Coweeta LTER June 2000 Meeting Presentation Abstracts
compiled and edited by Brian D. Kloeppel

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Co-PIs not attending:
Fred Benfield
Wayne Swank
Lloyd Swift
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James Vose

Co-PIs attending, but not presenting:
Barry Clinton
Dac Crossley
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Bruce Haines
David Newman

Oral Presentation
ADL, SINA M.* and DAVID C. COLEMAN. University of Georgia, Athens, GA 30602. Why Are There So Many Protists in the Soil?

We have initiated a study of soil unicellular organisms (protists) at Coweeta and at Horseshoe Bend to determine whether there are patterns to succession of these species. It is hypothesized that succession will occur over seasonal changes, but also on a shorter time scale, from day to day, as abiotic and biotic conditions change. Two approaches seem to be useful. The first is to monitor recolonization events. Plots of soil (75 x 75 cm) are dug out and replaced with sterile soil or organic matter free sand, each with or without litter supplement. Species composition and abundances are monitored and compared with plots set up at different seasons, and with control plots. The second approach involves burying sterile soil-columns (15 cm x 2 cm) of known organic matter composition. The columns are rapidly colonized by soil organisms. The difference in community structure between the "column soil" and "control soil" immediately outside of it are analysed. These columns can be used in the lab to follow changes under more controlled conditions. Soil columns established with one abiotic gradient provide further evidence of niche separation as species arrange themselves along the gradient. Thus far it is possible to state several conclusions regarding the association of certain species with particular abiotic factors. For instance, some require gravimetric water (colpodid ciliates) whereas others prefer much reduced moisture content (*gymnameobae*). *Testacea* and *Filosea* (amoebae) prefer fresh surface litter with high moisture. Other common species such as the *Mastigameobidae* prefer waterlogged partially anaerobic conditions, and otherwise remain in deeper soil layers. We are monitoring these plots to determine to what extent there are correlations between biotic factors, e.g. litter composition and community structure.

Poster Presentation

BATHALA, NEETI* and RONALD L. HENDRICK. University of Georgia, Athens, GA 30602. The Effects of Nitrogen and Phosphorus on Fine Roots and Mycorrhizae Across Different Taxonomic Groups, Mycorrhizal Types, and Biomes.

Nitrogen often limits productivity and can alter carbon allocation to, and the dynamics of, plant root systems. However, the effects of N on belowground processes are inconsistent, and can differ significantly among forest types. The primary goal of this project is to better understand how N and P interact with different mycorrhizal types (ectomycorrhizal and vesicular arbuscular mycorrhizal) and taxonomic groups (conifers vs. angiosperms) across different ecosystems in controlling root and mycorrhizal dynamics. The effect that differences in N availability (created by fertilizer treatment) have on soil pools, root system biomass and length, fungal biomass, and hyphal length are being evaluated between bulk or root-free (i.e. ingrowth cores) soil.

First year field data indicated that there were no significant effects of N or P, alone or in combination, on any of the variables measured. There were, however, significant differences among sites and between bulk vs. root-free soil on hyphal length (216.8 cm g $soil^{-1}$ to 161.0 cm g $soil^{-1}$) and phosphatase activity (199.4 EU g $soil^{-1}$ hr^{-1} to 122.8 EU g $soil^{-1}$ hr^{-1}). The EM species (white spruce and balsam poplar) had much greater hyphal length in both bulk and root-free soil than the AM species (sugar maple, tulip poplar), 324.4 cm g $soil^{-1}$ to 49.0 cm g $soil^{-1}$ and a greater P-ase activity of 187.1 EU g $soil^{-1}$ hr^{-1} vs. 135.0 EU g $soil^{-1}$ hr^{-1}, respectively. Greenhouse data indicated similar differences in hyphal length for EM vs. AM species. However, AM tulip poplar increased hyphal length with increasing fertilization from 77.2 cm g $soil^{-1}$ to 113.0 cm g $soil^{-1}$ ($P=0.003$) while EM infected hemlock showed a decrease in hyphal length from 219.9 cm g $soil^{-1}$ to 138.9 cm g $soil^{-1}$ ($P=0.005$) with additions of N and P.

Oral Presentation

COLEMAN, DAVID C.*[1], KIMBERLY ANDREWS[1], SHARON F. TAYLOR[1], CHRISTINA J. WRIGHT[1], AND J. ALAN YEAKLEY[2]. [1]University of Georgia, Athens, GA 30602 and [2]Portland State University. Organic Matter Inputs and Contents in Soils of Understory-Free and Hurricane-Impacted Hillslopes at Coweeta Hydrologic Laboratory.

We hypothesized that organic matter (OM) levels in *Rhododendron*-free cut-slope soils would progressively decline compared to the pre-cut and hurricane impacted slope. We measured canopy inputs to the system in blow-through and litter traps along 4 altitudinal transects from 5 to 20 m above the stream in WS 55. Although highly variable, inputs to blow-through traps were about 0.5 the mass per m^2 received by litterfall traps, which does not support the "debris dam hypothesis" of *Rhododendron* stems, from our 1990 proposal. Soil OM levels have remained nearly constant across several years post-cut, as have standing crops of root mass. Follow-up studies are planned for the next 5-10 years to test the idea that dead *Rhododendron* roots are more recalcitrant than dead tree roots.

Oral Presentation

GARDINER, EDWARD P.[1]*, JUDY L. MEYER[1], and PAUL V. BOLSTAD[2]. [1]University of Georgia, Athens, GA 30602 and [2]University of Minnesota, St. Paul, MN 55102. Assessing the Legacy of Sediment on the Little Tennessee River Basin in Macon County, North Carolina.

