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Accomplishments

*** What are the major goals of the project?**

This integrated project is designed to address the five LTER core research areas by examining how hydroclimate variability and the human-modified landscape separately and interactively alter southern Appalachian Mountain ecosystem processes and biotic communities that, in turn, affect the vulnerabilities of regional socio-ecological systems. This research builds on long-term studies and monitoring activities across numerous permanent plots within and beyond the Coweeta Basin that include over 20 years of tree demographic data representing more than 350,000 tree-years. Performance and abundance of a suite of tree, herb, invertebrate, salamander and bird species are being measured on experimental plots within and beyond the Coweeta Basin that support investigation of primary production, spatial and temporal distribution of populations, movement of organic and inorganic matter and disturbance. In a large-scale experimental removal of rhododendron, multiple investigators are examining processes at the interface between terrestrial and stream ecosystems in relation to management through intensive plot-scale and extensive reach-scale treatments to assess issues central to LTER core research including vegetation dynamics, soil microbial communities, soil extracellular enzyme activity, aquatic macroinverterbrate communities, as well as nutrient pools and fluxes. Modeling of past and present hydroclimate variability is being used to integrate information about ecosystem function and risks across square-meter to regional geographies. The Coweeta Listening Project translates and communicates community-relevant results from Coweeta LTER research to engage the western North Carolina community in a process that links science, policy and management. The Coweeta Schoolyard Program includes field-based environmental education and in-classroom support for middle school teachers and students, as well as outreach programs to land owners on the importance of riparian corridor integrity.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

We are examining how hydroclimate variability and the human-modified landscape separately and interactively alter southern Appalachian Mountain ecosystem processes and biotic communities that, in turn, affect the vulnerabilities of regional socio-ecological systems. Our major activities this past year fall into the interrelated programmatic areas of 1) measuring performance and abundance of suites of organisms in a series of permanent plots within and beyond the Coweeta Basin; 2) a large-scale experiment to examine the long-term effects of hemlock mortality and rhododendron (Rhododendron maximum) removal on terrestrial and in-stream ecosystem processes; 3) modeling efforts of past and present hydroclimate variability to establish ecosystem function and the vulnerability of socio-ecological systems across square-meter to regional geographies; and 4) translating and communicating community-relevant results from Coweeta LTER research to engage society with science in the southern Appalachian Mountains.

1) Long-term studies in permanent plots include analysis of cultural ecosystem services that depend on biodiversity including human perceptions of the occurrence, abundance and diversity of wildflower and bird communities in the French Broad River Valley. Complementary work examines forest bird community characteristics in the Coweeta Basin and surrounding areas from avian point counts and mist-netting, and vegetation and lepidopteran surveys. We worked in experimental salamander plots to examine the effect of salamander removal on Aphaenogaster ant seed retrieval under the hypothesis that removing a top ant predator would result in greater ant abundance and thus greater seed dispersing efficiency. We completed an intensive field data campaign in support of an investigation of age- and height-related controls on plant functioning. We are also examined performance of individual species and

plant functional types across gradients of soil moisture in six long-term plots on north and south-facing slopes at high and low elevations. Finally, we continued (year 10) measuring of temperature and soil moisture in permanent herb plots so we can examine plant and plant-trait variation as a function of hydroclimate variability.

2) We initiated a project to examine the long-term effects of hemlock mortality and rhododendron (Rhododendron maximum) removal. We monitored summer stream temperatures above, below, and within the 300m study reaches for the reference and three treatment streams. Installed and monitored water level sensors to assess how stream chemistry varied with water levels. We also investigated the effects of riparian gaps on stream temperatures and channel morphology within and downstream of riparian gaps by conducting physical channel surveys and monitoring stream temperatures. We measured in each of the four focal stream reaches: (a) algal standing crop three times (spring, summer and winter), by taking ten samples with a Loeb sampler in five riffles and five pools and analyzing samples for AFDM and chlorophyll a; (b) leaf litter standing stock in the stream channel (ten grab samples) and leaf litter input (ten litter baskets) four times (early summer, late summer, fall, and winter); (c) stream respiration throughout the summer using a single oxygen probe and five station re-aeration measurements once annually over a 100 m reach; and (d) nitrogen uptake once in the summer using the plateau method over a 100 m reach. We manipulated the presence and absence of macroconsumers (crayfish and salamander larvae) to examine trophic dynamics and consumer control of basal resources (algal growth accrual and decomposition at the patch scale) by nesting 5 paired electric exclosures and controls within both the reference and the cut-scatter/burn treatment stream reaches. We also measured the responses of the macroinvertebrate community in the four streams by sampling at 6 locations prior to and after the manipulation. Finally, DNA was extracted from soil samples collected from the rhododendron removal experiment plots, which were frozen to be sequenced and analyzed once post-treatment samples have been collected.

3) We began to integrate our long-term tree census data with FIA data assimilated for density, biomass, growth, survival, and recruitment to model biodiversity and biomass accumulation at the individual tree scale, the plot scale (size-species distributions), and ecoregion scale (biomass per area). The model predicts distribution and abundance driven by climate and species interactions with the added benefit of inferring which demographic rates and environmental variables are limiting at population frontiers. Organisms experience climate through their interactions with others, and by incorporating joint species distributions we are able to model at the regional scale since all types of data submit to a single framework. Climate data is being modeled from PRISM and DAYMET data in order to calibrate MODIS land-surface temperatures for the SE. We have developed new drought stress indices that better characterize the response of vegetation to climate including surpluses and deficits. We have also been building in differences in stomatal behavior between major species groups to the RHESSys model to differentiate response to drought, and the landscape partitioning of stomatal behavior over ridge to hollow gradients. Finally, we are developing a framework to assess urban land cover influences on atmospheric and land surface hydrometeorological

processes that involves observational analysis and numerical modeling experiments. This will include spatio-temporal analysis of precipitation extremes and development of frameworks for downscaled regional experiments that connect into the RHESSys model supported by the Coweeta environmental network that streams data in near real-time.

In effort that parallels the modeling of physical and biotic interactions, we are laying the foundation to examining the vulnerability of regional socio-ecological systems. We are currently collecting and organizing existing data in the Blue Ridge Mountains region that characterize human-induced changes of topsoil physical properties affecting infiltration, storage, and runoff of water using USDA soil profile data from across the region. We also began to develop long-term, watershed-level charge balances to backcast dissolved organic carbon concentrations toward understanding the size and direction of relevant carbon fluxes contributing to the observed declines in soil carbon across the Coweeta basin. We are laying the foundation for examining socio-ecological processes that drive and are affected by hydroclimate change by assembling an extensive geospatial database. This includes developing preliminary measures to allow integration of human quantitative and qualitative migration and mobility data, sourced from Census and other administrative sources, with ecological measures by deployment of dasymetric modeling.

4) In the Coweeta Schoolyard LTER program we continued our fall Migration Celebration field days for over 271 5th and 6th graders and expanded our Kids in the Creek field day to over 694 middle and high school students in 8 different schools representing 5 counties in western North Carolina and north Georgia. In total, we hosted 20 events and served 1,500 students. We also engaged in diverse outreach and translation events such as the Shade Your Stream program as well as tours and public encounters that included an adult education class on climate change at the Asheville Arboretum.

