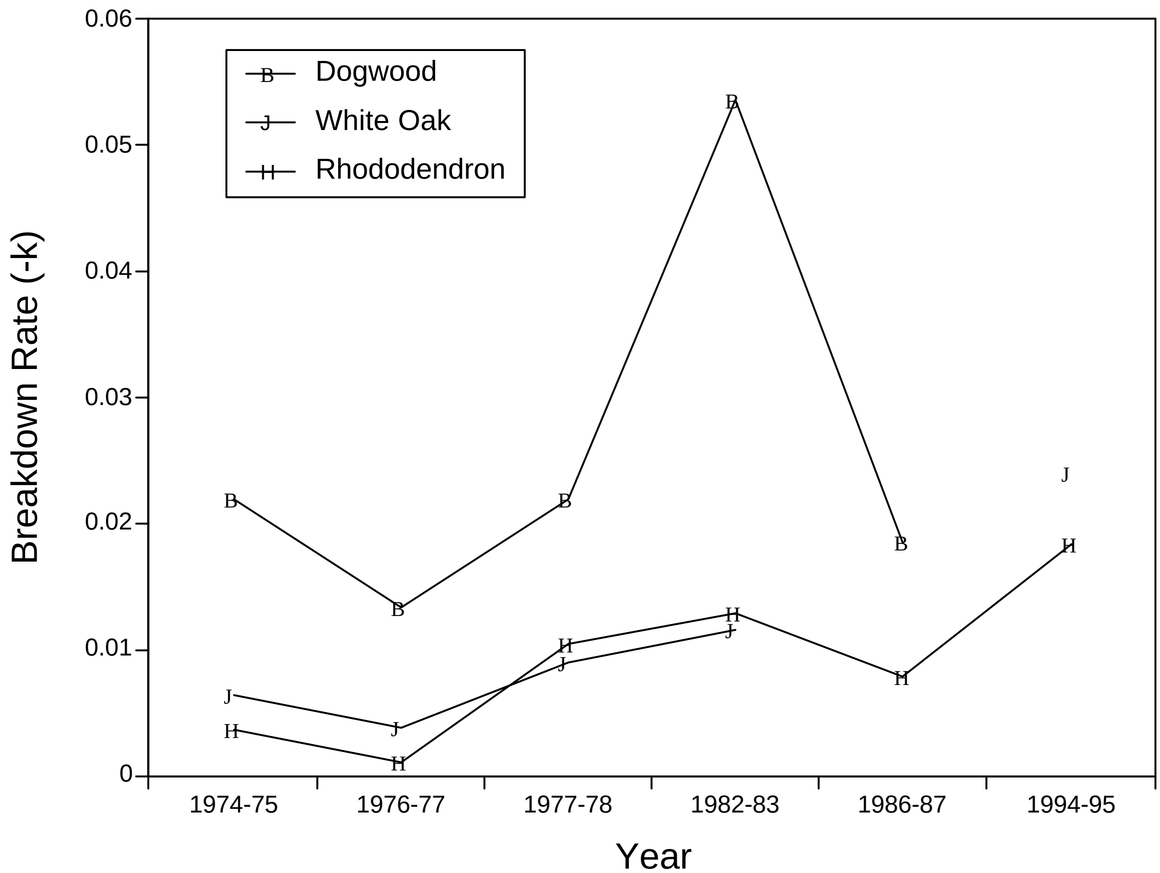


Fig 1. Leaf breakdown rates in BHB prior to (1974-75), during (1976-77), shortly after (1977-78), and over the long term (1982-83, 1986-87, 1994- 95).

Virginia Tech Regionalization Stream Studies-Benfield & McTammany

Recent work on the Virginia Tech stream portion of the regionalization project has centered on selecting sites for measuring invertebrate biodiversity and stream function in streams with differing land-use history and trajectory. In the early days of the project, multiple streams were selected from the Little Tennessee and French Broad basins using topo maps and driving the streams because the GIS database was still under development. Our analyses of land-use effects on invertebrate and fish diversity were performed using the post-sampling GIS database and published in PNAS. In short, we found rather predictable differences in biodiversity between agricultural and forested streams but found some forested streams that appeared to have fauna characteristic of agricultural streams. The GIS data demonstrated that these apparently forested streams were largely agricultural in the 1950's suggesting legacy effects from previous land-use.

In the second phase of the project, we began using the GIS data base developed by Bolstad to search for streams in the region that have different land-use trajectory based on the 1950 and 1990 GIS maps. Our goal was to attempt to quantify legacy effects of agriculture on stream structure and function. Our strategy was to select 3 suites of streams for study: 1) streams that were agricultural in 1950's and 1990's; 2) streams that were forested in the 1950's and 1990's; 3) streams that were agricultural in the 1950's but forested in the 1990's. We set about categorizing essentially all 1-4 order streams in the FB & LT basins plus streams in Grayson County Va (New River Basin) and developed a data base of streams fitting the categories outlined above. Using current GIS maps, we found many steams whose watersheds were 50-60% agriculture in the 1950's but were >95-99% forested in the 1990's. We then began visiting the streams to select specific sampling sites and discovered patterns of land-use that did not conform to what was expected from the GIS database. For example, most the 1-5% open/agricultural that has not regrown in forest lies in the stream corridors. Much of this open land is old family homes, gardens, tobacco plots, small pastures, etc. These areas did not show up on the GIS due to the pixel scale employed. We believe we now need to alter our strategy in site selection to focus on stream corridors at a smaller scale. We are attempting to secure more recent satellite imagery that will be at much smaller pixel scale and will then re-evaluate "1990's" land-use in the 3 basins. After re-evaluating the land-use and selecting streams, we plan to initiate field studies on invertebrate diversity in early spring 2000 and on decomposition in fall 2000. We will also begin characterizing the streams chemically and physically in summer 2000.

Paul Bolstad (pbolstad@forestry.umn.edu) – No Research Summary

James Clark (jimclark@acpub.duke.edu)

Understanding how forests respond to environmental change requires models that extrapolate from short-term observations to long-term (decade to century) dynamics. The current "gap dynamic" paradigm does this extrapolation under the assumption that recruitment is governed by conditions within canopy gaps 30 m in diameter. Much empirical evidence and our experimental tests of the paradigm suggest that diversity in many forests may depend on much larger canopy gaps than assumed in the models now used to forecast forest response to global change. If the underlying assumptions of the models are unrealistic, then predictions under novel environments of the future are likely misleading.

The new gap grant use a series of field experiments and model tests that together will demonstrate i) gap sizes at which recruitment limitation is severe, and ii) whether maintenance of forest diversity depends on large gaps. Field studies will both test for specific life history stages at which recruitment limitation occurs and the factors responsible for limitation, while also providing parameter estimates for modeling studies. We will determine the extent to which fecundity, seed dispersal, predation in seed banks, and availability of soil microsites affect recruitment in the closed forest understory and in gaps of different sizes. Two modeling approaches will be used to determine the population and community consequences of experimental results. To determine the effects of demography observed in experimental and natural gaps on growth rates we will use parameters in a stage structured population model. Analysis of the model will provide growth rate estimates implied by demography for each gap type and the contributions (sensitivities and elasticities) of each life history stage to population growth. An individual based model will be use to incorporate spatial elements, including seed dispersal and
competition for light. Analysis of this model will provide estimates for the effects of gap size on forest diversity. Together field experiments and modeling studies will allow us to assess the contribution of disturbance to forest dynamics and, thus, assess how forests may respond to novel environments in the future.

Barton D. Clinton (bclinton@sparc.ecology.uga.edu)

Research on the Role of *Rhododendron maximum*

From 1995 to 1998, Erik Nilsen, Orson Miller, and myself through funding provided by USDA CSRS-NRI, conducted a study designed to identify mechanisms associated with competition between *Rhododendron maximum* and other important hardwood species. The purpose was to further explain causes for the lack of regeneration beneath rhododendron. In that study, a combination of several laboratory experiments and a field study revealed several sources of inhibition to seedling establishment, in addition to low light, all of which were in the form of an apparent chemical inhibition. The most conclusive were decreased rates of root elongation from germinating seed (Nilsen et al. 1999), and delayed mycorrhizal infection rates on woody seedling roots (Walker et al. 1999). The conclusion is that below ground interaction between rhododendron and other hardwood species may explain as much or more of the observed absence of seedling recruitment beneath rhododendron as does low light. A recently funded renewal will allow us to examine more closely the interaction between mycorrhizal species. We have added an additional dimension by including *Kalmia latifolia* in our studies of the role of evergreen understories in southern Appalachian forests.

Nilsen, E.T., T.T. Lei, J.F. Walker, O.K. Miller, S.W. Semones, and B.D. Clinton. 1999. Allelopathic potential of *Rhododendron maximum*: Inhibition of seedling survival: Could allelopathy be a cause? Amer. J. Bot. **:**-**.

Walker, J.F., T.T. Lei, S.W. Semones, E.T. Nilsen, B.D. Clinton, and O.K. Miller. 1999. Suppression of ectomycorrhizae on canopy tree seedlings in *Rhododendron maximum* L. (Ericaceae) thickets in the southern Appalachians. Mycorrhiza 9:49-56.

David C. Coleman (coleman@sparc.ecology.uga.edu)

Progress Report for the period, June-December 1999, Coweeta LTER project

We have made considerable progress on several projects with which I am involved, on a day-to-day scientific basis. These are listed in order of time and effort expended, not counting the general work entailed as co-lead PI, shared between Jim Vose and myself, with considerable time and effort expended by Brian Kloeppel, Site Manager.