Past land use strongly determines the present condition of stream ecosystems. For example, sediment remains within stream channels as a result of erosion due to widespread forest clearing earlier this century. We used the Revised Universal Soil Loss Equation (RUSLE) to measure the impact of land use legacies on contemporary fish distributions in the Little Tennessee River Basin in Macon County, North Carolina. Photographs and satellite imagery allowed us to view land cover over a 40-year period (1950-1992) and to simulate sheet erosion. We then classified watersheds according to their presumed sediment inputs through time. We predict that fish assemblages from the early 1990's will reflect trajectories of sediment exposure over the period we considered. Integrating historical imagery, landscape modeling, and historical fish collection data, we explore the importance of sediment exposure and timing as they have influenced fish assemblages.

Oral Presentation
GRAGSON, THEODORE L.* University of Georgia, Athens, GA, 30602. Overview of Coweeta Regionalization Research.

The regionalization section comprises eight presentations organized around the topic of disturbance. The guiding hypothesis is that the frequency, intensity and extent of disturbance in the Southern Appalachian region is a response to both biophysical and socioeconomic conditions, such that changes in land use cascade in their effect through terrestrial and aquatic ecosystems. The common themes that unite these presentations also set them apart from more conventional ecological and social scientific research: the determination of the onset, not merely duration, of phenomena; the recognition of scalar, as opposed to organic, processes; and the search for spatially explicit, rather than statistical, explanations. In developing past-to-present or present-to-future scenarios of human-environmental interaction built around what are increasingly referred to as legacies, this set of presentations effectively address G. P. Marsh's great question of "Whether man is of nature or above her?" (Marsh 1864). This is important because humans have manipulated and shaped in diverse and subtle ways essentially all places on the face of the Earth, and any theory of environmental change that rests exclusively on physical forces is partial at best. Still, the human contribution to disturbance is more often an analytical afterthought than a research dimension to judge by such statements that the composition of modern plant communities in North America are largely a legacy of climate change during the Quaternary (e.g., Tausch et al. 1993).

Oral Presentation
GROSSMAN, GARY D.*, P. RINCON, and MARK FARR. University of Georgia, Athens, GA, 30602. A Method for Establishing Critical Habitat Requirements for Stream Fishes.

Hill and Grossman (1993 Ecology) demonstrated that the third derivative of prey capture success curves (i.e. plots of experimental data graphing the % of prey captured versus velocity) were excellent predictors of focal-point velocities occupied by two abundant drift-feeding fishes (rainbow trout and rosyside dace) in Coweeta streams. We used experiments to derive prey capture success curves at 18C, approximate summer temperature of the intermediate reaches of Coweeta Creek, for three additional species of drift-feeding fishes (*Luxilus coccogenis*, *Notropis leuciodis*, and *N. lutipinnis*). We also derived curves for rosyside dace, because the maximum temperature used by Hill and Grossman (1993) was 15 C. Prey capture success curves for the

four species all were of similar shape and explained large amounts of variation in the data (range of r^2 values 0.81-0.97). There were significant differences in prey capture success curves among size classes of a species. Regardless of site, the third derivative of prey capture success curves was a good predictor of focal-point velocities occupied by these species in the field and almost always fell within one standard deviation of mean focal-point velocities.

Oral Presentation
HILLERISLAMBERS, JANNEKE*, BRIAN BECKAGE, JAMES S. CLARK. Duke University, Durham, NC 27708 USA. Prevalence of Density Dependent Mortality in Temperate Deciduous Forests.

The recent discovery that negative density dependent mortality affects a large number of trees in tropical communities (53 spp - 18% of the forest tree community in BCI) has increased interest in the Janzen-Connell model of tree species coexistence. This model suggests that density dependent mortality regulates the coexistence of numerous tree species in the tropics, and is responsible for the latitudinal gradient in species diversity. To test the latter prediction, we set out to determine the prevalence of density dependent mortality in a temperate deciduous forest. At 100 one m^2 quadrats located across five permanent vegetation plots, we collected three years of seed rain and seed bank densities, and tagged seedlings as they emerged to determine seed germination and seedling survival. To test for density dependent mortality, we determined whether the relationship between recruit density and seed density is a saturating one (i.e. proportion of seeds surviving to seedlings decreases at high seed densities). Across years and sites, there were seven species (25% of the forest tree community) with sufficient recruitment to determine the relationship between seed density and recruit density. Although the strength of effect varied across species, all seven species (*Acer pennsylvannicum, Acer rubrum, Betula lenta, Fraxinus americana, Liriodendron tulipifera, Quercus rubra*, and *Vitis spp*.) were strongly affected by density dependent mortality, and the strength of the effect increased with time. Although density dependent mortality probably plays an important role in regulating community structure, our results suggest that this mechanism cannot explain the latitudinal gradient in species diversity.

Oral Presentation
JOHNSON, BRENT R.* and J. BRUCE WALLACE. University of Georgia, Athens, GA 30602. Effects of Long-Term Litter Exclusion on Larval *Eurycea Wilderae* in a Southern Appalachian Headwater Stream.

Larval salamanders are the top predators in fishless headwater streams of the southern Appalachians. Beginning in fall 1993, allochthonous organic matter was excluded from a headwater stream to assess the role of detritus in stream ecosystems. Previous studies have shown that litter exclusion resulted in reduced abundance, biomass, and secondary production of benthic macroinvertebrates. We conducted a repeated mark-recapture study that examined growth, population size, and movement of larval *Eurycea wilderae*. Salamander larvae were sampled monthly for one year from the litter exclusion stream, a nearby reference stream, and a "recovery" reach below the litter exclusion stream. In the litter exclusion stream, daily growth rates of salamanders were significantly reduced (ANOVA, $P<0.05$). Preliminary results also indicate that population density is smaller in the exclusion stream. Furthermore, population size data indicates conventional benthic sampling methods may underestimate *E. wilderae* abundance.

Larval movement did not significantly differ between streams (ANOVA, P>0.05). This study demonstrates the importance of the detrital resource in these headwater streams and how its reduction can affect higher trophic levels.