Specific Objectives: The specific objectives of this project center on examining how hydroclimate variability and the human-modified landscape separately and interactively alter southern Appalachian Mountain ecosystem processes and biotic communities that, in turn, affect the vulnerabilities of regional socio-ecological systems. Long-term studies in permanent plots address issues pertaining directly to the spatial and temporal distribution of populations selected to represent trophic structure; the pattern and control of organic matter accumulation in surface soils and sediments; and the patterns of inorganic inputs and movements of nutrients through soils and waters. We are determining how the performance of individual herb species and plant functional types (phenological guilds) vary with soil moisture; investigating trade-offs between plant functional traits, herbivory, and pathogen infection along a gradient of soil moisture; and evaluating how interspecific competition, herbivory and pathogens affect the performance of transplanted individuals of Hepatica nobilis along a soil moisture gradient. Some plot-level work is designed to understand how tree species and their mycorrhizal type determine the exchange of C and N between plants and soils, why deep soil carbon is declining over the last several decades at CWT, and how reductions in rainfall affect tree species growth and nitrogen fixation. Plot-level work is complemented by quantification of primary controls on forest structure, particularly height, biomass, and overstory species

composition. Finally, quantification of rainfall interception along a forest age chronosequence is used to estimate landscape variation and controls on surface soil moisture, that helps in scaling from plot-level to the region.

This work relates to our large-scale riparian rhododendron manipulation experiment examining pattern and control of primary production, as well as patterns, frequency and effects of disturbance. At the reach scale, our objective is to understand how Rhododendron removal alters algal accrual, decomposition, nutrient cycling, respiration and stream trophic dynamics including shifts in top-down consumer control of algal accrual and decomposition. We are also determining whether riparian rhododendron cutting increases stream temperatures to determine: if increases persist downstream of the treatment reach; whether hydrologic behavior is similar and consistent among the four streams; and, if we can predict the rate of diurnal temperature damping of water flowing through the hyporheic zone. Answering these questions requires quantifying stream temperature increases within riparian gaps and temperature attenuation downstream of gaps; it also entails quantifying the rate of channel narrowing within riparian gaps and channel expansion downstream of gaps. Other aspects of this experiment include examining the influence of changes in vegetation on soil nitrogen cycling and mobility on the composition of soil microbial communities. It also involves testing the effect of rhododendron removal on terrestrial and stream ecosystems particularly crayfish abundance and fish communities, and the changes in taxonomic and functional diversity of stream macroinvertebrate communities.

The integration of LTER core research areas comes in part through our modeling efforts. By incorporating species-level differences in stomatal behavior into our RHESSys model we seek to determine landscape partitioning of stomatal behavior over ridge to hollow gradients. This supports our investigation into determining the influence that downslope subsidy has on biodiversity by creating structured gradients in resource availability subject to inter-annual hydroclimate and availability of surplus water. Through our investigation of the existence and dynamics of watershed rainfall-moisture storage-runoff threshold behavior, our objective is to determine the impact of biotic drivers of potential evapotranspiration on runoff threshold dynamics and the existence of a runoff signal of interannual variability in these biotic controls. By coupling our terrestrial ecohydrology model with an aquatic metabolism model we will evaluate and deconvolve the role of the two environments in processing carbon and nitrogen in streamwater. Such efforts are central to incorporating sources of uncertainty into the developing models. Other regional work relates directly to measuring pattern, frequency and effects of disturbance unique to the So Appalachian domain and the refinement of the models. Developing a methodological framework for conducting downscaled regional climate modeling using NARCCAP analyses and the WRF Model will make it possible to conduct experiments on CONTROL and NO-URBAN footprints to assess spatio-temporal trends in extreme precipitation in the region. This links to our objective to understand the human role in changing physical properties of soil, and specifically soil hydrology, through activities including deforestation, cultivation, reforestation, and urbanization. The objective in this case is to inform hydrologic models so they can capture the temporal and spatial

dynamics of soil properties as mediated by human activities and so determine how productivity varies spatially in function of edaphic factors and climate across a mountainous landscape at present and under future climate scenarios.

Knowledge of human decisions, behavior, and actions contribute directly to LTER research and our social science research objective is to examine questions of socio-ecological connections among organisms, biological processes, and the abiotic environment as they pertain to social responses to future environmental change. By documenting seasonal changes in the spatial distribution of nature viewing opportunities we are developing a spatial model of those spatiotemporal patterns. Measuring the effect of habitat fragmentation caused by residential development contributes to determining its relation to the population dynamics and trophic structure of resident bird species. Determining the relation between human activities on the land, topography and canopy structure contribute to determine ecosystem carbon and water cycling. By illustrating values, worldviews, and patterns of social connection and division that result from exurbanization we are able to provide baseline data for long-term research on regional landscape modification as well as perceptions of and responses to vulnerability. Research on knowledge of environmental and climate change will provide insights into the diverse ways that people inhabit, engage with, and observe the southern Appalachian landscape and factors that give rise to this diversity. It also contributes to our understanding of the diverse theories of environmental change (including theories of causes, effects, timescales, spatial scales, and likely consequences) in the region and how they compare with one another and with scientific theories of environmental change. Such knowledge is central to understanding the ways that people conceptualize and enact responses to environmental change. Research on environmental journalism reveals the media landscape that shapes people's perceptions of and responses to environmental change, and helps determine the discursive and cognitive frameworks through which people consider socio-environmental issues such as climate change, exurbanization, landscape conservation, species-specific conservation, and water-related issues. In short, it can both encourage new conceptual frameworks and theory that can advance understanding of site-specific dynamics while serving to relate such results to other ecosystems and different spatial scales.

Significant Results: Warren et al. (2015) examined the effects of exurbanization on seed dispersing ant nesting and foraging, seed retrieval, dispersal direction and subsequent impact on myrmecochores using a matrix of forested and exurbanized habitats to test whether (1) exurban edges decrease ant nest colonization and seed foraging, (2) ants disperse seeds away from exurban edges, and (3) consequently, there is lower ant-dispersed plant abundance nearer exurban edges. They found that exurban development poses little impact on keystone seed-dispersing ants because they foraged, colonized and thrived in fragmented woodland habitats as well as they did in intact forests. Exurban edges changed ant behavior, however, so that they generally moved seeds toward forest interiors, and, hence, away from edges. Corresponding to this behavioral change, they found that ant-dispersed plants declined with proximity to edges, whereas other woodland herbs with dispersal modes other than ants were unaffected. They show a deleterious biotic cascade between exurban edge, keystone ants and herbaceous plants. Species-mediated services, such

as seed dispersal and pollination, are key resources, and assessing the full consequences of land use change therefore necessitates evaluation of impacts on biotic interactions.

Novick et al. (2015) merged concepts from stomatal optimization theory and cohesion-tension theory to examine the dynamics of three mechanisms potentially limiting to leaf-level gas exchange in trees during drought: a) a 'demand limitation' driven by an assumption of optimal stomatal functioning, b) 'hydraulic limitation' of water movement from the roots to the leaves, and c) 'non-stomatal' limitations imposed by declining leaf water status within the leaf. Model results suggest that species-specific 'economics' of stomatal behavior may play an important role in differentiating species along the continuum of isohydric to anisohydric behavior. They specifically show that non-stomatal and demand limitations may reduce stomatal conductance and increase leaf water potential, promoting wide safety margins characteristic of isohydric species. Direct comparisons of modeled and measured stomatal conductance further indicated that non-stomatal and demand limitations reproduced observed patterns of tree water use well for an isohydric species, but that a hydraulic limitation likely applies in the case of an anisohydric species.