1. Hillslope-riparian studies with Yeakley, Taylor, Kloeppel, et al. This work continues on a less-intensive basis, with lysimeters being read during the growing season, and other micrometeorological and abiotic measurements being made monthly. Coleman and Zuckerman are retrieving litterbags of Rhododendron and Chestnut Oak litter three times yearly (every four months), and they are being analyzed for ash-free dry matter (for decomposition measurements of k values), Carbon and Nitrogen. This work will continue for another three full years, to follow up on soil edaphic conditions through the end of 2002.

2. Hillslope-riparian studies in the region, with Zuckerman and Coleman. An extensive network of litterbags will be set up in early 2000 in the Little Tennessee and French Broad River basins, to examine the range of conditions on a gradient from urban to rural sites. This will follow changes in nutrient contents, and also look for any heavy metals or other pollutants that might be affecting the decomposition processes in the region. This will be presented in a poster by Zuckerman in the Thursday Jan. 6, 2000 meeting.

3. Progress on soil respiration historical measurements. Working in collaboration with Lloyd Swift and Mark Hunter, I have obtained soil moisture and temperature data for the monthly measurements of soil respiration from early IBP days, taken by Steve Pomeroy and Bob Todd, and the REU work of John Hutton in summer and fall of 1995. Using stepwise multiple regressions, we have accounted for from 58-60% of the total variance in the soil respiration across four sites, in the lower portions of WS's 6,13,17, and 18. The doubling of soil respiration across 25 years seems to be real, and reflects a greater standing crop of soil OM and possibly root tissues as well. This work will be sent in to Pedobiologia or Can.J. For. Res. in the next 2-3 months.

4. The DIRT experiment: New cross-site studies, on long-term effects of forest floor components manipulation (Coleman,Vose, Knoepp, Adl). In collaboration with Knute Nadelhoffer of Harvard Forest, and Kate Lajtha, Andrews Forest, we are exploring an extensive and long-term 30-50 years + experiment in one or more of our gradient sites at Coweeta. This would entail massive trenching, litter additions, and removals, and we would plan to obtain supplemental funding from NSF for this work. Several sites across the North American continent have indicated interest, including BNZ,AND,CDR,CWT,HFR. Coleman will present a few minutes overview of this new study, for consideration by the entire group.

5. Cross-site study of decomposition in temperate and tropical terrestrial and aquatic habitats (Coleman, Hunter, Pringle, and Adl). Our key questions revolve around the impacts of macro- and micro-decomposers on high and low-quality litters (in terms of C/N and

palatability, astringency, etc.). Our study is on target, with litter collected, and litterbags to be emplaced at Coweeta and at Luquillo in late January. The aquatic portion will begin in May with work by Pringle and Greathouse at PR. This work will be described briefly at our January meeting. December 15, 1999

Dac Crossley (dac@sparc.ecology.uga.edu)

One Current Project:

Title: A two-year study of leaf litter decomposition and associated microarthropods on the gradient.

Status: Litterbags have all been collected, weighed, and await analysis for C and N. Preliminary counts of microarthropods are completed. Detailed analysis (identification of species) is proceeding.

Rationale: Previously, Coeli Hoover collected litterbags for one year and accepted type II error; finding essentially no difference in decomposition rates or microarthropods. Karen Lamoncha studied soil cores and found only minor differences in microarthropod populations. I decided to repeat the litterbag study, this time over a two-year period, where I hope to pick up a gradient effect.

Pertinent publications this year:

Crossley, D. A. Jr., Randi A. Hansen and Karen K. Lamoncha. 1999. Response of forest floor microarthropods to a forest regeneration burn at Wine Spring Watershed (Southern Appalachians). Pp. 1-15 *in* J. E. Cook and B. P. Oswald (eds.) Proceedings of the First Biennial North American Forest Ecology Workshop, Raleigh, NC.

Crossley, D. A. Jr. and David C. Coleman. 1999. Microarthropods. Pp. C59-C65 *in* Malcolm E. Sumner (ed.-in-chief) Handbook of Soil Science. CRC Press, Boca Raton.

Crossley, D. A. Jr. and David C. Coleman. 1999. Macroarthropods. Pp. C65-C70 *in* Malcolm E. Sumner (ed.-in-chief) Handbook of Soil Science. CRC Press, Boca Raton.

Heneghan, L., D. C. Coleman, D. A. Crossley, Jr., and Zou Xaioming. 1999. Nitrogen dynamics in decomposing chestnut oak (*Quercus prinus* L.) leaf litter in mesic temperate and tropical forests. Appl. Soil Ecol. 13: 169-175.

Heneghan, L., D. C. Coleman, X. Zou, D. A. Crossley, Jr., and B. L Haines. 1999. Soil microarthropod contributions to decomposition dynamics: tropical-temperate comparisons of a single substrate. Ecology 80: 1873-1882.

Katherine Elliott (kelliott@sparc.ecology.uga.edu) – No Research Summary

Ned Gardiner (ned@sparc.ecology.uga.edu)

GIS Summary

System Administration/Data Management

- Prepared for the NSF site review by finalizing the layout of the GIS web site and preparing to integrate our GIS database with the rest of the Coweeta database. Developed a set of arcview projects for the NSF review team.
- Supplemental funds from Meyer were used to hire an assistant to create a database of streams and watersheds mapped at 1:24K scale for the French Broad and Pigeon basins, thus completing our coverage of western North Carolina (manuscript submitted).
- Installed ESRI's internet map server (IMS 1.0) to provide live mapping capabilities for investigators. This function is hosted by an NT server. Will organize workshop at All-Scientists' Meeting on internet mapping. Used IMS for communicating with Virginia Tech investigators on hazard project.
- Attended Data Managers' meeting in Spokane, WA. Was elected to IM executive committee for 3-year term.
- Installed Y2K patches to GIS server and workstations. Isolated GIS server and 2 dedicated workstations (total = 3; 1 NT; 1 unix client; 1 unix server) from the mail server (sparc) to prevent dependencies between the systems.

New Imagery

- Successful bid to NASA for high resolution (ADAR 5500) imagery of riparian areas in the Little Tennessee Basin. Imagery will cover several stream regionalization sites, the mainstem of the L.T. in North Carolina, and Jack Webster's floodplain/primary production sites. Imagery not received.
- Purchased Landsat 7 image from Fall 1999 for Little Tennessee Basin. Collaborating with Kloeppel on REU project using imagery in a tree physiology study. Imagery not received.
- Ordered color infrared NAPP (1:40,000) photos for the L.T. Not received.

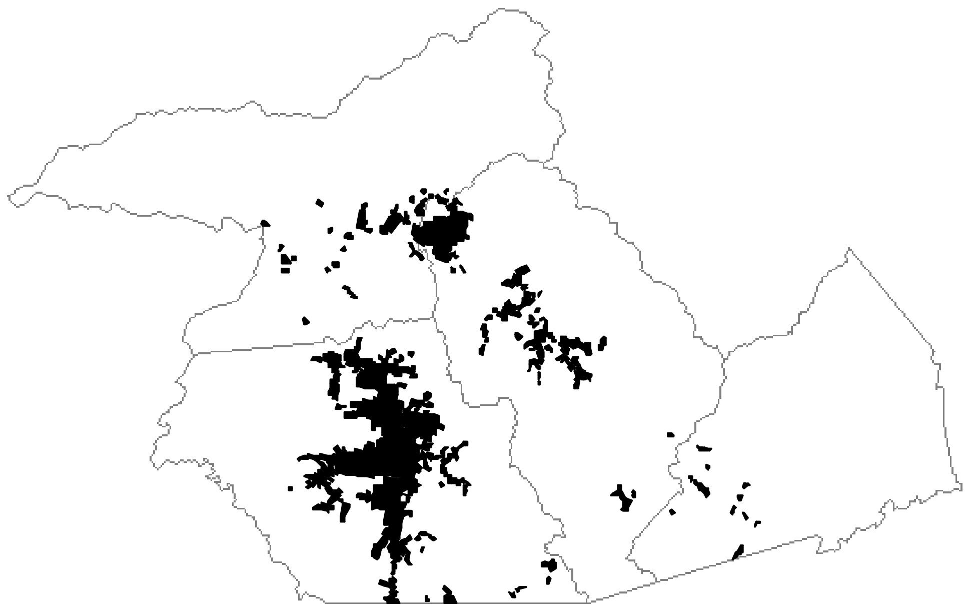
Ongoing

- Implementing RUSLE erosion/sedimentation model in L.T. using multiple date imagery from Bolstad. Collaborating with Bolstad and Meyer.
- Collaborating on the hazard site identification project.

Ted Gragson (tgragson@uga.edu)

A MOMENT ON THE BLUE RIDGE LANDSCAPE. This book examines the human-landscape relation in the Southern Appalachian Blue Ridge to determine the extent to which regional vegetation patterns represent a response to historic factors (e.g., cutting history, timing of site abandonment) versus terrain factors (e.g., slope position, soil properties). The purpose is to link distinct uses of the land to site-specific changes in order to assess whether changes are short-term or directional, and whether they reflect past or continuing disturbances. This serves to understand the evolution of modern vegetational landscapes, the response of communities to novel disturbance processes, and the relevance of preserving and managing certain landscapes. It is also the basis for distinguishing between human contributions and natural contributions to environmental change and so dispel scenarios for Southern Appalachia in which early settlers patiently chop their way out of the dark woods into the sunlight or timber barons slash and burn their way across the landscape.