Oral Presentation
JURGELSKI, WILLIAM *and THEODORE L. GRAGSON. University of Georgia, Athens, GA 30602. The Robert Love Survey Project: Overview, Preliminary Results, and Future Directions.

This presentation will summarize our work with the records of the Robert Love Survey of 1820, the first land survey of western North Carolina in the vicinity of the Coweeta Hydrologic Laboratory. The survey covered some 71,000 acres in what are today Macon, Jackson, Swain, and Transylvania counties, NC, of lands that prior to 1820 had been part of the homeland of the Cherokee Indians. The records from the survey include a plat map showing the locations of the properties that were laid out during the survey, and surveyor's notes with descriptive information about these properties. The notes include the names of any occupants, and the location and species of the trees that were used to mark the property boundaries. We have created a GIS map of the surveyed lands, and entered all of the information from the surveyor's notes into a database linked to the map. Our objective is to use this information to reconstruct the landscape and forest composition of the region as it existed at the time of initial Euro-American settlement. This will provide a baseline against which subsequent environmental changes can be measured, and will allow questions of historical interest concerning early 19th century Cherokee and Euro-American land use practices to be addressed. In addition, by attaching the names of individuals to specific properties, the Robert Love Survey records may facilitate the use of later land use records such as the agricultural censuses of the mid to late 19th century that are referenced by property owner rather than by location.

Poster Presentation
KLOEPPEL, BRIAN D.* University of Georgia, Athens, GA 30602. Overview of the Organization of Biological Field Stations (OBFS) and Coweeta Hydrologic Laboratory.

The Coweeta Hydrologic Laboratory and LTER Program has been a member of the Organization of Biological Field Stations (OBFS) since 1997. The OBFS is an association of more than 200 field stations and professionals concerned with field facilities for biological research and education, primarily in North America and Central America. This poster is a professional product and travelling endorsement for OBFS and its members. OBFS also generates a "Field Studies Opportunities" poster each year that has included Coweeta since 1997. In the last few years, there has been increasing collaboration and networking between the OBFS and LTER networks. The current National Ecological Observatory Network (NEON) initiative discussion has been promoting the collaboration of these two networks to provide more thorough coverage of research and natural areas and to involve more scientists and educators in the NEON initiative. OBFS also maintains a large web site that contains numerous resources (http://www.obfs.org/). In addition, OBFS also conducts an annual meeting each September. I will be participating and representing Coweeta in the September 2000 annual meeting at H. J. Andrews Forest near Blue River, Oregon.

Oral Presentation
KLOEPPEL, BRIAN D.[1]*, MATTHEW C. FREEMAN[2], PAUL V. BOLSTAD[3]. [1]University of Georgia, Athens, GA 30602, [2]Wesleyan University, Middletown, CT 06459, [3]University of Minnesota, St. Paul, MN 55102. Modeling Tree Stem Temperature to Estimate Wood Respiration.

Forest carbon cycling has received increased attention as hypotheses related to global climate change are tested to predict long-term environmental effects. While forest carbon pools at the stand level are relatively easy to estimate, forest carbon fluxes remain difficult to estimate due to multiple driving variables. The woody respiration of southern Appalachian forests has been estimated by invoking a stratified random sampling design including forest stands in three topographic positions (ridge, midslope, and cove) and three age classes (200+ years, ~100 years, ~20 years). Allometric relationships were developed and used to scale measurements to the tree level. Stand biometric data were used to scale respiration estimates to the stand level. Relationships of stem temperature to air temperature were needed to estimate stem wood respiration flux. Four sites measuring air temperature and stem temperature on 25 or more trees were established on north and south facing slopes in mature and old growth study sites. Four potential models were evaluated to predict stem temperature from climate station air temperature data: lag, sinusoidal curve, single tree regression, and whole site regression. Single tree analyses indicated that up to 94.8 % of the variation in stem temperature data was explained by air temperature whereas sensor aspect, tree height, tree diameter, and topographic position explained only minimal variation. Previous data sets indicate that stem respiration Q_{10} values ranged from 1.63 in red maple to 2.57 in chestnut oak. Summarized calculations of woody respiration for nine southern Appalachian forest stands ranged from 305 to 770 g m^{-2} soil $year^{-1}$.

Oral Presentation
KNOEPP, JENNIFER D.* and JAMES M. VOSE. Coweeta Hydrologic Laboratory, USFS, Otto, NC 28763. Regulation of Nitrogen Mineralization and Nitrification: Separating Vegetation and Climate.

Long-term measurements of soil nitrogen (N) transformations were made along an environmental gradient within the Coweeta Hydrologic Laboratory basin in western North Carolina. Measurements were made at varying intervals using *in situ* closed core incubations from 1991 to 1996. Data showed that while there was a strong seasonal pattern of N transformation rates, factors other than the environmental gradient were important in regulating rates of nitrogen mineralization and nitrification. We hypothesized that vegetation composition may also be an important factor since vegetation composition also varies along the gradient. Our objective in this study was to separate vegetation and climate. During the growing season of 1999 we took *in situ* soil cores from each of the five gradient plots and transplanted them to all other gradient plots for their 28-day incubation. Soils from the site with the greatest *in situ* N transformation rates had the greatest rates at all other sites. These results indicate that the vegetation has an over-riding effect on soil N transformations. Data also suggest that transplanting soil with high N transformation rates from a cool high elevation site to a warm low elevation site may cause rates to increase.

Oral Presentation
LEIGH, D.S.*, B.J. FREEMAN, M.C. FREEMAN, E.A. KRAMER, M.J. PAUL, C.M. PRINGLE, A.D. ROSEMOND, R. CIFALDI, A. ROY, and D. WALTERS. The University of

Georgia, Athens, GA 30602. Land Cover and Geomorphic Indicators of Biotic Integrity in Piedmont Streams.