Schliep et al. (2015) developed a modeling strategy to learn about biomass change at the plot level and model cumulative uncertainty to accommodate this dependence among neighboring trees. Predictions of above-ground biomass and the change in above-ground biomass require attachment of uncertainty due to the range of reported predictions for forests, but because above-ground biomass is seldom measured, there have been no opportunities to obtain such uncertainty estimates. Standard methods involve applying an allometric equation to each individual tree on sample plots and summing the individual values. However, the interdependence between competing trees means the uncertainty at the plot level from aggregating individual tree biomass overestimates variability - the variance at the plot level should be less than the sum of the individual variances. As an alternative, plot-level variance is modeled using a parametric density-dependent asymptotic function, and plot-by-time covariate information is introduced to explain the change in biomass. These features were then incorporated into a hierarchical model to obtain an inference within a Bayesian framework that was used to analyze data for the eastern United States from the Forest Inventory and Analysis (FIA) Program of the US Forest Service. This region contains roughly 25,000 FIA monitored plots from which there are measurements of approximately 1 million trees spanning more than 200 tree species. Due to the high species richness in the FIA data, they combine species into plant functional types and derived predictions of biomass and change in biomass for two plant functional types.

Despite compelling reasons to involve nonscientists in the production of ecological knowledge, cultural and institutional factors often dis-incentivize engagement between scientists and nonscientists. Burke et al. (2015) detail efforts to develop a biweekly newspaper column to increase communication between ecological scientists, social scientists, and the communities they work in. Community generated topics are addressed by a writing collective of social and natural scientists, while the column is meant to foster public dialog about socio-environmental issues and lay the groundwork for the coproduction of

environmental knowledge. The collective approach to writing addresses some major barriers to public engagement by scientists, but the need to insert ourselves as intermediaries limits these gains. Overall, they demonstrate that efforts at environmental communication praxis have not generated significant public debate, but they support future coproduction by making scientists more visible in the community creating pathways for scientists to begin engaging the public. The research highlights an underappreciated barrier to public engagement: many field scientists, for example, seek out neutral and narrowly defined connections that permit research access that are largely incompatible with efforts to address controversial issues of environmental governance.

Jackson et al. (2015) surveyed 49 wadeable streams in the Upper Little Tennessee River Basin, of which 45 had low levels of development, in order to investigate: interactions of riparian vegetative conditions on active channel width, variability of width within a reach, large wood frequency, mesoscale habitat distributions, mesoscale habitat diversity, median particle size and per cent fines. Conversion of riparian forest to grass has reduced aquatic habitat area (quantified by active channel width), channel width variability, wood frequency, mesoscale habitat diversity and obstruction habitat (wood and rock jams), and such conversion has increased the fraction of run and glide habitat. Channels with grassy riparian zones were only one-third to three-fifths of the width of channels with forested riparian zones, and channels with grassy or narrow forested riparian zones were nearly devoid of wood. Particle size metrics were strongly affected by stream power and agricultural cover in the basin, but the data suggest that elimination of riparian forest reduces median bed particle size. Results indicate that even modest increases in the extent and width of forested riparian buffers would improve stream habitat conditions.

Chamblee et al. (2015) examined how water contamination risk from an inactive hazardous waste site is capitalized into surrounding vacant land prices. After public knowledge of the first instance of off-site contamination, they found that shallow groundwater contamination potential is negatively capitalized into land prices, as is proximity to a known contaminated well. Public knowledge of off-site contamination and associated land price changes occurred after the North Carolina’s 10-year statute of repose. Findings raise questions concerning such statutes when environmental contamination has a long latency period, especially given a recent Supreme Court ruling that Superfund law does not preempt state statutes of repose. The innovation in the paper is focusing on the disparate impacts of surface water contamination and ground water contamination, of which the latter might not be recognized until after the statute of repose has expired. The statute of repose focuses on how long after the contamination event occurred during which damaged parties can sue for compensation. If the statute of repose expires then damaged parties are precluded from suing for compensation that reduces market efficiency and social welfare.

Key outcomes or Other achievements: (nothing additional to add)

*** What opportunities for training and professional development has the project provided?**

The Coweeta LTER Schoolyard program directly engaged with 1,500 students on 20 different occasions. Coweeta

Schoolyard LTER coordinated and led the 6th annual Migration Celebration where we collaborated with the non-profit Southern Appalachian Raptor Research (SARR) and Land Trust for the Little Tennessee (LTLT) to lead 271 5th and 6th grade students from Mountain View Intermediate in activities concerning migration, including tagging Monarch butterflies, banding migratory songbirds, and learning the different strategies that animals use to cope with scarce resources. We once again coordinated a 4-day Kids in the Creek field trip for approximately 284 8th graders from Macon Middle School, Nantahala School, Highlands School, and Trimont Christian School that involved aquatic biologists from the Land Trust for the Little Tennessee (LTLT), U.S. Fish and Wildlife Service, North Carolina Division of Water Quality, and North Carolina Wildlife Resources Commission. The program meets 8th grade science curriculum standards, and focuses on the hydrosphere and water quality as part of the North Carolina Standard Course of Study.

In March we held a Kids in the Creek event for 90 students from Hayesville Middle School, collaborating, with the Hiwassee River Watershed Coaltion and LTLT to host the event. In May we collaborated with LTLT and Watershed Association for the Tuckasegee River (WATR) to host a Kids in the Creek event for 98 9th -12th grade students from Smoky Mountain High School. And in September we collaborated with the National Park Service, LTLT, and WATR to host a Kids in the Creek event for 121 Swain Middle School 8th graders. The Science Study Boxes continue to be used by local teachers and were checked out a total of 7 times during the 2014/2015 academic year, serving 2,054 students.

One REU student was hosted this year. A national announcement was made, 20 applications were received, and four students were interviewed (two men, two women - one from University of Missouri, one from the University of Georgia, one from Mississippi State, and one from the University of Rhode Island). Kerndja Bien-Aime, a young Haitain American from the University of Rhode Island was awarded the REU. Kerndja worked in residence under the direct supervision of Dr. John Maerz and two female Ph.D. graduate students (Kira McCentire and Jillian Howard) on a project related to our study of the effects of climate on the ecology of terrestrial salamanders. Kerndja assisted with monthly surveys of salamanders on 96 forest plots within the Coweeta Basin learning unmarked and capture-mark-recapture techniques for studying salamander population ecology. She developed a project examining whether the diets of salamanders varied across forests as a function mean annual precipitation and soil moisture using a non-lethal lavage technique to collect hundreds of diet samples from around the Coweeta Basin across a precipitation and soil moisture gradient. Kerndja found that salamander diets did vary as a function of moisture, with salamanders from drier sites consuming a higher proportion of more mobile taxa compared to salamanders in wetter sites. Kerndja used her REU experience to obtain a field research and outreach position in Rhode Island and is preparing to apply to graduate school next year.