North America in general and Southern Appalachia in particular represent one of the few places on Earth where it is possible to unequivocally establish initial conditions for Euro-American land use history. This is possible because of the detailed land survey records that often describe vegetation and other properties of the land prior to major alteration by Europeans. The moment in history marking initial conditions for this book is February 27th, 1819 – the day the Cherokee signed the treaty transferring 679,169 acres to the state of North Carolina. The central evidence used to reconstruct the landscape that now forms large portions of present-day Macon, Swain, Jackson and Transylvania counties is a singular set of documents from the 1820 Robert Love Survey.



This is the first parcel-level land survey of this portion of North Carolina and it was carried out in the short interval of two months just over one year after the signing of the 1819 Treaty. Information was collected on 644 tracts of various sizes totaling 71,527 acres of former Cherokee lands. The survey captures in detail the cultural and natural features of the landscape in the Middle Towns heartland of Cherokee country at the moment the Blue Ridge was officially opened to settlers and the frontier was born. Individual chapters cover Cherokee population and land-use from 1690 to 1819; the emergence of speculative land markets and absentee ownership after the Revolutionary War; procedures and results of the Love survey; instrumental value of land and tree species; and the first transfer of each land parcel from public to private ownership via auction between 1820 and 1829. Although a small number of such studies have been carried out in New England, the Northeast, and the upper Midwest, nothing comparable exists for the southeast despite the wealth of documentary evidence suitable to the purpose.

Gary Grossman (grossman@arches.uga.edu)

Personnel: G. Grossman, B. Ratajczak, C. Gibson, J. Little K. McDaniel, and T. Petty

Although our lab has been studying the Coweeta fish assemblage as a whole as well experimenting with individual species, the majority of the recent work has centered on the numerically dominant species the mottled sculpin (*Cottus bairdi).*

We examined the life history characteristics of the sculpin. We found that the sex ratio of the population was 1:1, but that the age and length structure of the population did not remain constant among all years and sites. Fecundity of this species was positively correlated with length (best predictor), somatic weight, and age. Most sculpin reproduced at age 2, however there were a small number of precocial individuals that spawned at age 1.

We also examined the effects of environmental heterogeneity on the foraging behaviors and population dynamics of this predatory benthic stream fish,. The first objective was to characterize the individual level response of sculpin to prey patch dynamics. Analysis of sculpin movements displayed two distinct patterns, area restricted movements within a resource patch (patch use) and directional movements between patches (patch abandonment). Adult sculpin focused their foraging activities within patches that had high prey densities and high prey colonization rates. Adults abandoned patches when prey densities reached a threshold level that was significantly lower than the average density of resources within patches available. Finally, size dependent social interactions inhibited the ability of juvenile sculpin to utilize prey patches efficiently.

The second objective was to link individual sculpin behaviors to sculpin population dynamics in a dynamic landscape. Four years of mark recapture data showed that sculpin habitat selection was consistent with the "Ideal Despotic" model of habitat selection. Also, the habitat selection by sculpin and habitat-dependent survivorship of juveniles provides a mechanistic explanation for the high spatial and temporal stability of sculpin in this system.

We completed a study examining the impact of predation by sculpin on benthic macroinvertebrate density, biomass, and assemblage structure at the patch scale. Baskets containing clean substratum were either covered with mesh (to prevent fish predation) or left open and then placed in pairs in both random sites and patches occupied by sculpin. After 3 weeks, the baskets were removed, and macroinvertebrates counted, mass estimated, and identified to the family level. Analyses showed that predators significantly reduced macroinvertebrate biomass in sculpin patches, but did not affect prey density. This change may be due to sculpin predation on larger prey in the open baskets, but also due to increased densities of predatory stoneflies in exclusion baskets at these sculpin patches.

Next, we assessed the impacts of density-dependent and density independent mechanisms, recruitment limitation and habitat limitation on long term variation in the per capita rate of change of sculpin populations using a 12 year data set at 3 sites. Despite a 4 year drought within this 12 year period, the stability of the sculpin populations in all three was high, suggesting that these populations are regulated. Step-wise multiple regression analyses indicated that the multiple causal mechanisms significantly affected per capita rate of change for both total population and individual life history stages in all three sites. In two of the sites, density-dependence had the greatest overall effect on per capita rate of change. At these sites, density-independence also explained a significant but smaller amount of variation. This density-independence mechanism, however, was the primary mechanism influencing per capita rate of change at the remaining site.

We also have begun a series of collaborative research efforts focused mottled sculpin. These collaborations involve: 1) construction of a flow-based, size-structured population model for this species (with Dr. Brenda Rashleigh of USEPA), 2) assessment of the role of the lateral line and other sensory modalities in prey selection by mottled sculpin (with Prof. Sheryl Coombs of Loyola University, Chicago), and 3) assessment of the genetic structure and maternal and paternal relationships for mottled sculpin in the Coweeta drainage (with Prof. J. Avise, Dr. Brady Porter, and Anthoney Fiumera, all of UGA).

Finally, we are currently analyzing population data for the less abundant species in the upper Coweeta drainage: longnose dace (*Rhinichthys cataractae*), rosyside dace (*Clinostomus funduloides*) and rainbow trout (*Oncorhynchus mykiss*) as well as examining fecundity and growth for longnose dace. Research will also begin this spring dealing with lab experiments on prey capture success, patch profitability and prey abundance perception for the rosyside dace (*Clinostomus funduloides).* We are continuing our long-term studies of fish assemblage structure.

Bruce L. Haines (haines@dogwood.botany.uga.edu)

Haines activities on Coweeta LTER project

1. Why are nitrogen mineralization rates highest on the coldest end of the elevational gradient? Is there a "nitrification promoter" leaching from the decomposing tissue of perennial herbs? This question is being addressed as his first project by Gregory Bonito. We will have a Bonito and Haines Poster reporting the first finding at the 6 January 2000 meeting.

2. What are regulators of COS and CS2 emissions from soil? Jason Piluk has submitted a Doctoral Dissertation Improvement Proposal titled " Sulfur gas biogenesis from a temperate forest floor: roles of soil properties, biochemical precursors and biota" to NSF requesting funding to answer these questions. The soil samples will come from Coweeta.

3. contributor to:

Yeakley, J.A., B. W. Argo, D.C. Coleman, J. M. Deal, B. L. Haines, B. D. Kloeppel, J. L. Meyer, W. T.Swank and S. F. Taylor. Hillslope nutrient dynamics following upland riparian vegetation disturbance. Ecological Applications. (submitted Decembr 1999).

Qualls, R.G., B. L. Haines, W.T.Swank, and S.W.Tyler. Soluble organic and inorganic nutrient fluxes in clearcut and mature deciduous forests. Soil Science Society of America Journal. (in press for June 2000).

Beckage, B., J. S. Clark, B.D. Clinton, and B. L. Haines. A long term study of tree seedling recruitment in Southern Appalachian forests: the effects of canopy gaps and shrub understories.(In revision for Canad. J. of Forest. Res.)

Gene Helfman (helfman@sparc.ecology.uga.edu)

Gene Helfman et al. Land use and fishes. 1999.

A major complication in our work to date has been a lack of good stream temperature data. For example, a positive correlation between forested streams and trout (and a negative correlation between trout and native fishes) is possibly confounded by the effects of temperature, (i. e., we have not controlled for the fact that trout are usually in headwater areas with low temperatures that are also typically areas of low native fish diversity). We purchased temperature loggers and placed them in our 36 synoptic sampling sites in Little T and French Broad streams. Data are accumulated on an hourly basis over a month and then downloaded. We now have 9 months worth of temperature data, which will also be useful to the limnologists and insect ecologists engaged in the regionalization work.

Mark Scott has incorporated the temperature data described above into a hierarchical model linking land use to stream physical and chemical conditions. Response of fishes to intensive land use is primarily related to two habitat factors: nutrient loading and sedimentation. He is currently compiling species' life history information to examine relationships among these factors.

Paula Marcinek, a UGA undergrad, and Mark conducted an REU study inspired by our earlier findings on the effects of riparian deforestation on fishes. A question that had arisen concerned just how much reforestation was needed to mitigate the effects of deforestation. Using GIS (based on 1992 coverages), we located two streams -- Cartoogechaye River and Burningtown Creek -- near Franklin that contained at least 2 km of deforestation that then flowed through an extensive forested area. We were to sample fishes and habitat characteristics at various locales downstream from the edge of the deforested section, getting farther into forested riparian water. Or at least that was the plan. Upon groundtruthing what the GIS assured us were continuous patches of downstream forested riparian zone, we found instead a mosaic of cleared and vegetated riparian zones, suggesting how quickly the southern Appalachians are changing but also that GIS resolution is short of a unequivocal Godsend. Time constraints and a lack of any better sites forced us to sample regardless and to treat the data as a continuum of sites with differing vegetation coverage. The data are quite equivocal, with differences between the two sites but no trends with respect to deforestation except in the darters, a known sensitive family. We are now exploring additional, creative ways of analyzing the data (e.g., possible effects of patchiness of vegetation on fishes and habitats).

We have been involved in the planning of the hazard site sampling plan. We produced two papers (Hardy et al. 1999. PNAS; Jones et al. 1999 Cons. Biol), both of which have been reported on in public media. We also gave presentations at meetings of the American Society of Ichthyologists and Herpetologists, Ecological Society of America, and American Fisheries Society.