The overall goal and objective is to define the predictive capabilities of scale-variable attributes of land cover (GIS-based) and geomorphology as risk assessment indicators of biotic integrity of stream ecosystems on the southern Piedmont. The watershed under investigation is the upper Etowah River basin north of Atlanta, Georgia. Given various aspects of historical landscape change, our research is investigating the following three ancillary questions. (1) Do physical stressors and the corresponding ecological response vary as a function of land cover in the watershed? (2) Is this relationship consistent within watersheds of vastly different sizes? (3) Do antecedent land cover conditions (>50 years ago) influence the physical stressor and ecological response relationship? The approach to answer these questions involves two main projects over a three year period. The first project involves a comprehensive field survey of the geomorphic condition, habitat, water quality, and biological integrity in 30 streams draining watersheds of three distinct size classes of about 15, 50, and 100 km2. These watersheds have variable land cover of 50 to 100 % forest, based on the 1993 multi-resolution land characteristic (MRLC) databases. The stream reaches are surveyed for a length of at least 15 stream widths. Regression analysis is used to develop predictive models of biotic conditions from geomorphic indicators, habitat assessment, water quality, and land cover characteristics. The second project involves a detailed analysis of geomorphic conditions, stream habitat, and biotic integrity of six streams (out of the original 30) that appear as unexplained residuals in the predictive models. This will involve an expansion of six surveyed reaches to a length of at least 1 km and further assessment of the reach-scale versus watershed-scale controls on biotic integrity.

During January 2000, raw data from all aspects of the field survey were finalized and are being analyzed along with the land cover data. The preliminary findings suggest that reach-scale geomorphic and habitat assessments are somewhat better indicators of biotic integrity than the 1993 watershed-scale land cover characteristics. For example, the average particle size of the stream bed (in phi units) is highly correlated with the relative abundance of pool species of fish, exhibiting a correlation coefficient of 0.82. In contrast, the best correlation between pool species and land cover is found with percent agriculture, exhibiting a correlation coefficient of 0.60, and all other land cover classes are not significantly correlated. The significance of the preliminary findings may be that objective reach-scale assessments of physical characteristics are better indicators of biotic conditions than 1993 watershed land cover. However, more analysis of linkages between the watershed-scale land cover and reach-scale physical conditions are needed to explore causal relationships and develop multiple regression models that may provide the best indicators of biotic conditions.

Poster Presentation
MCGHEE, M. ELIZABETH (presented by AMY LYN EDWARDS*). University of Georgia, Athens, GA 30602 USA. Accession and Curation of Vertebrates from Western North Carolina.

In 1994, Dr. Joshua Laerm began an ambitious project to assess the distribution, relative abundance, and habitat associations of small mammals at Coweeta using the vegetational community study plots established by the LTER at Coweeta Hydrologic Laboratory. In addition to mammals however, reptiles, amphibians and invertebrates were also taken in his pitfall traps. The study was expanded in western North Carolina to include other Macon County sites in the Wine

Spring watershed and sites in Jackson County as well as in Pisgah National Forest in Buncombe County, where collecting finally concluded in June 1998.

Laerm's methods resulted in a very large number of specimens. These specimens were then curated and catalogued into the collections at the Georgia Museum of Natural History. My poster will show species, numbers, and localities that are at least partially curated and/or catalogued to date. Currently over 10,000 mammals, reptiles and amphibians have been recorded from these studies including approximately 23 species of mammals, 22 species of amphibians, and 4 species of reptiles.

Oral Presentation

MCTAMMANY, MATTHEW* and E. FRED BENFIELD. Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061-0406. Biological and Metabolic Properties of Streams Reforesting from Agriculture: Progress and Future Directions.

Agriculture has a long history in the southern Appalachian region, but recent socioeconomic trends have resulted in reversion of some agricultural lands to forest. Reforestation of agricultural land should lead to recovery of associated streams from agriculture effects, but we have shown that aquatic biota have not recovered in forested streams that were agricultural 50 years ago. We are working on an experiment to address the recovery of stream structure and function in areas that are reforesting after long-term agricultural use. We analyzed changes in land cover over the past 50 years for small watersheds (500-1000 ha) across the southern Appalachian region. From this analysis, we categorized all watersheds in several sub-basins across the region based on the spatial (riparian and whole watershed) and temporal properties of land use. The categories we are using to study the effects of reforestation are long-term forest, recovered forest, light agriculture, moderate agriculture, heavy agriculture, and reforesting agriculture. We have been visiting streams to select 5 sites from each category for further study (30 streams). This summer, we will begin to analyze geomorphology, biodiversity, and metabolism of streams in forested, reforesting, and agricultural areas. We will compare streams based on their current and historical land use. We plan to develop models for stream properties that incorporate spatial and temporal dimensions of landscape change for the southern Appalachian region.

Oral Presentation

MULLER, ROBERT N.*, RANDALL K. KOLKA, CHARLES C. RHOADES, and MARY A. ARTHUR. University of Kentucky, Lexington, KY 40506. Development of Research Opportunities between Coweeta and the University of Kentucky's Robinson Forest.

For more information about Robinson Forest or the Department of Forestry see: www.uky.edu/Agriculture/Forestry/forestry.html

A recent visit by Southern Research Station researchers to the University of Kentucky's Robinson Experimental Forest initiated discussions regarding potential cross-site research between UK and Coweeta. At this meeting we will introduce Coweeta scientists to Robinson Forest, UK's forestry research interests and consider links between our research programs.

Robinson Forest is a 5983 ha experimental forest located in the rugged eastern section of the Cumberland Plateau. Its landscape consists of long rectilinear sideslopes cut into a horizontally-bedded substrate of sandstone, shale, siltstone and coal. Its forests are typical of the

mixed mesophytic forest region and range from xeric oak-pine dominated stands to rich mesic cove hardwoods. The University acquired Robinson Forest in 1923 after extensive logging. As a result of the long duration of university ownership, we have a good picture of landuse changes including fire, cultivation and logging that has occurred over the past 80 years.