In addition to the Coweeta LTER Schoolyard activities and the REU award, Coweeta LTER investigators provided numerous opportunities for training and professional development to high school, undergraduate, and graduate students from their home institutions and elsewhere as well as staff both from the project as well as other LTER projects. In addition, several co-PIs incorporate portions of their research in to regularly taught courses, lead multi-day field trips to the project area in which students engage in field work, or offered mini-courses on selected topics that emerge from their Coweeta LTER research. Noteworthy activities this year included:

Three undergraduate students and one graduate student from University of Texas at San Antonio, and one graduate student from University of Southern Mississippi received training in field methods. Four undergraduate students from Mars Hill University participated in field data collection and data analysis. Two Indiana University Masters students spent the summer at Coweeta collecting a dataset that will be used to investigate height- and age-related controls on ecosystem carbon and water cycling. One of the students presented results at the fall 2015 American Geophysical Union meeting in San Francisco. Two undergraduate students and one graduate student from Buffalo State University were provided training opportunities in field sampling, experimental design, data analysis and writing.

An international masters student from France carried out supervised fieldwork in Buncombe County, and received training in qualitative research techniques, including sampling, interviewing, conducting and analyzing freelists,

and analysis of interview transcripts.

A University of Georgia doctoral student conducted research on throughfall displacement. A graduate student and an undergraduate student gained experience with regional climate modeling and cluster computing. An undergraduate student assisted with the development and pilot-testing of a data-collection protocol for qualitative analysis of human migration. Finally, two PhD students, seven undergraduate students, and one international undergraduate student from Brazil participated in aquatic sampling in the Rhododendron manipulation experiment.

One graduate student and two undergraduate students from the University of Wisconsin presented results of their research at national meetings. An MS student and three undergraduate students from Virginia Tech participated in macroinverterbrate sampling and identification on the Rhododendron manipulation experiment. A graduate student from University of North Carolina - Chapel Hill gained experience writing MATLAB code for analysis of precipitation/soil moisture/rainfall time series for analysis of nonlinear behavior and thresholds, and presented at a national meeting. And, a PhD student from the University of Minnesota was trained in time series statistical analysis, and an MS student from the same institution received advanced training in forest biometry data collection and analysis procedures, spatial database development, and sampling.

Eleven staff members participated in a three-day training course covering datalogger programming, radio and modem configurations, LoggerNet software utilization, and overall site deployment best management practices. In addition, two LTER technicians travelled to the Carey Institute to learn about their Quality Assurance/Quality Control program and archive system, learning how samples and data were entered and tracked using the Laboratory Information Management System (LIMS). In October, three LTER field technicians and three LTER lab technicians took part in a 1-day rhododendron removal workshop where they learned about some of the results of this joint Coweeta LTER-Coweeta USFS research project. Finally, a Jobs Corps student gained valuable experience working with the Analytical Lab Manager to inventory and organize archived soil and forest vegetation samples then summarized what she learned for Coweeta scientists and peers.

Our deployment of a near-real time sensor network for the Coweeta LTER enabled us to partner with the GCE LTER in hosting a workshop on the GCE Data Toolbox for 14 LTER Information Managers. This workshop contributed to an increased user base for the GCE Data Toolbox, both within and beyond the LTER community. It also resulted in online documentation that allows anyone with a MATLAB license to download the GCE Data Toolbox and begin using it to process environmental data.

*** How have the results been disseminated to communities of interest?**

In addition to published products as listed elsewhere, following is a selected summary of investigator and student engagement with distinct communities of interest:

Katherine Elliott (USFS) planned and organized a workshop “Riparian Forest Restoration after the loss of eastern hemlock by removing rhododendron” designed to provide information to federal, state and private land managers. The workshop involved scientists at SRS-4353 and Coweeta LTER investigators, and it was held at the Coweeta Hydrologic Laboratory.

Scott Pearson (Mars Hill) provided environmental education related to his LTER avian ecology research to visitors to the Big Bald Bird Banding Station (Madison County, NC), and served as a committee member for Southern Appalachian Highlands Conservancy, a regional land trust, using his knowledge of the region and understanding of landscape ecology to inform their strategic decisions about land conservation efforts.

Kim Novick (Indiana University) initiated a Citizen Science program on tree leaf phenological observations in Indiana based on similar work at Coweeta LTER in which activities are incorporated into field trips, routine data collection, and public hikes.

Monica Turner (University of Wisconsin) contacted over 300 visitors at public forests (both State and Federal public lands) asking them to participate in research on public perceptions of public forests in which individuals were given the opportunity to also ask questions about science and patterns of biodiversity in the Southern Appalachians.

Jason Love (LTER Site Manager) co-led 6 different university and adult outreach events, reaching 130 participants and including: a presentation on the history of Coweeta Research to the Otto Community Development Organization (20 adults); a tour for a group of Wildlife & Forestry students from Stephen F. Austin State University (12 students and 2 adults); a workshop on Rhododendron Removal and Restoration for state, federal, and non-profit land managers (45 adults); a Butterfly walk on Franklin Greenway for Friends of the Franklin Greenway (4 adults and 3 children); a presentation on Butterflies of the Smokies for Franklin Garden Club (38 adults); and the Gibson Bottoms Naturalist Ramble and Coweeta LTER Research overview for Franklin Bird Club (6 adults). In addition, the Forest Service and LTER staff conducted 40 tours at the Coweeta Hydrologic Lab in which more than 300 people were reached.

Brian Herndon (LTER IM) co-organized and lead a working group session at the 2015 LTER All Scientist Meeting entitled 'Automating sensor data processing and Q/C with the GCE Data Toolbox' that demonstrated the capabilities of the GCE-developed software for parsing information and generating ecological metadata language (EML) that is PASTA compatible. Presentation included demonstrating use of this software for various Coweeta LTER site level activities, highlighting the numerous quality control features of the software, and provided feedback from participant questions.

Brian Burke (Appalachian State University) and Jennifer Rice (University of Georgia) led a continuing education course at the NC Arboretum regarding the social dimensions of climate change.

*** What do you plan to do during the next reporting period to accomplish the goals?**

Regional numerical modeling simulations will be conducted for the French Broad and Little Tennessee river basins to assess the regional impact of land cover/landuse on a suite of hydrometeorological variables including temperature, precipitation, and runoff. The Weather Research and Forecasting (WRF) model, coupled with the NOAH Land Surface Model with an embedded Urban Canopy Model, will be applied to a set of sensitivity experiments to evaluate LCLU changes in the basin from the early 1900s to the Present. WRF will be initialized with downscaled climate analysis from the NARCCAP program or CMIP5, then using appropriate statistical analysis techniques, we will quantify the hydrometeorological response to different and increasingly complex LCLU configurations. Particular interest will be given to urban LCLU changes (sensu Shepherd et al. 2013, Gustafson et al. 2013). Gridded hydrometeorological variables from the WRF-NOAH simulations will be provided as input to RHESSys to evaluate ecological and hydrologic response within the system. This analysis will serve as a precursor for understanding the synergistic roles of LCLU within a warming climate system.

Six additional environmental sensor stations will be installed within the Coweeta Basin at the beginning of 2016 once radio communication dead zones within the basin are addressed. Three stations will also be installed within the Bee Tree Watershed near Asheville, NC once the final station locations are determined. These new soil moisture stations measure and record at 5 minute intervals, creating datasets with 12 times greater resolution than previously established soil moisture and soil temperature stations.

A second, temporary flux tower will be installed at a grassland site near Coweeta in support of a project investigating how reforestation affects surface and air temperature, that will complement the data analysis and interpretation of the existing USFS Coweeta flux tower. A new field campaign will be initiated in summer 2016 to explore how air and soil water drainage affects leaf- and tree-level carbon and water cycling.