Ron Hendrick (hendrick@smokey.forestry.uga.edu)

Host, Symbiont and Site Factors Controlling Root and Mycorrhizal Dynamics
Students: Neeti Bathala (PhD) and Gary Rachel (PhD)

We have made extensive use of new, non-LTER plots in association with the NSF-funded cross-site study supporting much of our research. Most of our efforts at CWT have been in WS 3, a tulip poplar-dominated forest. In addition to the replicated 30 x 30 m N fertilized and control plots, we established sub-plots in during the summer of 1998 to examine the interaction of nitrogen with phosphorus in affecting root and mycorrhizal dynamics. The experiment is a split plot design, with 3m x 3m sub-plots arranged in a 2 x 2 factorial of N and P. Each sub-plot is further split with either bulk or root-free (i.e. ingrowth cores) soil. All plots and cores have been subject to a fertilization treatment of 100 kg N or P per hectare per year applied during the summers of 1998 and 1999.

The experiment is ongoing, but our first-year results showed no significant effects of N or P, either alone or in combination, on any of the root or mycorrhizal variables measured. There were however significant differences between bulk vs. root-free soil on phosphatase activity and hyphal length. No significant differences were apparent in mycorrhizal infection although additional sites and sub-samples may indicate otherwise.

We instituted another project this past year to better understand how different mycorrhizal-host combinations influence vertical stratification (e.g. EM overstories with ericoid mycorrhizal understories) and successional dynamics through their morphology, physiology and stratification within the soil. The project combines both traditional and molecular techniques, and also includes sites in middle (oak) and south (pine) Georgia. CWT sites have been located in two areas (near WS 3 and near gradient plot 118). The site near WS 3 consists of hemlock, tulip poplar and rhododendron, while the other site is similar to 118 in its dominance by mixed oak and mountain laurel. Soil samples from each of these plots have been collected for determination of organic and inorganic nitrogen and phosphorus content within each genetic horizon, and additional samples will be collected for various assays of biological activity. We are now beginning to work out the techniques for the molecular identification of mycorrhizal fungal species inhabiting the root systems of the major species at each site.

Mark Hunter (mhunter@sparc.ecology.uga.edu)

Insect Herbivore Population Dynamics and Canopy-Forest Floor Interactions

Our research at the Coweeta LTER Site focuses on links between population dynamics and ecosystem function. Specifically, we explore the factors that determine the distribution and abundance of insect herbivores in space and time, and the impact of herbivory on soil processes. Our work can be divided into two main areas.

1. Determinants of Insect Herbivore Population Change. We are exploring the biotic and abiotic factors that influence insect population dynamics. We have shown that variation in foliage chemistry can play a major role in determining the distribution and abundance of insects on forest trees. In addition, predation pressure from birds can act to reduce the abundance of insect herbivores, but only on high quality trees on nutrient-rich soils. Elevation also appears to play a significant role in the dynamics of insect populations. Although background defoliation levels often decline with elevation, the high elevation sites also appear to be the most susceptible to dramatic insect outbreaks. We continue to explore the relative roles of soil quality, foliar chemistry, and predation pressure on herbivore dynamics. Disturbance can also affect the interactions among plants, insects, and their natural enemies. For example, hurricane Opal resulted in the generation of forest gaps in which the foliar phenolics of surviving trees were significantly elevated. Despite these elevated levels of phenolics in leaves, defoliation levels were higher in sites damaged by the hurricane prompting further work in this system.

2. Effects of Defoliation on Ecosystem Function. Defoliation in the forest canopy results in the deposition of frass, greenfall, and modified throughfall on the forest floor. We are exploring the effects of herbivory on soil processes including rates of decomposition, soil respiration, and nutrient dynamics. In addition, we are investigating the responses of soil fauna and flora to herbivore-derived inputs from the canopy. We have shown that herbivore activity results in increased nitrate concentrations in both soils and streams. Moreover, frass and throughfall additions result in blooms of both collembola and bacterivorous nematodes in the soil. Experimental manipulations suggest that inputs from canopy herbivores may be as important for some soil organisms as seasonal inputs of leaf litter. Ultimately, we hope to unravel the effects of herbivore inputs on soil quality for canopy trees to explore the potential feedbacks between canopy and forest floor.

Additional Funding for Coweeta Research:
1999-2002: Canopy herbivory and soil processes in a temperate and tropical forest. NSF Competitive Research Grant, Ecosystem Ecology, $300,000. Co-Pi’s M.D. Lowman and T.D. Schowalter.
1999-2001: Top-down and bottom-up effects on herbivores: Nutrient availability and the trophic interactions of insects on oak. NSF Competitive Research Grant, Ecology, $70,000.
1999-2000: Coweeta LTER Equipment and Cross-Site Supplement. NSF Long-Term Ecological Research, $35,000. Co-Pi’s D.C. Coleman, B.D. Kloeppel, and C.M. Pringle.
1996-1998: Short- and long-term effects of hurricane Opal on a forest ecosystem. NSF SGER Grant, Long-term studies in environmental biology program, $24,961.

Recent Relevant Publications:
Forkner, R.E. & M.D. Hunter. 2000. What goes up must come down? Nutrient additions and predation pressure on oak insects. **Ecology** (in press).
Reynolds, B.C., M.D. Hunter, & D.A. Crossley Jr. 2000. Effects of canopy herbivory on nutrient cycling in a northern hardwood forest in western North Carolina. **Selbyana** (in press).
Hunter, M.D., R.E. Forkner, & J.N. McNeil. 2000. Heterogeneity in plant quality and its impact on the population ecology of insect herbivores. In: **Ecological Consequences of Habitat Heterogeneity** (Ed. M.A. Hutchings). Blackwell Scientific (in press).
Hunter, M.D. & R.E. Forkner. 1999. Hurricane damage influences foliar polyphenolics and subsequent herbivory on surviving trees. **Ecology** 80: 2676-2682.
Hunter, M.D. & R.E. Forkner. 1998. Effects of abiotic disturbance on the foliar tannins of *Quercus rubra* L. and subsequent defoliation by insect herbivores. In: **Diversity and Adaptation in Oak Species** (Ed. K.C. Steiner), Pp 252-261. The Pennsylvania State University Press
3 January 2000

Brian Kloeppel (kloeppel@sparc.ecology.uga.edu)

My research efforts with carbon dynamics have continued with several projects at Coweeta including collaboration with Bolstad and Vose on a new tree temperature acclimation project. In addition, I also had a recently funded proposal to initiate cross-site collaboration with the Bialowieza Forest, managed and primieval research forests in Poland (see below).

We were also successful with two major site funding proposals including funding for the renovation and expansion of the Coweeta Dorm as well as funding for upgraded internet connections to Coweeta for the next six years (1999-2004) (see below).

Coweeta LTER Related Publications:

Martin, J.G., B.D. Kloeppel, T.L. Schaefer, D.L. Kimbler, and S.G. McNulty. 1998. Aboveground biomass and nitrogen allocation of ten deciduous southern Appalachian tree species. Canadian Journal of Forest Research 28: 1648-1659.

Yeakley, J.A., B.W. Argo, D.C. Coleman, J.M. Deal, B.L. Haines, B.D. Kloeppel, J.L. Meyer, W.T. Swank, S.F. Taylor. 200_. Hillslope nutrient dynamics following upland riparian vegetation disturbance. Ecological Applications 00: 000-000. (submitted 23 December 1999).

Proposals Funded:

National Science Foundation. 1999-2002. Carbon and water dynamics in mature and old growth forests in Poland and the United States: supplement to Coweeta LTER grant DEB-96-32854. $15,057. B.D. Kloeppel (PI) with D.C. Coleman.

National Science Foundation. 1999-2001. Biological Field Stations and Marine Laboratories (FSML): Coweeta Dormitory Expansion and Renovation at Coweeta Hydrologic Laboratory. $198,000. B.D. Kloeppel (PI) with D.C. Coleman.

National Science Foundation. 1999-2000. Communications LTER supplement to the LTER program at Coweeta Hydrologic Laboratory (DEB-96-32854). $290,000. B.D. Kloeppel (PI) with D.C. Coleman.

Jennifer Knoepp (jknoepp@sparc.ecology.uga.edu) – No Research Summary

Liz McGhee (emcghee@museum.nhm.uga.edu)

Supplemental Collections Grant

My supplemental grant has been active approximately four months. During that time, I have hired one full time and one part time employee. Equipment and supplies have been purchased. The focus of the supplement is in three areas:

1. Complete the processing of mammals that were collected in snap and live traps from western North Carolina and were stored in freezers at the Museum. This includes identification, skinning, stuffing, cleaning of skulls, cataloguing, and data entry.
2. Extract and clean skulls from pickled shrews that have already been catalogued.
3. a. Sort out snails, millipedes, and centipedes from remaining unsorted invertebrate material.
   b. Locate expert(s) willing to handle identification.

To date, #1 and #2 are underway. They will continue to be a time consuming slow process. Step ‘a’ of #3 is complete. See details below.

1. 150 skins & skulls have been processed from frozen material. Each specimen takes approximately 1.5 hours to process so I am fairly satisfied with our progress. In addition, there had been a backlog of approximately 300 specimens with preparation complete, but awaiting cataloguing numbering, and data entry. These 300 specimens were prepared prior to the beginning of the supplemental grant. Cataloguing is now underway.
2. So far, 94 shrew skulls have been extracted from pickled material. Skull extraction takes about 10 minutes per skull. The time consuming part is the cleaning process which can take weeks in our dermestid beetle colony. This is due to the unpalatable taste of the pickled tissue. Should bug cleaning fail, we will have to hand clean each skull which can take approximately 30-45 minutes per skull and risk damaging the skull.