Active research has been conducted at Robinson Forest since 1969. Our past and current research focuses on three general areas of study: 1) long-term monitoring; 2) gradient research; and 3) large-scale manipulative studies. Since 1969 research related to Robinson Forest has produced approximately 100 peer-reviewed publications, 40 theses and eight dissertations.

We have monitored hydrologic flow and water quality in six watersheds since the early 1970's. We monitor precipitation volume and chemistry in six locations with one station dating back to 1981. Other long-term data sets include a series of Forest Service plots that were established in 1958 to determine the effect of gap size on the reproduction and development of desirable oak species. These plots have been resampled 3 times since establishment, the last occurring in 1992. Also, we performed a complete forest inventory in 1982 and recently finished a second inventory in 1999.

Because of the highly dissected nature of the terrain, important environmental gradients are driven primarily by aspect and slope position. Gradient research at the forest has focused on the interaction between these site factors and forest composition, productivity and nutrient cycling. Because of Robinson Forest's geologic and morphological structure, sites with widely differing species composition and nutrient cycling characteristics occur on identical substrates. Within this framework we have recently initiated an assessment of carbon pools and mineralization rates across the environmental gradients that occur in the forest.

Several watershed scale studies have been conducted on the forest, the most notable assessed the impact that forestry best management practices (BMPs) have on stream water quality. We are currently seeking support to conduct a similar paired-watershed experiment to assess the influence of streamside management zones (SMZs) on water quality and stream biota. Our motivation for discussing linkages between the Coweeta and Robinson Forest research programs is a desire to expand our ability to address regional questions of forest ecosystem management. The interpretation of work currently under review for Robinson Forest (i.e. effects of streamside management zones on water quality and stream ecosystems) would be amplified by conducting parallel work at Coweeta. Forest ecosystem gradient studies conducted jointly at both research forests allow the opportunity to identify and interpret patterns across the Appalachian region. Further, it may be possible to validate Coweeta's hydrologic models by adding data from our hydrologic network and to extend assessment of long-term water quality trends for the Appalachian region. Finally, we think that this link will be a good complement to our other ongoing work with the Southern Research Station and the National Forest System.

Oral Presentation

PEARSON, SCOTT[1]*, MONICA TURNER[2], and PAUL BOLSTAD[3]. [1]Mars Hill College, Mars Hill NC 28754; [2]University of Wisconsin-Madison, Madison WI 53706; [3]University of Minnesota, St. Paul, MN 55108. Changes in Abundance and Spatial Pattern of Forest Communities Between 1950 and 2030.

The abundance and spatial pattern of forest community types can affect ecosystem function and the persistence of populations of native species. Remotely sensed data have documented changes in forest cover in the Southern Blue Ridge Province since 1950. A recent paper by Wear and Bolstad projected forest cover change to 2030 using econometric models for four study areas in

NC and VA. For the same study areas, we combined maps of forest cover for four time periods (1950, 1970, 1990, and projections for 2030) with maps of potential forest types to measure changes in the abundance and spatial pattern of four forest communities. The forest community types were: northern hardwoods, cove hardwoods, mixed hardwoods, and oak-pine. The maps of potential forest types were derived from spatially explicit topographic information (e.g., elevation, land form, aspect).

Forest cover increased in all four study areas between 1950 and 1990. The abundance of cove hardwoods, mixed hardwoods, and oak-pine showed the greatest amount of change. Changes in northern hardwoods were minimal. Low-elevation forest types showed declines in the Cane Creek study area; further declines were projected for 2030. Increases in forest cover were accompanied by reduced fragmentation of habitats, as measured by increases in forest patch size and decreases in the number of patches. The density of buildings within the forest also increased during the study period. The most dramatic increases were observed in the Cane Creek watershed near Asheville, NC. Grayson County, VA, the most rural study area, showed the least amount of change in building density. While increases in forest cover will provide additional habitat for native species, increases in building density within forests may offset these gains for some species.

Oral Presentation

PULLIAM, H. RONALD[1]* and JAMES S. CLARK[2]. [1]University of Georgia, Athens, GA, 30602 and [2]Duke University, Durham, NC 27708 USA. Summary and Overview of Coweeta Terrestrial Research.

No abstract submitted.

Poster Presentation

RACHEL, GARY C* and RONALD L. HENDRICK. University of Georgia, Athens, GA, 30602. Interactions between Soil, Mycorrhizal Fungi, and Root Architecture – Their Impact on Community Structure.

Spatial and temporal distributions of particular woody species and genera are sometimes correlated with their type of mycorrhizal infection (e.g. facultative AM/EM *Salix* at high latitudes, various early successional AM hardwoods, ericoid mycorrhizal understories in coniferous EM forests, etc.). However, the mechanisms governing these patterns are largely unknown. The objectives of this study are to: 1) quantify the distribution and abundance of mycorrhizal species of the three major types of mycorrhizae: ecto- (EM), arbuscular (AM), and ericoid in Coweeta forests, 2) quantify the extent to which various mycorrhizal-host combinations are related to nitrogen and phosphorus soil fractions and spatial distributions, 3) quantify mycorrhizal infection rates, carbon, nitrogen, and phosphorus exchange rates, and fungal exo-enzyme production abilities, and 4) quantify mycorrhizal infection influence on root branching and proliferation (i.e. architecture).

Fungal DNA extraction from soils will be followed by quantitative PCR, cloning, and subsequent RFLP analysis to differentiate different fungal species present within the soil. RFLP patterns will be compared to those from mycorrhizal fungi voucher samples. Initial DNA extraction involves the comparison of several methods to improve quantity of extracted fungal DNA, while removing humic compounds inhibitory to PCR, cloning, and RFLP analysis.

Methodologies to be evaluated involve the use of various lysis methods, both mechanical and chemical, several buffers and purification systems. Element exchange and exo-enzyme production will be evaluated using selected mycorrhizal fungal species in a greenhouse study. Root architecture will be evaluated in a greenhouse study comparing the influence of different mycorrhizal fungi on branching, proliferation, and growth rates.