Long-term biotic monitoring and experimental plots within the Coweeta basin, Great Smoky Mtns Nat. Park, Duke Forest and Mars Hill will be resampled. These are the basis for examining the evolution and interaction of

space/time patterns of the forest canopy relative to watershed geomorphology, hydrologic cycling and transport. Growth increment measurements of all trees on all plot sites will be recorded, providing the opportunity to involve all census sites in the synthetic modeling activities.

In activities associated with the Rhododendron Removal Experiment, we will continue to monitor water level time series and summer stream temperature time series in the streams at a much finer spatial scale to assess the scale of higher temperature patches within the stream created by local increases in solar insolation. The following measurements will be made in the four focal streams: (1) algal standing crop three times per year; (2) leaf litter standing stock in the stream channel (grab samples) and leaf litter input into stream (baskets) four times per year; (3) respiration during summer; (4) nitrate uptake once during summer; and (5) two 28-day in situ trophic experiments in the fall. Monitoring of crayfish populations will also continue. DNA will be extracted and sequenced from samples collected from the experiment, and how changes in nitrogen cycling and decomposition are associated with differences in microbial community composition and richness will be examined. Artificial ant nests will be placed at field plots Coweeta in conjunction with the ongoing Rhododendron removal experiment.

Coupling of terrestrial and aquatic ecosystem model will continue in order to integrate joint processing of nitrogen and carbon in streamwater export. There will also be an extension of the terrestrial ecohydrologic models to incorporate xylem anatomy influences on water use of canopy over the ridge-riparian gradient, lateral redistribution of moisture, runoff regimes, and vulnerability of different topographic position/species assembly to drought conditions. In addition, there will be continued refinement of methods to evaluate emergent behavior of streamflow regimes as a function of canopy biodiversity and spatial arrangement of distinct physiologic behavior.

For the Coweeta LTER Schoolyard program, we will continue the Migration Celebration in the fall and the Kids in the Creek in the spring. We will also continue to update and replenish supplies and activities in our Science Study Boxes.

Products

Books

Turner, Monica G. and Gardner, Robert H. (2015). *Landscape Ecology in Theory and Practice, 2nd edition 2nd.* Springer. NY. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: Doi 10.1007/978-1-4939-2794-4

Book Chapters

Leigh, D. S. (2015). Multi-millennial Record of Erosion and Fires in the Southern Blue Ridge Mountains, USA. *Natural Disturbances and Range of Variation: Type, Frequency, Severity, and Post-disturbance Structure in Central Hardwood Forests* Greenberg, C. H. and Collins, B. S.. Springer. New York. 167-202. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Inventions

Journals or Juried Conference Papers

Barrett, John, E. (2015). Global environmental change and the nature of aboveground net primary productivity responses: insights from long-term experiments. *Oecologia*. 177 (4), 935-947. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: DOI 10.1007/s00442-015-3230-9

Berdanier, A. and J.S. Clark (). Multi-year drought-induced morbidity preceding tree death in Southeastern US forests. *Ecological Applications*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi: 10.1890/15-0274.1

Bumpers, Philip, M. and Maerz, John, C. and Rosemond, Amy, D. and Benstead, Jonathan,

P. (2015). Salamander growth rates increase along an experimental stream phosphorus gradient. *Ecology*. 96 (11), 2994-3004. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/14-1772.1

Burke, Brian J. and Welch-Devine, Meredith and Gustafson, Seth (2015). Nature Talk in an Appalachian Newspaper: What Environmental Discourse Analysis Reveals about Efforts to Address Exurbanization and Climate Change. *Human Organization*. 74 (2), 185-196. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Burke, Brian, J. and Welch-Devine, Meredith and Gustafson, Seth and Heynen, Nik and Rice, Jennifer, L. and Gragson, Ted, L. and Evans, Sakura, R. and Nelson, Donald, R. (2015). Can Science Writing Collectives Overcome Barriers to More Democratic Communication and Collaboration? Lessons from Environmental Communication Praxis in Southern Appalachia. *Environmental Communication*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: Doi: 10.1080/17524032.2014.999695

Caldwell, Peter V. and Kennen, Jonathan G. and Sun, Ge and Kiang, Julie E. and Butcher, Jon B. and Eddy, Michele C. and Hay, Lauren E. and LaFontaine, Jacob H. and Hain, Ernie F. and Nelson, Stacy A.C. and McNulty, Steven G. (2015). A comparison of hydrologic models for ecological flows and water availablity. *Ecohydrology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/eco.1602

Cecala, Kristen, K. and Maerz, John, C. (2015). Context-dependent responses to light contribute to salamander responses to landscape disturbances. *Canadian Journal of Zoology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1139/cjz-2015-0111

Chamblee, John, F. and Dehring, Carolyn, A. and Depken, Craig, A., II and Nicholson, Joseph, R. (2015). Water Contamination, Land Prices, and the Statute of Repose. *The Journal of Real Estate, Finance, and Economics*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s11146-015-9514-3

Craig, Matthew, E. and Pearson, Scott, M. and Fraterrigo, Jennifer, M. (2015). Grass invasion effects on forest soil carbon depend on landscape-level land use patterns. *Ecology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Elliott, K. J., Miniat, C. F., Pederson, N., and Laseter, S. H. (2015). Forest tree growth response to hydroclimate variability in the southern Appalachians.. *Global Change Biology*. 21 4627-4641. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi:10.1111/gcb.1304

Elliott, Katherine J. and Vose, James M. and Knoepp, Jennifer D. and Clinton, Barton D. and Kloeppel, Brian D. (2015). Functional role of the herbaceous layer in eastern deciduous forest ecosystems. *Ecosystems*. 18 221-236. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-014-9825-x

Fang, Yuan and Sun, Ge and Caldwell, Peter and McNulty, Steven G. and Noormets, Asko and Domec, Jean-Christophe and King, John and Zhang, Zhiqiang and Zhang, Xudong and Lin, Guanghui and Zhou, Guangsheng and Xiao, Jingfeng and Chen, Jiquan (2015). Monthly land cover-specific evapotranspiration models derived from global eddy flux measurements and remote sensing data. *Ecohydrology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/eco.1629

Ferguson, Paige F.B. and Conroy, Michael and Chamblee, John F. and Hepinstall-Cymerman, Jeff (2015). Using structured decision making with landowners to address private forest management and parcelization: balancing multiple objectives and incorporating uncertainty. *Ecology and Society*. 20 (4), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5751/es-07996-200427

Ferguson, Paige F.B. and Conroy, Michael and Hepinstall-Cymerman, Jeff (2015). Occupancy models for data with false positive and false negative errors and heterogeneity across sites and surveys. *Methods in Ecology and Evolution*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/2041-210x.12442

Graves, Rose and Pearson, Scott M and Turner, Monica G. (2015). Landscape patterns of bioenergy in a changing climate: implications for crop allocation and land-use competition. *Ecological Applications*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1890/15-0545.1

Hwang, Taehee and Band, Lawrence E. and Hales, T. C. and Miniat, Chelcy F. and Vose, James M. and Bolstad, Paul V. and Miles, Brian and Price, Katie (2015). Simulating vegetation controls on hurricane-induced shallow landslides with a distributed ecohydrological model. *Journal of Geophysical Research: Biosciences*. 120 (2), 361-378. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2014jg002824