3. The snails, millipedes, and centipedes have been sorted and processed out of formalin and into alcohol. At this time, I have feelers out to find someone willing to take on the identification of the millipedes and centipedes. The snails will be identified in-house courtesy of Amy Edwards.

In addition, cataloguing of 4300 herps and 1200 mammals from Pisgah National Forest, Buncombe County, North Carolina has been completed. Data entry is under way and I expect to have added these to the museum’s data base files by the end of January. These specimens are part of the western North Carolina regionalization effort and were collected during Norman Hicks master’s research supported by Coweeta LTER funds.

Judy Meyer (meyer@sparc.ecology.uga.edu)

DOC dynamics in streams (Meyer 1999)

Dissolved organic carbon (DOC) in stream water represents both a loss of organic matter from terrestrial ecosystems and an important organic matter resource for streams. A long-term record of DOC concentration in stream water was used to examine changes occurring with forest succession. In 1977 a watershed at Coweeta Hydrologic Laboratory, NC was clearcut using cable logging. DOC concentrations in stream water have been measured weekly since 1979 in the stream draining the clearcut and in a stream draining a nearby reference watershed. Over the twenty year period, seasonal patterns of DOC concentration were consistent in the two streams with highest concentrations in autumn (October) and lowest concentrations in spring (March). The reference stream had consistently higher DOC concentrations throughout the two decades. Changes in DOC concentration occurring with forest succession were less than the changes in response to annual differences in precipitation, which were considerable over the two decades. Interannual variation in seasonal average DOC concentration in the stream draining the clearcut is related to potential soil leaching losses (soil C/Q). Variation in streamwater DOC concentration among years and watersheds is directly related to the amount of leaf litter in the streams, a phenomenon also observed in the litter exclusion study.

Land use change and sediments in streams (Meyer et al. 1999, Sutherland et al. 1999)

Excessive sedimentation is a significant threat to riverine ecosystems, particularly in the southern Appalachians, which has the most diverse assemblage of temperate freshwater fishes in the world. Little research has been done on the effects of sediments on southern Appalachian fishes, so there is only a limited scientific basis for making recommendations on an allowable concentration of suspended sediment that would be protective of the unique aquatic biota of this region. We have sampled fish (37 species) and sediments in ten tributaries in two river basins in the Blue Ridge physiographic province: Etowah River and Little Tennessee River. Sampling sites varied in the extent of land-disturbing activities in the watershed and hence in the the amount of suspended sediments, bedload transport, and infilling of benthic habitat by sediments. The streams could be divided into two groups based on their suspended sediment regime at baseflow and their fish assemblages: (1) "Low turbidity" sites where baseflow turbidities never exceed 15 NTU and where baseflow turbidity exceeds 10 NTU in less than 20% of samples, and (2) "High turbidity" sites where turbidity at baseflow sometimes exceeds 15 NTU and exceeds 10 NTU in more than 20% of baseflow samples. The fish assemblages at low turbidity sites were characterized by a ten-fold higher abundance of adult rainbow trout and higher abundances of fishes that feed on benthic invertebrates and that spawn in crevices and in clean gravel. Low turbidity streams had higher populations of darters and sculpins. The fish assemblage at high turbidity sites was different. These sites had more fish that spawned in pits excavated in soft sediments and somewhat more fish that built nests that rise above the stream bottom. Both of these reproductive modes render the species less sensitive to excessive sedimentation. On the basis of differences observed in fish assemblages in these two groups of streams, the following standards would be protective of fishes in the Blue Ridge physiographic province: Turbidity values in samples of stream water collected during baseflow conditions should never exceed 15 NTU; turbidity can exceed 10 NTU in only one out of five stream water samples collected during baseflow conditions. Baseflow turbidity values in excess of these indicate excess sedimentation that threatens the integrity of Southern Appalachian fish assemblages.

Role of macroconsumers in Southern Appalachian streams

This project is being done in collaboration with Cathy Pringle, Kate Schofield and Andrew Sutherland. In previous summers, we have used the electric exclusion technique to exclude macroconsumers (crayfish, fish, and large benthic insects) in streams whose watersheds differed in dominant land use. We have explored the different impact of macroconsumers on algae in streams flowing through forested, agricultural, suburban and urban watersheds as well as experimentally manipulating sediment regime to determine whether elevated sedimentation alters consumer impacts on lower trophic levels. Kate is currently writing up the results of these experiments as two manuscripts and chapters in her dissertation. This summer and fall we examined the impacts of macroconsumer removal and elevated sedimentation on leaf decay using the electric exclusion technique in Ball Creek. Using rhododendron leaves that had been preconditioned in the stream, we followed their decay with and without macroconsumers in both summer (when few alternative leaves are present) and autumn (when many are present). We also investigated the impact of elevated sediments on the role of macroconsumers in red maple leaf decay during autumn. We are currently analyzing these data.

Identification of sites at risk for development

Several investigators have been identifying sites for future long-term stream research using the GIS coverages developed by Wear and Bolstad that display a site's hazard index, i.e. likelihood for development. We have located several candidate streams with high probability of future development and are visiting those sites this month. Sampling as described in the proposal will begin in spring.

Intersite research – LINX (Lotic Intersite Nitrogen eXperiment) continues

We added $^{15}NH_4Cl$ over six weeks to Upper Ball Creek to follow the uptake, spiraling, and fate of nitrogen in a stream food web during autumn (Tank et al. in review). A priori predictions of N flow and retention were made using a simple food web mass balance model. Values of ^{15}N were determined for stream water ammonium, nitrate, dissolved organic nitrogen, and various compartments of the food web over time and distance and then compared to model predictions.

Ammonium uptake lengths were shortest at the beginning of the tracer addition (28 m) and increased through time (day 20 = 82 m, day 41 = 94 m), and ammonium residence time in stream water ranged from 4 min on day 0 to 15 min on day 41 (Tank et al. in review). Whole-stream ammonium uptake rates, determined from the decline in $^{15}NH_4$ in water over the stream reach, decreased from 191 mg N m^{-2} d^{-2} on day 0 to 83.2 mg N m^{-2} d^{-2} on day 41. Temporal trends in the NH_4 mass transfer coefficient (V_f) were similar to uptake rates; V_f was highest on day 0 (7.4×10^{-4} m s^{-1}) and lower on days 20 and 41 (2.7×10^{-4} m s^{-1} and 2.8×10^{-4} m s^{-1}, respectively). Rates of nitrification were estimated to be very low throughout the tracer addition and accounted for <3% of $^{15}NH_4$ uptake on day 0.

Total retention of ^{15}N at the end of the experiment by the nine largest biomass compartments within the study reach accounted for only 12.3% of added ^{15}N, with leaves and FBOM representing the largest portions (Tank et al. in review). Export of ^{15}N by suspended particulate and dissolved N accounted for an additional 11% and 30% of added ^{15}N respectively.

Results from the ^{15}N tracer addition in Upper Ball Creek demonstrate the high ammonium demand associated with microbes colonizing leaf detritus and the resultant linkage to invertebrate shredders. In Upper Ball Creek in autumn, spiraling of NH_4 is very tight, NH_4 residence time in water is short, and uptake rates are very high. Analyses of N spiraling in unimpacted streams provide an ecological foundation for assessment of spiraling in high-N streams.

With Fulbright and NSF funding, Diane Sanzone and Jen Tank completed a LINX ^{15}N release in a tundra stream in Iceland during summer 1999. Those data are currently being analyzed.

Presentations

Meyer, J. L. 1999. Two decades of recovery from clearcutting in the southern Appalachians. Annual Meeting Ecological Society of America, Spokane WA.

Meyer, J.L., A. Sutherland, K. Barnes, D. Walters, and B. Freeman. 1999. A scientific basis for erosion and sedimentation standards in the Blue Ridge physiographic province. Georgia Water Resources Conference.

Sutherland, A., J.L. Meyer and N. Gardiner. 1999. Effects of land-use change on sediment transport and fish assemblage structure in southern Appalachian streams. Georgia Water Resources Conference.

Several LINX-related presentations at NABS, which I have not included here.

Publications

Meyer, J.L., A. Sutherland, K. Barnes, D. Walters, and B. Freeman. 1999. A scientific basis for erosion and sedimentation standards in the Blue Ridge physiographic province. Pp. 321 – 324 in K.J. Hatcher (ed.), Proceedings of the 1999 Georgia Water Resources Conference.

Sutherland, A., J.L. Meyer and N. Gardiner. 1999. Effects of land-use change on sediment transport and fish assemblage structure in southern Appalachian streams. Pp. 318 – 320 in K.J. Hatcher (ed.), Proceedings of the 1999 Georgia Water Resources Conference.

In Review. Tank, J.L., J.L. Meyer, D.M. Sanzone, P.J. Mulholland, J.R. Webster, and B.J. Peterson. Analysis of nitrogen cycling in a forest stream during autumn using a ^{15}N tracer addition. Limnology and Oceanography.

In review. Sanzone, D.M., J..L. Tank, J.L. Meyer, P.J. Mulholland and S.E.G. Findlay. Microbial incorporation of nitrogen in stream detritus. To be submitted to Hydrobiologia.