Poster Presentation
REYNOLDS, BARBARA C.* AND MARK D. HUNTER. University of Georgia. Athens, GA. 30602. Effects of Canopy Herbivores on Soil Respiration.

We tested whether experimental inputs from canopy herbivores would affect soil processes such as respiration, nutrient cycling, and decomposition along an elevation gradient at the Coweeta Hydrologic Laboratory. The five treatments we used were frass additions, throughfall additions, removal of all litter that fell during the study, removal of greenfall that fell during the study, and controls. Soil respiration was significantly reduced on low and mid elevation sites in litter exclusion, greenfall exclusion, and throughfall addition treatments. Throughfall additions containing PO_4-P and NO_3-N contributed to increases in PO_4-P, but decreases in NO_3-N in soil solution samples compared to controls. We postulate that mycorrhizal fungi could have taken up the NO_3-N. The reduced respiration we measured in throughfall treatments could also be explained by the presence of mycorrhizal fungi out-competing free-living soil microbes, since mycorrhizal fungi are reported to have greater respirational efficiency than free-living soil microbes. We observed no significant treatment effects on litter decomposition. Phosphate concentrations in soil solutions differed significantly with elevation. Elevation had no significant effect on decomposition.

Poster Presentation
SALMORE, ALISSA K.* and MARK D. HUNTER. University of Georgia, Athens, GA, 30602. Elevational Trends in Alkaloid Production in Sanguinaria Canadensis.

Evaluation of geographic gradients according to biotic interactions have shown that, with decreasing latitude, there is an increase in pressure on plant populations by herbivores and pathogens. One result of this latitudinal gradient is an increase in plant defenses from north to south in the northern hemisphere. We investigated the pattern of allocation to defense and reproduction in *Sanguinaria canadensis* (*Papaveraceae*) along an elevational gradient over two growing seasons to determine: 1) whether elevational gradients provide comparable results with latitudinal gradients, and 2) whether allocation to defense occurs at the expense of allocation to reproduction. Alkaloid concentrations in *Sanguinaria canadensis* provide evidence for an elevational cline in the production of defensive compounds; this pattern may fluctuate seasonally with plant growth and reproductive phenology. Evidence for the existence of a trade-off between defense and reproduction in this study is equivocal. *Sanguinaria* concentration increased with seed and elaiosome weights, which supports the alternative hypothesis that facilitation exists between defense and reproduction in *S. canadensis*. Three minor alkaloid concentrations assessed in November 1998 decreased with increasing number of seeds, while all alkaloid concentrations increased with seed weight that year.

Oral Presentation

SANZONE, DIANE M.[1]*, JUDY L. MEYER[1] and JENNIFER L. TANK[2]. [1]University of Georgia, Athens, GA, 30602 USA and [2]University of Illinois, Urbana, IL, 61801 USA. Nitrogen Transfer from Stream to Riparian Foodwebs: Results from Eight ^{15}N Tracer Experiments.

Movement of nutrients and organic matter between aquatic and terrestrial habitats may have a greater impact on assemblage structure and community dynamics than within-habitat inputs. In this study, we document the effect of aquatic prey subsidies on surrounding terrestrial predators in eight riparian zones using a stable isotopic ^{15}N tracer experiment to quantify the flow of nitrogen from aquatic to terrestrial food webs via emerging aquatic insects. We continuously dripped ^{15}N-NH_4Cl for six weeks into four temperate forested streams (North Carolina, Tennessee, New Hampshire, and Oregon), one tropical forest stream (Puerto Rico), a desert stream (Arizona), a grassland stream (Kansas), and one arctic stream (Iceland), and traced the flow of ^{15}N from the streams into spiders living in the riparian zone. After correcting for background ^{15}N values, we used simple mixing models to calculate proportion of ^{15}N tracer from emerging aquatic insects incorporated into spider biomass. In addition, we documented spider abundance, biomass and diversity along a transitional gradient at various distances from the stream bank (0-50m). Ground-dwelling spider abundance was highest within the first 10m of the stream bank in six of the eight streams, three of which had relatively high emergence production (desert, arctic, and temperate rainforest streams). Spider ^{15}N values were elevated above background levels and tracked that of emerging aquatic insects at these three sites, indicating a reliance on aquatic resources.

Poster Presentation
SCHOFIELD, KATE.* University of Georgia, Athens, GA 30602. Crayfish assemblages in southern Appalachian streams: Is there a correlation with watershed land use?

Crayfishes are an important component of many freshwater systems, yet little is known about how human alteration of aquatic environments affects crayfish assemblages. The influence of watershed development on crayfishes is especially relevant in the southern Appalachians, where crayfish diversity is high and residential development is increasing. I am sampling crayfishes in twelve southern Appalachian streams, representing three types of watershed land use: forest, pasture, and suburban/urban. At each site, randomly located samples are taken using a 1 m^2 Surber-type sampler. Results show that four crayfish species are found at these sites. *Cambarus bartonii* occurred most frequently (it has been found at 10 of 12 sites), while the other species tended to be more regionally restricted. Overall densities did not differ significantly between land use types. However, crayfishes were very patchily distributed, both between and within sites. For example, no crayfish were caught at one suburban/urban site, while another suburban/urban site averaged > 2 crayfish per m^2. At the latter site, several individual samples contained no crayfish, but other samples yielded up to 12 crayfish per m^2. These patterns of distribution likely reflect changes in habitat availability (e.g., unembedded substrate, leaf cover, etc.) both within and between streams.

Oral Presentation
SCOTT, MARK C* and EDWARD P. GARDINER. University of Georgia, Athens 30602. Proposed Development of a Watershed Model Predicting Ecological Response to Land Use Change.