Jackson, C. Rhett and Leigh, David, S. and Scarbrough, Sarah, L. and Chamblee, John, F. (2015). Herbaceous Versus Forested Riparian Vegetation: Narrow and Simple Versus Wide, Woody and Diverse Stream Habitat. *River Research and Applications*. 31 (7), 847-857. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/rra.2783

Knoepp, Jennifer D. and Taylor, R. Scott and Boring, Lindsay R. and Miniat, Chelcy F. (2015). Influence of Forest Disturbance on Stable Nitrogen Isotope Ratios in Soil and Vegetation Profiles. *Journal*. 79 (5), 1470-1481. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2136/sssaj2015.03.0101

Kominoski, John S. and Rosemond, Amy D and Benstead, Jonathan P. and Gulis, Vladislav and Maerz, John C. and Manning, Dvid W. P. (2015). Low-to-moderate nitrogen and phosphorus concentrations accelerate microbially driven litter breakdown rates. *Ecological Applications*. 25 (3), 856-865. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/14-1113.1

Leigh, D. S. and Gragson, T.L. and Coughlan, M.R. (2015). Pedogenic effects of mid- to late-Holocene conversion of forests to pastures in the French western Pyrenees. *Zeitschrift fÃ¼r Geomorphologie*. 59 225-245. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1127/zfg_suppl /2015/S-59212

Leigh, D. S. and Gragson, Ted L and Coughlan, M.R. (2015). Colluvial legacies of millennial landscape change on individual hillsides, place-based investigation in the western Pyrenees Mountains. *Quaternary International*. Online . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.quaint.2015.08.031

Lin, Laurence and Webster, Jackson, R and Hwang, Taehee and Band, Lawrence, E (2015). Effects of lateral nitrate flux and instream processes on dissolved inorganic nitrogen export in a forested catchment: A model sensitivity analysis. *Water Resources Research*. 51 2680–2695. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2014wr015962

Manning, David, W.P. and Rosemond, Amy, D. and Kominoski, John, S. and Gulis, Vladislav and Benstead, Jonathan, P, and Maerz, John, C. (2015). Detrital stoichiometry as a critical nexus for the effects of streamwater nutrients on leaf litter breakdown rates. *Journal*. 96 (8), 2214-2224. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1890/14-1582.1

Milanovich, Joseph R. and Maerz, John C. and Rosemond, Amy D. (2015). Stoichiometry and estimates of nutrient standing stocks of larval salamanders in Appalachian headwater streams. *Freshwater Biology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/fwb.12572

Norman, J. S., L. Lin, and J. E. Barrett. (2015). Paired carbon and nitrogen metabolism by ammonia-oxidizing bacteria and archaea in temperate forest soils.. *Ecosphere*. 6 (10), 176. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/ES14-00299.1

Novick, Kimberly A and Miniat, Chelcy F. and Vose, J. M. (2015). Drought limitations to leaf-level gas exchange: results from a model linking stomatal optimization and cohesion tension theory. *Plant Cell and Environment*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/pce.12657

Novick, Kimberly A and Oishi, A. Christopher and Ward, Eric J. and Siqueira, Mario B.S. and Juang, Jehn-Yih and Stoy, Paul C. (2015). On the difference in the net ecosystem exchange of CO2 between deciduous and evergreen forests in the southeastern United States. *Global Change Biology*. 21 (2), 827-842. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi 10.1111/gcb.12723

Pearson, Scott M and Elliott, Katherine J. and Love, Jason and Bradford, Mark (2015). Cryptic indirect effects of exurban edges on a woodland community. *Ecosphere*. 6 (11), 218. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1890/es15-00318.1

Rice, Jennifer L. and Burke, Brian J. and Heynen, Nik (2015). Knowing climate change, embodying climate praxis: experimential knowledge in southern Appalachia. *Annals of the Association of American Geographers*. 105 (2), 253-262. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1080/00045608.2014.985628

Rosemond, Amy and Benstead, Jonathan and Bumpers, Phillip and Gulis, Vladislav and Kominoski, John and Manning, David and Suberkropp, Keller and Wallace, Bruce (2015). Experimental nutrient additions accelerate terrestrial carbon loss from stream ecosystems. *Science*. 347 (6226), 1142-1145. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: DOI: 10.1126/science.aaa1958

Schliep, Erin, M. and Gelfand, Alan, E. and Clark, James, S. and Zhu, Kai (2015). Modeling change in forest biomass across the eastern US. *Journal*. 1-19. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10651-015-0321-z

Schwalm, C.R. and Huntzinger, D.N. and Cook, R.B. and Wei, Y. and Baker, I.T. and Neilson, R.P. and Poulter, B. and Caldwell, Peter and Sun, G. and Tian, H.Q. and Zeng, N. (2015). How well do terrestrial biosphere models simulate coarse-scale runoff in the contiguous United States?. *Ecological Modelling*. 303 87-96. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1016/j.ecolmodel.2015.02.006.

Steere, Benjamin, A. (2015). Revisiting platform mounds and townhouses in the Cherokee heartland: A collaborative approach. *Southeastern Archaeology*. 34 (3), 196-219. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: Doi: 10.1179/2168472315y.0000000001

Sun, Ge and Caldwell, Peter V. and McNulty, Steven G. (2015). Modelling the potential role of forest thinning in maintaining water supplies under a changing climate across the conterminous United States. *Hydrological Processes*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/hyp.10469

Wallace, J. Bruce and Eggert, Susan L. and Meyer, Judy L. and Webster, Jackson R. (2015). Stream invertebrate productivity linked to forest subsidies: 37 stream-years of reference and experimental data. *Ecology*. 96 (5), 1213-1228. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/14-1589.1

Wang, Lixin and Leigh, David S. (2015). Anthropic signatures in alluvium of the Upper Little Tennessee River

valley, Southern Blue Ridge Mountains, USA. *Anthropocene*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi:10.1016/j.ancene.2015.11.005

Wyderko, Jennie, A. and Benfield, E. Fred and Maerz, John, C. and Cecala, Kristen, K. and Belden, Lisa, K. (2015). Variable infection of stream salamanders in the southern Appalachians by the trematode Metagonimoides oregonensis (family: Heterophyidae). *Parasitol Research*. 114 3159-3165. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: DOI 10.1007/s00436-015-4550-8

Zhu, K., C. Woodall, and J.S. Clark (2015). Prevalence and strength of density-dependent tree recruitment. *Ecology*. 96 (9), 2319-2327. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1890/14-1780.1

Licenses

Other Conference Presentations / Papers

Oishi, A.C., Hawthorne, D., Miniat, C.F., and Brantley, S.T. (2015). *An interactive tool for processing sap flux data from thermal dissipation probes.*. Fifth Interagency Conference on Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Christine Sobek (2015). *Canopy and litter interception vary with forest age in the southern Appalachian Mountains.*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Tae Hee Hwang (2015). *Climate change homogenizes landscape vegetation patterns at the catchment scale*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Chris Oishi (2015). *Climatological controls on net primary productivity in a southern Appalachian forest*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Rhett Jackson (2015). *Coweeta (CWT) and the temperate montane deciduous forest of the southern Appalachians: Topographically complex, climatically variable, disturbed at multiple time scales, and human modified and utilized*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Larry Band (2015). *Critical zone processes at the watershed scale: Hydroclimate and groundwater mediated evolution of forest canopy patterns*. 3rd Intl. Conf. Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Larry Band (2015). *Critical zone processes at the watershed scale: Hydroclimate and groundwater mediated evolution of forest canopy patterns.*. 2nd International Symposium on the Dynamics of Coupled Natural and Human Systems. Beijing, China. Status = OTHER; Acknowledgement of Federal Support = Yes