David Newman (newman@smokey.forestry.uga.edu)

Summary of Coweeta-LTER related research

I have been involved in two projects related to the land use valuation and modeling effort. First, we have completed a survey of stream owners in Towns County, GA. I will be presenting a briefing on this at the meeting in Highlands. The survey fits into a variety of issues that are currently taking place in Georgia regarding stream buffers and the management of designated trout streams.

The other research that I have been involved with is assessing the impacts of differential property taxation in Georgia. As the reach of Atlanta lengthens, the need for positive policy measures regarding land use transition has become more pressing. The impact of property taxes on land use decisions may be important in determining marginal transitions. The research so far has focused on assessing the amount of land that has entered into Georgia's Conservation Use valuation program, the quality of that land, and the impacts that the program has had on county fiscal management. We plan to continue the research by assessing the differential impact of the program on non-eligible landowner groups.

Scott Pearson (spearson@mhc.edu)
Monica Turner (mgt@macc.wisc.edu)

Land use and Terrestrial Biodiversity - January 2000

Scott M. Pearson, Monica G. Turner, Chris E. Mitchell and Norman Hicks

Land use affects the diversity and abundance of terrestrial species in the Southern Blue Ridge Province. Our studies seek to discover which groups of forest-dwelling species are most sensitive to the influences of past land use intensity and forest fragmentation. Over the past three years, Pearson and Turner have documented the effects of these factors on vascular plant communities. With the assistance of two graduate students, Hicks and Mitchell, the investigations have been expanded to small vertebrates and invertebrates.

In 1997-1998, Hicks established grids of pitfall traps at 12 forested sites that comprise a gradient of intensity of past land use (i.e., post-agricultural forest, intensively logged forest, forest with light or no logging). Over twelve months of trapping, his results show strong seasonal variation in the abundance of salamander species. There appear to be few differences between the sites that have been continually forested; however, post-agricultural sites show differences in the abundances of some species of amphibians and mammals.

These traps also captured a large number of invertebrates (>50,000 specimens of 180 families). The largest number of invertebrates were observed at the sites with lowest land-use intensity, but the greatest diversity (families) was found in the post-agricultural forests (Figure 1). About 46% of the families were found in sites of all land-use intensities, about 11% of families were unique to sites in either extreme of the land-use gradient. The patterns hidden in this rich data set are still under investigation.

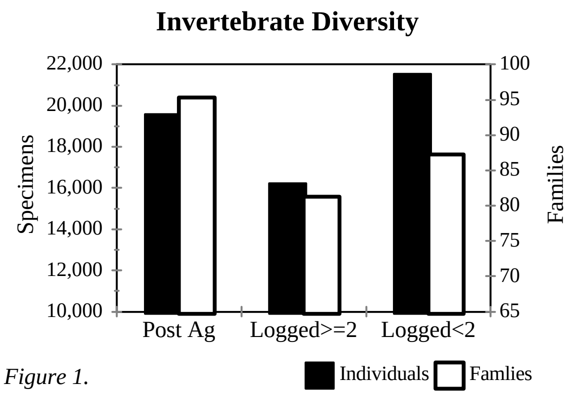


Figure 1.

Land use and habitat fragmentation influence the spatiotemporal dynamics of native herbs found in mesic deciduous forests of the Southern Blue Ridge Province. Previous analyses of herbaceous vegetation in the eastern U.S. forests predict that ant-dispersed species comprise 35-40% of herbaceous species and up to 75% of all emergent stems (Culver and Beattie 1981). However, wildflower myrmecochores (ant-dispersed herbs) are less abundant and more likely to be absent in small versus large patches of forest in the Southern Blue Ridge (Pearson et al. 1998).

During 1999, 376 ant collections were made from 25 forest patches that varied in patch area and land use history. Initial analyses indicate that the species diversity and overall activity of ants were greatest in the small-disturbed patches and lowest in the large-undisturbed patches (Figure 2). The large-undisturbed patches were dominated by one myrmecochorous ant species, *Aphaenogaster fulva*. Relative activity of *A. fulva* was comparable in large patches of either high or low past disturbance, but substantially lower in small-disturbed patches. However, the combined activity of the four dominant seed dispersing ant species was comparable between site classes. Therefore, it does not seem that an absence of seed-dispersing ants can explain the reduced numbers of myrmecochores observed in the small-disturbed patches.

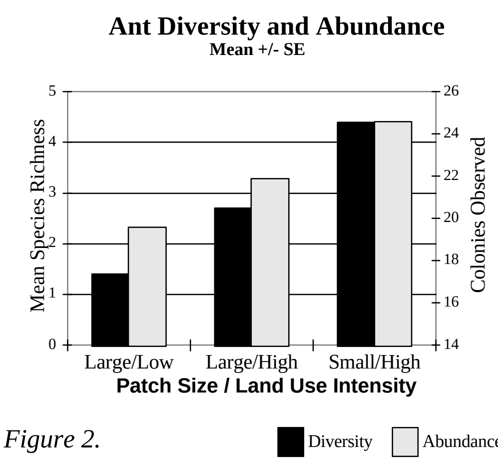


Figure 2.

Cathy Pringle (pringle@sparc.ecology.uga.edu)

The following report details research primarily done in collaboration with Judy Meyer and graduate students, Kate Schofield and Andrew Sutherland. Kate Schofield has played a leadership role in all field research and is the first author on the following manuscripts in preparation .

Manuscripts currently in preparation:

(1) Influence of sedimentation on top-down effects of macroconsumers in algal- and detrital-based food webs of a forested southern Appalachian stream.

We conducted stream sediment addition experiments in the presence and absence of fish and crayfish macroconsumers to examine the influence of sedimentation on top-down effects in algal-based (Summer 1997) and detrital-based (Fall 1999) food webs. An electric field was used as a mechanism for experimental exclusion of fishes and crayfishes, *in situ*.

(2) Food web dynamics and top-down effects of macroconsumers in algal-based food webs in streams along a gradient of land use in southern Appalachia.

Electric exclosure experiments manipulated the presence and absence of fish and shrimp macroconsumers in stream benthic environments at five sites (two sites in Summer 1997, three sites in Summer 1998) representing a gradient of watershed land use from forested to suburban/urban. In each experiment, we assessed macroconsumer effects on sedimentation, algal standing crop accrual and community composition, and benthic invertebrate colonization and community composition.

(3) Do stream macroconsumers have seasonal effects on *Rhododendron* decomposition?

We experimentally examined the effects of stream macroconsumers on leaf decay rates of pre-conditioned *Rhododendron* in spring versus fall.

(4) The relationship between crayfish assemblages and watershed land use: are there any trends?

Beginning in Summer 1999, crayfishes were sampled at twelve regionalization sites (four forest, four pasture, and four suburban/urban) to determine if their abundance, biomass, or species composition varied with watershed land use. Habitat variables (e.g., substrate size, embeddedness, etc.) also were collected at each site. Sampling will continue through Summer 2000.

Additional projects resulting from the work detailed above:

(1) LTER cross-site comparison: Evaluation of the role of fauna in leaf litter decomposition across gradients in litter quality and habitat type. In this project we are evaluating the decomposition of leaf litter in streams, riparian zones and on the forest floor at both the Coweeta and Luquillo LTER sites to test several hypotheses. We predict that the relative impacts of consumers on litter decomposition rates should increase with the quality of leaf litter available. This project is being pursued by Catherine Pringle in collaboration with David Coleman and Mark Hunter and is supported by an NSF Coweeta LTER Cross-Site Supplement Proposal (1999-2000).

(2) Description of a previously undescribed crayfish species (tentatively named *Cambarus tuckeseegeensis*) found at one of the regionalization sites and examination of intraspecific variation in two crayfish species (*Cambarus georgiae* and *Cambarus reburrus*) found at several

of the regionalization sites. These projects were initiated by Kate Schofield and are being pursued in collaboration with Dr. John Cooper of the North Carolina State Museum of Natural Sciences, based at least in part on specimens collected at the regionalization sites.

(3) Technique Paper: Refinement of the electric exclusion technique

Ron Pulliam (pulliam@sparc.ecology.uga.edu)

For the past two years, my students and I have been studying the distribution of understory herbs along an elevational and climatic gradient from the lower Piedmont of Georgia to the upper elevations of the Blue Ridge in North Carolina. The current proposal focuses on six focal species: two common orchids, both of which produce large quantities of very small, wind-dispersed seeds, Tipularia discolor and Goodyera pubescens, two long-lived, liliaceous woodland forbs with relatively small numbers of bird-dispersed berries, Polygonatum biflorum, and Smilacina racemosa (cf. *Maianthemum racemosa*), and two ant-dispersed woodland species (Hepatica nobilis (cf. *Hepatica americana*) and Hexastylis arifolia). These species were chosen for the following reasons:
1) all are widespread and relatively common throughout most of the study region;
2) collectively, they represent a wide range of dispersal vectors and dispersal distances, with equal representation of wind-dispersed, bird-dispersed, and ant-dispersed species;
3) all of the species are relatively easy to identify unambiguously in the field, and four of the species (Tipularia discolor, Goodyera pubescens, Hepatica nobilis, and Hexastylis arifolia) are persistent in the winter and can be surveyed almost any time of year;
4) preliminary field data suggest a strong and predictable influence of microclimate on the habitat distribution of the species.