Ongoing development pressures that result in urban/suburban sprawl have contributed worldwide to degraded water quality, loss of aquatic habitat, and imperilment of freshwater organisms. In the southern Blue Ridge Province, past and present deforestation patterns are strongly related to an increase in nutrient concentrations, dissolved solids, and fine sediments in streams. These changes in the physiochemical habitat template are in turn related to a decline in endemic fish species. The trend we observed toward homogenization of the highly distinctive upland fauna with surrounding lowland faunas points to a reduction in continental biodiversity with land development over time. Two competing hypotheses emerge as possible explanations for the ecological changes associated with deforestation we observed: 1) sedimentation of stream substrates reduce reproductive and foraging success of aquatic species, and 2) increases in nutrient, temperature, and light cause a shift in stream trophic structure. As the next step in potentially reversing the trend toward biodiversity loss, we propose that a spatially-explicit, GIS-based model be developed relating processes of sedimentation, nutrient loading, and temperature elevation to particular land uses (e.g. industrial/commercial, residential) and their location within the drainage basin (e.g. ridgetop, riparian zone). The process model outputs would be used with new field data to develop a companion empirical model predicting biotic response to environmental change. The coupled model would be used to assess the explanatory power of the two competing hypotheses described above. More generally, the model would serve as a link from Wear and Bolstad's projections of land use change to predictions with known confidence intervals of aquatic ecosystem response. The model would be useful to local governments and citizens' groups grappling with land use issues by providing probability estimates of ecological change associated with various development scenarios.

Oral Presentation

SUTHERLAND, ANDREW B.[1]*, E. FRED BENFIELD[2], EDWARD P. GARDINER[1], KARA GRIFFIN[1], GENE S. HELFMAN[1], MATT MCTAMMANY[2], JUDY L. MEYER[1], CATHY M. PRINGLE[1], and MARK SCOTT[1]. [1]University of Georgia, Athens 30602 USA and [2]Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061. Plans for Long-Term Research on the Biology and Geomorphology of Southern Appalachian Streams at High Risk for Development.

The purpose of this project is to collect pre- and post-disturbance data at streams whose watersheds are at high risk of being developed in the near future. Using Wear and Bolstad's hedonic model, we chose six streams under development pressure, three in the Little Tennessee basin and three in the French Broad basin. Two reference sites were also selected, one in each basin. Biotic and abiotic parameters will be measured at these sites once every five years for the next 30 years. We will measure the change over time in the algae, macroinvertebrate, and fish communities as well as several measures of habitat quality and geomorphology. To assess watershed conditions, we will assess changes in land cover/use using aerial photo interpretation and field observations. By establishing pre-disturbance conditions and following each stream for an extended period of time, we hope to better understand how urban/suburban development impacts the integrity of Appalachian streams.

Poster Presentation

SUTHERLAND, ANDREW B.* and JUDY L. MEYER. University of Georgia, Athens 30602. Effects of substrate embeddedness on behavior of the gilt darter (*Percina evides*).

We investigated the general behavior of the gilt darter (*Percina evides* Jordan and Copeland), a benthic fish whose distribution has been shrinking since the early part of this century. Direct observations (by snorkeling) were made in Fall 1999 in five streams that differed in sedimentation, measured as substrate embeddedness. Embeddedness varied from 40% - 70%. Ten fish were observed per stream, each for 15 minutes. Observations focused on foraging, swimming, and resting as well as number of feeding strikes. Time spent foraging, swimming, and resting was significantly different ($p < 0.001$) among sites, as was number of feeding strikes per observation period. We also found a marginally significant ($p = 0.08$) relationship between foraging time and mean substrate embeddedness. Number of feeding strikes versus embeddedness was also marginally significant ($p = 0.06$). Swimming and resting time were not correlated with embeddedness. Mean number of feeding strikes was significantly correlated to mean foraging time ($p = 0.03$). This study suggests that increasing embeddedness may affect the activity of this relatively silt-tolerant darter, implying that less tolerant benthic taxa may be more heavily influenced by increasing streambed sedimentation.

Oral Presentation

TAYLOR, SHARON F.[1]*, BRIAN D. KLOEPPEL[1], DAVE C. COLEMAN[1], and BRIAN BECKAGE[2]. [1]University of Georgia, Athens 30602 USA and [2]Duke University, Durham, NC 27708 USA. Riparian Zone Seedling Establishment, Dynamics, and the Influence of *Rhododendron maximum.*

The understory shrub *Rhododendron maximum* is associated with reduced regeneration of tree seedlings throughout the southern Appalachians. Four study sites were used to study natural seedling establishment in riparian zones where *R. maximum* is a dominant species: one *R. maximum* artificially removed treatment site, one *R. maximum* hurricane disturbed treatment site, and two *R. maximum* control sites. Each study site had ten randomly located 1-m^2 quadrats. All seedlings were tagged during an initial survey in May 1997 and during subsequent spring surveys. During each census, species, density, age, and height of seedlings were recorded. Abiotic characteristics including aspect, slope, soil moisture, and light availability, were measured for each quadrat. Coinciding research on the sites included transects instrumented with tension lysimeters. In the control sites, seedling density averaged 2.9 stems m^{-2} and mortality averaged 9.9 stems m^{-2}. At the treatment sites, seedling density averaged 22.9 stems m^{-2} and mortality averaged 10.2 stems m^{-2}. Mean heights for *Liriodendron tulipifera* and *Betula lenta*, dominant species in the hurricane disturbed quadrats, were 10.1 and 20.4 cm, respectively. *Acer rubrum* and *L. tulipifera* were prevalent in the artificially removed quadrats with mean heights of 1.0 and 4.5 cm, respectively. The results indicate that seedling establishment and height in riparian zones are strongly influenced by the removal or disturbance of *R. maximum*, and that the disturbance of *R. maximum* results in increased seedling germination, height, and survival.

Oral Presentation

JAMES M. VOSE (presented by JENNIFER D. KNOEPP*). Coweeta Hydrologic Laboratory, USFS, Otto, NC 28763. Coarse Woody Decomposition Across an Environmental Gradient: Results from Year 4 of the Reciprocal Transplant Experiment.