Bahn, R.A. and C.R. Jackson. (2015). *Effects of exurbanization in the Upper Little Tennessee River Basin: Sedimentation is predictable; flow and specific conductivity are not.*. Georgia Water Resources Conference. University of Georgia. Status = OTHER; Acknowledgement of Federal Support = Yes

Miniat, C.F., Hwang, T., and Band, L.E. (2015). *Estimating hillslope-scale soil strength for regional landslide forecasting.*. European Geophysical Union General Assembly. Vienna, Austria. Status = OTHER; Acknowledgement of Federal Support = Yes

Caldwell, P., Smithgall, K., Miniat, C.F., and Sun, G. (2015). *Impacts of changing forest structure and species composition on long term streamflow across the conterminous US.*. 4th International Conference Forests and

Water in a Changing Environment. Kelowna, BC, Canada.. Status = OTHER; Acknowledgement of Federal Support = Yes

Caldwell, P.V., Miniat, C.F., Brantley, S.T., Elliott, K.J., Laseter, S., and Swank, W.T. (2015). *Long term records provide insights on the relative influence of climate and forest community structure on water yield in the southern Appalachians.*. Fifth Interagency Conference on Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Elliott, K.J., Miniat, C.F., Caldwell, P.V., Swank, W.T., Brantley, S.T., and Vose, J.M. (2015). *Long-term changes in water use and streamflow following grass-to-forest conversion.*. 4th International Conference Forests and Water in a Changing Environment. Kelowna, BC, Canada.. Status = OTHER; Acknowledgement of Federal Support = Yes

Webster, J.R., Swank, W.T., Knoepp, J.D., and Miniat, C.F. (2015). *Long-term data reveals a regime shift in watershed nitrogen export.*. Ecological Society of America Annual Meeting. Baltimore, MD. Status = OTHER; Acknowledgement of Federal Support = Yes

Karen Allen (2015). *Moving beyond the exchange value: A deductive approach to nonmarket valuation and implications for conservation policy.*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Miniat, C.F., Zietlow, D.R., Brantley, S.T., Mayfield, A.E., Rhea, R., Jetton, R. and Arnold, P. (2015). *Physiological responses of eastern hemlock (Tsuga canadensis) to biological control and silvicultural release: implications for large-scale hemlock restoration.*. Fifth Interagency Conference on Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Caldwell, P.V., Miniat, C.F., Aubrey, D.P., Jackson, C.R. and McDonnell, J.J. (2015). *Precipitation partitioning in short rotation bioenergy crops- implications for downstream water availability.*. Fifth Interagency Conference on Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Charles Scaife (2015). *Predicting near-stream soil moisture using low-dimensional relationships in a small headwater catchment of the Coweeta Hydrologic Laboratory*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Elliott, K.F., C.F. Miniat, J.D. Knoepp, M.A. Crump, and C.R. Jackson. (2015). *Restoration of southern Appalachian riparian forests affected by Eastern Hemlock mortality.*. Interagency Conference on Research in the Watersheds. North Charleston, SC.. Status = OTHER; Acknowledgement of Federal Support = Yes

Cofer, T.M., Elliott, K.J., Bush, J.K., and Miniat, C.F. (2015). *Seed bank dynamics under Rhododendron maximum: Implications for restoration of southern Appalachian forests.*. Ecological Society of America Annual Meeting. Baltimore, MD. Status = OTHER; Acknowledgement of Federal Support = Yes

Knoepp, J.D., Elliott, K.J., Jackson, W., Vose, J.M., Miniat, C.F., and Zarnoch, S. (2015). *Soil and Stream Chemistry Relationships in High Elevation Watersheds.*. Fifth Interagency Conference on Research in the Watersheds. Charleston, SC. Status = OTHER; Acknowledgement of Federal Support = Yes

Elliott, K.J., Miniat, C.F., Pederson, N. and Laseter, S.H. (2015). *Southern Appalachian tree growth response to hydroclimate variability.*. 4th International Conference Forests and Water in a Changing Environment. Kelowna, BC, Canada.. Status = OTHER; Acknowledgement of Federal Support = Yes

Graves, R.A., S.M. Pearson, and M.G. Turner. (2015). *Spatial and temporal dynamics of a biodiversity-based cultural ecosystem service in the Southern Appalachians.*. International Association of Landscape Ecology. Portland, OR. Status = OTHER; Acknowledgement of Federal Support = Yes

Rose Graves (2015). *Spatial and temporal dynamics of wildflower blooms in the Southern Appalachians*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

C. Rhett Jackson (2015). *Stream temperature and overhead canopy: How important is rhododendron?*. USDA Forest Service Riparian Forest Restoration Workshop. Otto, NC. Status = OTHER; Acknowledgement of Federal Support = Yes

Turner, M. G., R. A. Graves, J. Qiu and C. Ziter. (2015). *Sustaining multiple ecosystem services and biodiversity: lessons from landscape ecology.*. International Association for Landscape Ecology. Portland, OR. Status = OTHER; Acknowledgement of Federal Support = Yes

Minucci, J.M., Miniat, C.F., and Wurzburger, N. (2015). *Symbiotic N2 fixation facilitates ecosystem resilience to hydroclimate variability.*. Ecological Society of America Annual Meeting. Baltimore, MD. Status = OTHER; Acknowledgement of Federal Support = Yes

Knoepp, J.D., See, C.R., Vose, J.M., Clark, J.S., and Miniat, C.F. (2015). *Variation in C and N pools and fluxes along an elevation, precipitation and vegetation gradient in Southern Appalachian forests.*. 4th International Conference Forests and Water in a Changing Environment. Kelowna, BC, Canada.. Status = OTHER; Acknowledgement of Federal Support = Yes

Jennifer Knoepp (2015). *Variation in carbon and nitrogen inputs and pools along an elevation, precipitation and vegetation gradient in southern Appalachian forests*. LTER All Scientists Meeting. Estes Park, CO. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley, S.T., Bolstad, P.V., Laseter, S.H., Oishi, A.C., and Miniat, C.F. (2015). *Variations in canopy and litter interception across a forest chronosequence in the southern Appalachian Mountains.*. 4th International Conference Forests and Water in a Changing Environment. Kelowna, BC, Canada.. Status = OTHER; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Cameron, C.S.. *Chemostratigrapic investigations of beaver wetlands along Jarrett Creek, North Carolina, USA*. (2015). University of Georgia. Acknowledgement of Federal Support = Yes

Kraseski, Kristin. *Damping of Stream Temperature Time Series by Hyporheic Exchange*. (2015). University of Georgia. Acknowledgement of Federal Support = Yes

Websites

Streaming Data Portal
http://coweeta.uga.edu/streaming

This portal provides links to data sets from the Coweeta LTER near-real-time sensor network for stations within the Coweeta Hydrologic Laboratory and regionally within southern Appalachia.