The Hypotheses. The goals of the research are to develop a rigorous method of delineating suitable habitat and to use this methodology to test predictions about how habitat, demography, and dispersal interact to influence species distributions. The approach combines field surveys, demographic studies, and field experiments to determine what is suitable habitat for each species and uses this information both to identify suitable habitat and to delineate source and sink habitats. The research plan is designed to make the concept of suitable habitat operational and to test the following hypotheses concerning the relationship of species distribution to the distribution of suitable habitat:

Hypothesis #1. Species-specific dispersal ability determines the overall relationship between species distribution and the distribution of suitable habitat. In particular, 1.a) *species with short-distance dispersal (e.g. ant-dispersed species) are frequently absent from suitable habitat due to dispersal limitation,* and 1.b) *species with long-distance dispersal ability (e.g. bird- and wind-dispersed species) are often present in unsuitable (sink) habitat* due *to frequent recolonization and rescue* (sensu Brown 1977). Field surveys, habitat specific demographic analyses, and transplant experiments (Primack and Miao 1992) will be used to delineate suitable habitat and test this hypothesis.

Hypothesis #2. Each species occurs within a defined range of microclimatic conditions, and the geographic range of each species is limited by the occurrence of these conditions. In particular, we hypothesize that 2.a) *the upper elevation limits of Hepatica nobilis and Hexastylis arifolia are determined by low soil temperatures associated with extreme winter temperature events* and 2.b) *the* *lower latitudinal limits of Polygonatum biflorum and Smilacina racemosa are set by low soil moisture content associated with prolonged summer droughts.* The predictions will be tested by conducting introduction experiments and detailed demographic studies in a variety of habitats where environmental conditions are carefully monitored and, in some cases, experimentally manipulated.

Ron Rouhani (ron@sparc.ecology.uga.edu)

Information Management Summary 1999

1. Making a CD to be provided to the Site Review Team members, so that they may review some documentation prior to the visit. Presenting a presentation for the Site Review Team and answering all there questions concerning data management at Coweeta.

2. Hardware/Software Upgrade of our Server to ensure Y2K compliance.

3. Changing online code to Y2K compliance. (i.e. Van, Gps, Dorms, 4x4 reservation tools which are online)

4. Combining the Metadata and Siteuse form into one online form to make it easier for the user and for us to keep a track of research being done at Coweeta.

5. Moving over 12 TYPE II datasets over to the TYPE I dataset.

6. Updating the Online Publication database. We had 28 new 1999 entries added to our database.

7. Updating and maintaing the Coweeta School Yard LTER webpage.

8. Updating and maintaing the RiverBank webpage.

9. Organizing and placing all of our Metadata's (Type I or II) online for everyone to be able to see.

10. Compiling statistics from our webpage access by users. The report may be accessed via the web by going to "What's New" page from our webpage.

Wayne T. Swank (wswank@sparc.ecology.uga.edu)

LTER related activities the past year included the following:

1. A 10-week visiting fellowship at the University of Durham, England. Conducted time series analysis, in collaboration with, Fred Worrall and Tim Burt, to examine long-term discharge and streamwater nutrient (focus on nitrate) concentrations for WS7 and WS2. Paper in preparation for European Geophysical Meeting in April 2000. We will subsequently apply the model technique to Watersheds 6, 13, 37 along with respective controls. Also collaborated with colleagues at four other Universities – Aberdeen, Cambridge, Lancaster, and Plymouth. Nick Chappell at Lancaster is applying some of

their hydrologic models to Coweeta catchments and initial runs look interesting, but more work is needed. We are preparing a proposal, due in February, to NERC (English NSF) for on-site research at Coweeta. Many of my contacts will be visiting Coweeta in the next 18 months and I will be contacting appropriate Coweeta investigators to see if you are interested in exchanging ideas with these scientists.

2 Prepared and/or submitted papers on: (a) long-term hydrologic and water quality responses following clearcutting and logging on WS7 (with J. Vose and K. Elliott); (b) watershed management contributions to land stewardship: case studies in the Southeast (with D. Tilley), invited paper for a National Conference in March; (c) portions of chapters for a book on " Safe Drinking Water Act: Effect of Forest Management Activities".

3. Continued to work on second Coweeta book.

Lloyd Swift (lswift@sparc.ecology.uga.edu) – No Research Summary

James Vose (jvose@sparc.ecology.uga.edu) – No Research Summary

Bruce Wallace (wallace@sparc.ecology.uga.edu)

Title: **Effects of Resource Limitation on a Detrital-based Ecosystem**

Citation: Ecological Monographs 1999. Vol 69:409-442.
By: J. Bruce Wallace, S. L. Eggert, Judy L. Meyer, and J. R. Webster
Abstract: We examined the importance of terrestrial detrital inputs to secondary productivity of a headwater stream. Following a year of pretreatment studies on two headwater streams, we excluded terrestrial litter inputs (= treatment) to one stream while using the other as a reference. We excluded litter for 3 yr followed by 1 yr of small woody debris ($\leq$ 10 cm diameter) removal and litter exclusion. Monthly benthic samples were collected from dominant mixed substrate (cobble, pebble, and sand-silt) as well as moss-covered bedrock outcrop substrates. We used randomized intervention analysis (RIA) to test the null hypotheses that no change in abundance or biomass of functional feeding groups or specific taxa occurred in the treatment stream relative to the reference stream.
(abstract reduced for space)

Title: **Small Wood Dynamics In A Headwater Stream**

Citation: Verh. Internat. Verein. Limnol. 27 (In press)
By: Wallace, J. B., Webster, J. R., Eggert, S. L., Meyer, J. L.
Summary: We excluded terrestrial litter inputs including woody debris to a headwater stream in western North Carolina (USA) for 4 years. Following 3 years exclusion, we removed all small woody debris ($\leq$ 10 cm diameter) by hand, and obtained a whole stream assessment of wood. Weight of wood removed was only 1.1 x greater than estimates with line-intercept techniques, but 3.6 x higher than estimates obtained using a benthic corer. We construct a budget for woody

debris based on estimates of wood input, export, and respiration. Results of this budget show the stream is a net accumulator of woody debris.

Title: **Patterns of organic matter flow in stream food webs with reduced detrital resource base.**
Citation: Ecology (In press)
By: R. O. Hall, J. B. Wallace, and S. L. Eggert
Abstract: Food webs based on flows of organic matter were developed for two small streams to examine food web response to a large detrital resource reduction. These food webs can elucidate the role of individual taxa and their trophic interactions in context of ecosystem-level organic matter flow. At the study site, Coweeta Hydrologic Laboratory in the southern Appalachians, leaf litter inputs and associated microbial assemblages are the main energy source for headwater stream food webs. We eliminated leaf litter inputs to one stream using a net placed over the first 180 m of stream from the spring seep. Food webs based on flow of organic matter were developed for a reference stream and the litter-excluded stream for two months, July and December of year 1 of the litter exclusion, to examine effects of the leaf litter exclusion on the trophic base of the food web, size distribution of flows, predator-prey interactions, and trophic structure.
(abstract reduced)

***Title*:** Large woody debris in a headwater stream: long-term legacies of forest disturbance

Citation: Internat. Review of Hydrobiology (submitted)
By: J. Bruce Wallace, Jackson R. Webster, Sue E. Eggert, Judy L. Meyer, and Edward R. Siler
Abstract: We excluded litter (leaves and wood) inputs to an Appalachian headwater stream for 5 years. Leaves disappeared from the streambed very rapidly (< 1 year) following litter exclusion, however, a large residual mass of woody debris remained. After excluding inputs of leaf litter and wood to a headwater stream for 3 years we removed all small wood (< 10 cm diameter) from the stream. There was close agreement (within 10%) between estimates of mass of small woody debris made using line intersect methods and that made by direct removal. Two years later, we removed all large woody debris (LWD = > 10 cm diameter) from the wetted perimeter of the stream. Five annual estimates of LWD mass made with line intersect methods exceeded those of complete removal by a factor of about 2x, although total wood removed was within the 95% confidence interval of that estimated by the line intersect method. Species of wood removed from the stream displayed weak similarity (percent similarity = 45 to 49%) with recent (1993 and 1972) measures of basal area of tree species in the surrounding forest, but stronger similarity (65%) with tree species measured in 1934. About 37% of the LWD removed consisted of American chestnut, Castanea dentata, (~24 %) and black locust, Robinia pseudoacacia, (~14%), which currently represent < 1.5% of the basal area of the surrounding forest. LWD in the stream reflects large inputs of chestnut following the chestnut blight in the1930s and inputs of early successional species such as black locust following extensive timber harvesting in the early 1920s. These earlier disturbances to the forest were important sources of LWD that remain in the stream today. Thus, the structure and function of present day streams are influenced by forest disturbances that occurred over six decades ago.
key words: large woody debris, chestnut blight, stream, forest, disturbance, dynamics

Title: **A method for marking larval salamanders and its use in determining individual growth rates.**

Publication: The Journal of the North American Benthological Society (submitted)

By: Brent R. Johnson and J.B. Wallace. Department of Entomology, University of Georgia, Athens, GA 30602.

Abstract: Long-term marking of larval salamanders has been problematic due to their small size and ability to regenerate appendages. We marked larvae of the Blue Ridge Two-lined salamander, *Eurycea wilderae* Dunn, by subcutaneous injection of acrylic polymers. Individual growth rate was measured by conducting a mark-recapture study in a 100-m headwater stream reach at the Coweeta Hydrologic Laboratory, North Carolina, USA. Larvae were collected monthly from November 1997 to April 1999 by sampling the entire wetted area at night using a headlamp and aquarium dip net. On each sample date, captured larvae were anesthetized with 0.1% MS-222, snout-vent length was measured, and each larva was given a unique mark. A total of 428 larvae were marked and released during the study period and 98 larvae were recaptured for growth estimates. Growth was nearly constant over the course the year and the daily individual growth rate was 0.0024 mg AFDM d^{-1}. Marking had no adverse effects on *E. wilderae* growth and survival in either the field or laboratory. Acrylic polymer injection provides a practical way to conduct field studies on amphibian larvae under natural conditions. The method can also be used to estimate population size, individual movements, and secondary production.