One of the difficulties in establishing cause and effect relationships between ecosystem processes and environmental conditions across the terrestrial gradient plots is that species composition also varies. In 1996, I initiated a study to separate the effects of environmental conditions vs. species differences on log decomposition. Log sections from eight species were placed at four locations near each gradient plot. Logs have been re-measured at 2-year intervals and weight loss determined. Averaged across species, the lowest decomposition rate has occurred at 527 and the highest decomposition rate at 218. The fastest individual species decomposition rate has occurred for basswood and the lowest for black locust. Two species, black locust and pitch pine, show no predictable pattern in decomposition rate among plots. In general, the remaining species have greater decomposition at low elevation sites (118, 218) than high elevation sites (427, 527).

Oral Presentation
WALKER, JOHN F.* and ORSON K. MILLER, JR. Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061-0406. Diversity of Terrestrial Macrofungi at Coweeta: Preliminary Assessment.

A database of terrestrial macrofungi at Coweeta is being developed as part of ongoing research (with Erik Nilsen and Barry Clinton) into tree seedling establishment under ericaceous shrubs. Alpha diversity was intensively sampled weekly or biweekly over three years on a site limited to a single slope. Mushrooms were also collected from throughout the Coweeta Hydrologic Laboratory area, though mainly from roadsides and easily accessible areas, during these visits. In addition, we hosted forays by the Asheville Mushroom Club two fall weekends. This database was developed both to compare ectomycorrhizal fungal diversity between areas with versus without ericaceous shrubs, and to initialize a species list for the Coweeta. Fungal diversity listed for Coweeta thus far includes approximately 400 species, but is heavily biased toward ectomycorrhizal taxa (3/4) and is far from being complete. Many taxa are additionally documented by dried specimens (maintained at the Virginia Tech Mycological Herbarium), fresh notes at the time of collection, color photographs, and microscopic descriptions. Part of our research involves identification of ectomycorrhizal fungi directly from tree seedling rootsystems in areas with or without ericaceous shrubs. This is being accomplished by comparing PCR-RFLP banding patterns from the dried mushroom specimens with DNA amplified from the roots by fungal specific primers. We will continue to voucher fungi at Coweeta for an additional 2-3 years for this purpose, and ultimately will present a more thorough listing. For the time being, this preliminary assessment of fungal diversity will be made available for the Coweeta website species listings.

Oral Presentation
WEAR, DAVID.

No abstract submitted.

Oral Presentation
WEBSTER, JACKSON R.* Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061. Coweeta and Intersite Stream Research.

Coweeta stream researchers have played a major role in intersite studies, including both synthesis activities and intersite research. We currently have two active intersite studies of streams. The LINX (Lotic Intersite nitrogen eXperiment) study is in the writing and synthesis phase. We currently have one paper published, five in press, three more submitted, and at least five in preparation (complete draft exists). We have also made 36 presentations at meetings and 13 more are scheduled for presentation this summer. NPARS (Nitrate Processing and Retention in Streams) is just beginning its second year of field work. Preliminary results suggest far more retention of nitrate in streams than suggested by previous studies.

Oral Presentation

WEBSTER, JACKSON R. Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061. Summary and Overview of Coweeta Stream Research.

No abstract submitted.

Oral Presentation

YEAKLEY, J. ALAN[1]*, BARRY W. ARGO[2], DAVID C. COLEMAN[2], JAMES M. DEAL[2], BRUCE L. HAINES[2], BRIAN D. KLOEPPEL[2], JUDY L. MEYER[2], WAYNE T. SWANK[3] and SHARON F. TAYLOR[2]. [1]Portland State University, Portland, OR 97207-0751, [2]University of Georgia, Athens, GA 30602, [3]Coweeta Hydrologic Laboratory, USDA-Forest Service, Otto, NC 28763 USA. Hillslope Nutrient Dynamics following Upland Riparian Vegetation Disturbance.

We investigated the effect of removing riparian *Rhododendron maximum* on hillslope nutrient export to streams. Transects were established on adjacent hillslopes in a first order watershed at Coweeta to quantify soil water content, free water surface depth, and soilwater and groundwater chemistry. For two years, background dynamics were measured for nutrients (K^+, Na^+, Ca^{2+}, Mg^{2+}, NO_3^--N, NH_4^+-N, PO_4^{3-}-P, SO_4^{2-}) and dissolved organic carbon (DOC). A terrain-based hillslope hydrology model was calibrated for hillslope water outflow, spanning both storms and season-long droughts. In August 1995, the riparian rhododendron thicket on one hillslope was cut, with subsequent regrowth eliminated by clipping. In October 1995, Hurricane Opal uprooted 9 canopy trees (> 30 cm diameter) on the other hillslope.

During three following years, NO_3^--N tripled and DOC decreased on the rhododendron cut hillslope. Other soilwater nutrients did not vary from background concentrations. No effects were observed in groundwater nutrient concentrations or export from the riparian understory treatment. In contrast, nutrient concentrations on the storm affected hillslope showed marked changes, beginning in the growing season (spring 1996) following the hurricane. NO_3-N soilwater concentrations showed persistent 500X increases on the storm affected hillslope, resulting in a 5X increase in hillslope NO_3-N flux and a doubling of mean NO_3-N streamwater concentrations downstream. Persistent changes were also seen in soilwater pH (decrease), SO_4^{2-} (decrease), Ca^{2+} (increase) and Mg^{2+} (increase). After these vegetation disturbances, no significant changes were observed in either microbial immobilization of nutrients in soils on the storm slope or in the hillslope water flux. These results suggest that nutrient uptake by canopy dominant vegetation is the most important control on NO_3-N export in upland forested riparian zones, and that disruption of the root-soil connection in dominant trees via uprooting promotes significant nutrient loss to streams.