Title: Life history and production of stream insects.

Citation: 2000. Annual Review of Entomology 45: 81-108.

By: A. D. Huryn, and J. B. Wallace

Abstract: Studies of the production of stream insects are becoming more numerous, and general factors controlling the variability of their production are becoming evident. In this review, we focus on the influence of life-history attributes on secondary production of stream insects and other macroinvertebrates. Annual production of macroinvertebrate assemblages in various world-wide streams ranges over four orders of magnitude (~1 to 10^3 g dry mass m^{-2}). The highest levels of production are reported for assemblages dominated by filter-feeders in temperate streams. Filter-feeding enables the accrual and support of high biomass, which supports the highest levels of production. Frequently disturbed communities in warm-temperate streams are also very productive. Biomass accrual by macroinvertebrates is limited in these warm-temperate streams, and rapid growth rates, rather than high biomass, accounts for high invertebrate production. Macroinvertebrate assemblages of cool temperate and arctic streams have the lowest production because of limited nutrients, food, or temperature. Currently, our understanding of mechanisms influencing stream secondary production remains somewhat limited because of geographical bias, paucity of community-wide studies, and limited knowledge concerning the importance of biotic interactions.

David Wear (Wear_Dave/srs_rtp@fs.fed.us) – No Research Summary

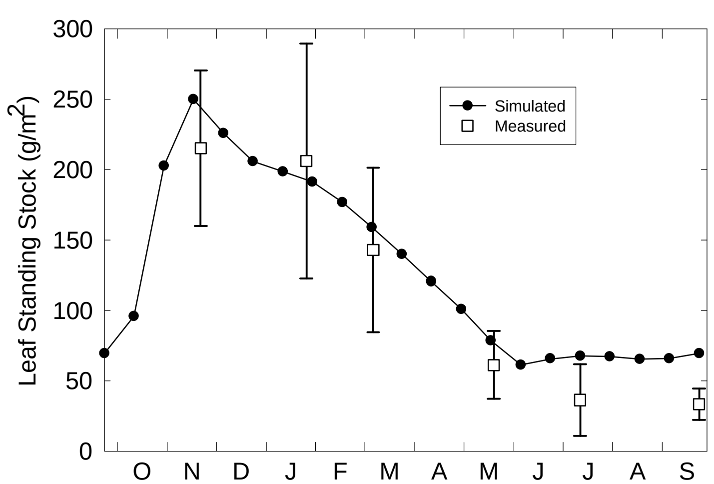
Jack Webster (jwebster@vt.edu)

Webster, Benfield Progress Report, Jan 2000

As reported last year, we are continuing our work on organic matter dynamics in the Little Tennessee River with emphasis on comparison of riparian and instream energy sources. Matt Neatrour finished his masters research on floodplain organic matter dynamics, showing that floodplain inputs to the river are important but are generally less than instream primary production. He is working on a manuscript for journal submission. Our measurements of instream primary production are continuing. Despite loss of one sonde to vandalism, we are accumulating a fairly complete data set.

Little Tennessee River Metabolism Summary

	GPP ($gC/m^2/d$)	R ($gC/m^2/d$)	P/R
July 1998			
Riverside	0.30	1.12	0.27
August 1998			
Riverside	0.53	0.98	0.54
Prentiss	0.48	0.77	0.62
November 1998			
McLarney	0.61	0.60	1.02
March 1999			
Riverside	0.08	0.61	0.13
Iotla	0.78	1.21	0.64
McLarney	0.40	1.42	0.28
May 1999			
Riverside	0.12	1.18	0.10
Prentiss	0.13	0.65	0.20
Iotla	0.61	0.92	0.66
McLarney	0.51	0.75	0.68
June 1999			
Riverside	0.20	0.80	0.25
Prentiss	0.67	1.04	0.64
Iotla	0.63	1.40	0.45
McLarney	0.61	0.52	1.18
July 1999			
Riverside	0.44	1.33	0.33
Prentiss	0.47	1.21	0.39
Iotla	1.27	1.48	0.86
McLarney	1.92	1.47	1.31
August 1999			
Prentiss	0.69	1.09	0.63
McLarney	1.88	2.32	0.81
November 1999			
Prentiss	0.70	1.48	0.47
Iotla	0.78	0.63	1.24
McLarney	1.37	1.18	1.17



This fall we developed a model of leaf breakdown using data from Hugh White Creek. We presented these results at a meeting in Austria, and a manuscript has been submitted for inclusion in the proceedings of the meeting.

Intersite Activities

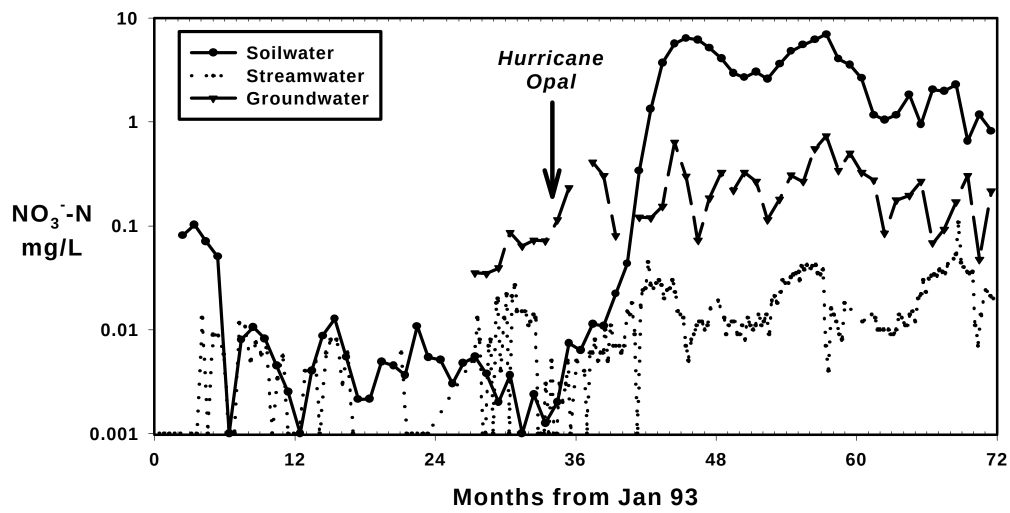
We are continuing to work on synthesis of data from the LYNX study. One paper to be submitted to Science (Peterson et al.) is close to submission. Mulholland is also working on a synthesis of metabolism data. The NPARS (Nitrate Production and Retention in Streams) is in full swing. This project is a collaboration of Coweeta (Webster and Valett), Oak Ridge (Mulholland), and New Mexico (Dahm).

Alan Yeakley (yeakley@pdx.edu)

Coweeta LTER 1999 Research Summary

1. Riparian vegetation disturbance project. A calibrated hillslope hydrology model was achieved for the project site, and used to estimate nutrient flux before and after disturbance from the hillslopes. We conducted random invention analyses (RIA) for differences for soilwater, groundwater and streamwater for both the vegetation removal slope and the storm disturbance slope. The work was presented at the AGU meeting in San Francisco, and a manuscript summarizing the nutrient responses both to understory rhododendron removal and to canopy windthrow and uprooting was completed (Yeakley et al, submitted). A second manuscript summarizing model calibration and longterm hydrology of the project is in progress (Yeakley and Swank, in prep). After 3 years of post-disturbance response on the project, we stopped collecting water chemistry data during the dormant season (Nov99-Mar00). The primary results of the project were that understory removal resulting in significant increases in soilwater NO_3^--N, but had no effect on groundwater nutrient concentrations or hillslope nutrient export. In contrast, canopy tree uprooting in the riparian zone resulted in 500X increases in soilwater NO_3^--N, an increase in groundwater NO_3^--N and a doubling of mean streamwater NO_3^--N that persisted at least 3 years after disturbance (see Figure below.)

NO_3^--N Response on the Storm Slope



2. Longterm tree vegetation study. We analyzed data results from the 1998 re-inventory of the permanent vegetation plots on WS 2 and WS 18 (established in 1982-83, and re-inventoried in 1989). We found significantly higher mortality following the droughts of the 1980s (12 stems/ha/yr) vs mortality during the wetter period in the 1990s (4 stems/ha/yr). Mortality in

dogwood was higher on the north-facing WS18 during the wet period, while mortality in red oak species was higher on the south facing WS 2 during the dry period. This work was presented at the ESA meeting in Spokane, and a manuscript is in progress (Clinton and Yeakley, in prep).

3. 1999 Publication activities.

Clinton, B.D. and Yeakley, J.A. Tree mortality in the southern Appalachians following extended wet and dry periods. *American Midland Naturalist*, in prep.

Yeakley, J.A. and Swank, W.T. Model calibration and longterm hydrologic dynamics in an upland forested riparian zone during vegetation removal. *Water Resources Research*, in prep.

Yeakley, J.A., Argo, B. W., Coleman, D.C., Deal, J.M., Haines, B.L., Kloeppel, B. D., Meyer, J.L., Swank, W.T. and Taylor, S.F. Hillslope nutrient dynamics during upland riparian vegetation disturbance. *Ecological Applications*, submitted.