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Gragson, Theodore	PD/PI	4
Band, Lawrence	Co-Investigator	1
Barrett, John	Co-Investigator	1
Benfield, E.	Co-Investigator	1
Bolstad, Paul	Co-Investigator	1
Burke, Brian	Co-Investigator	1
Clark, James	Co-Investigator	2
Depken, Craig	Co-Investigator	1
Elliott, Katherine	Co-Investigator	1
Emanuel, Ryan	Co-Investigator	1
Fraterrigo, Jennifer	Co-Investigator	1
Hepinstall-Cymerman, Jeff	Co-Investigator	1
Holloway, Steven	Co-Investigator	1
Jackson, Rhett	Co-Investigator	2
Knoepp, Jennifer	Co-Investigator	2
Leigh, David	Co-Investigator	1
Maerz, John	Co-Investigator	1
Miniat, Chelcy	Co-Investigator	2
Novick, Kim	Co-Investigator	1
Pearson, Scott	Co-Investigator	1

Name	Most Senior Project Role	Nearest Person Month Worked
Pringle, Catherine	Co-Investigator	2
Rice, Jennifer	Co-Investigator	1
Shepherd, J.	Co-Investigator	1
Strahm, Brian	Co-Investigator	1
Swank, Wayne	Co-Investigator	1
Turner, Monica	Co-Investigator	1
Warren II, Robert	Co-Investigator	2
Welch-Devine, Meredith	Co-Investigator	1
Wenger, Seth	Co-Investigator	1
Wurzburger, Nina	Co-Investigator	1
Baas, Peter	Faculty	1
Bradford, Mark	Faculty	1
Hwang, Taehee	Faculty	2
Lin, Laurence	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Miles, Brian	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Oishi, A.	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Bahn, Robert	Other Professional	2
Bellflower, Suzanne	Other Professional	1
Bernardes, Sergio	Other Professional	1

Name	Most Senior Project Role	Nearest Person Month Worked
Brantley, Steven	Other Professional	1
Brooks, Joshua	Other Professional	1
Brown, Cindi	Other Professional	3
Butler, William	Other Professional	1
Caldwell, Peter	Other Professional	2
Chandler, Richard	Other Professional	3
Clapp, Roger	Other Professional	1
Clinton, Patsy	Other Professional	3
Conroy, Michael	Other Professional	1
Cooper, Robert	Other Professional	1
Desmond, Dennis	Other Professional	1
Duncan, Jon	Other Professional	2
Fowler, Randy	Other Professional	1
Fraley, Stephen	Other Professional	1
Francis, Judy	Other Professional	1
Fuller, Scarlett	Other Professional	1
Hawthorne, Sandra	Other Professional	1
Herndon, Brian	Other Professional	12
Hopey, Mark	Other Professional	1
Johnson, Virgil	Other Professional	7
Kinney, Vanessa	Other Professional	1

Name	Most Senior Project Role	Nearest Person Month Worked
Laseter, Stephanie	Other Professional	3
Leslie, Andrea	Other Professional	1
Long, Dwight	Other Professional	1
Love, Jennifer	Other Professional	1
McLarney, Bill	Other Professional	1
Meador, Jason	Other Professional	1
Meador, Kristen	Other Professional	1
Monar, Kelder	Other Professional	1
Moore, Callie	Other Professional	1
Peeples, Gary	Other Professional	1
Phillips, Brian	Other Professional	1
Plemmons, Heather	Other Professional	1
Rosemond, Amy	Other Professional	1
Sharma, Ajay	Other Professional	1
Smathers, Stephanie	Other Professional	1
Sprague, Lynn	Other Professional	1
Webster, Jack	Other Professional	1
West, Shannon	Other Professional	1
Williams, Ed	Other Professional	1
Bower, Katherine	Technician	12
Gregory, Sheila	Technician	12

Name	Most Senior Project Role	Nearest Person Month Worked
Harper, Carol	Technician	12
Hunt, James	Technician	3
Love, Jason	Technician	12
Marshall, Charles	Technician	3
Scott, Joel	Technician	12
See, Craig	Technician	8
Siminitz, Jordan	Technician	1
Sobek, Chris	Technician	3
Vulova, Stenka	Technician	3
Welch, Brandon	Technician	12
Zietlow, David	Technician	6
Abernathy, Heather	Graduate Student (research assistant)	3
Cameron, Christopher	Graduate Student (research assistant)	3
Candeias, Matthew	Graduate Student (research assistant)	3
Chitwood, Ryan	Graduate Student (research assistant)	3
Coats, Alan	Graduate Student (research assistant)	5
Dudley, Maura	Graduate Student (research assistant)	5
Dymond, Salli	Graduate Student (research assistant)	1
Eliason, Kevin	Graduate Student (research assistant)	3
Graves, Rose	Graduate Student (research assistant)	5
Howard, Jillian	Graduate Student (research assistant)	3

Name	Most Senior Project Role	Nearest Person Month Worked
Kraseski, Kristin	Graduate Student (research assistant)	1
Kwit, Matt	Graduate Student (research assistant)	3
McDonald, Jacob	Graduate Student (research assistant)	3
McEntire, Kira	Graduate Student (research assistant)	3
Merker, Samuel	Graduate Student (research assistant)	3
Miles, Micah	Graduate Student (research assistant)	3
Minucci, Jeffrey	Graduate Student (research assistant)	3
Missik, Justine	Graduate Student (research assistant)	2
Ream, Kelsey	Graduate Student (research assistant)	3
Scaife, Charles	Graduate Student (research assistant)	6
Singh, Nitin	Graduate Student (research assistant)	1
Sorrells, Robert	Graduate Student (research assistant)	3
Sullivan, Jeremy	Graduate Student (research assistant)	3
Tomasek, Brad	Graduate Student (research assistant)	3
Wei, Yingchu	Graduate Student (research assistant)	2
Brockman, Lauren	Undergraduate Student	3
Bunch, Benjamin	Undergraduate Student	3
Gallegos, Sarah	Undergraduate Student	3
Gooden, Molly	Undergraduate Student	3
Hart, Doug	Undergraduate Student	3
Kemmerlin, Aspen	Undergraduate Student	3

Name	Most Senior Project Role	Nearest Person Month Worked
Kidd, Anjelika	Undergraduate Student	1
Kirk, Shannon	Undergraduate Student	1
Lancaster, Grace	Undergraduate Student	3
Mark, John	Undergraduate Student	3
Reategui, Daniel	Undergraduate Student	3
Spratt, Savannah	Undergraduate Student	3
Bien-Aime, Kerndja	Research Experience for Undergraduates (REU) Participant	3
Benstead, Jon	Other	1
Chamblee, John	Other	1
Dehring, Carolyn	Other	1
Flowers, Kathy	Other	3
Gifford, Matt	Other	3
Hales, TC	Other	1
Kozak, Ken	Other	1
LaVaughn, Breanna	Other	3
McNab, H.	Other	1
Painter, R.	Other	1
Sourdril, Anne	Other	1
Vincent-Sweet, Stephanie	Other	1

Full details of individuals who have worked on the project:

Theodore L Gragson
Email: tgragson@uga.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: Lead Principal Investigator serving as point of contact for NSF-DEB and UGA-Sponsored Programs, and responsible for scientific and fiscal oversight of the project.

Funding Support: None

International Collaboration: Yes, France
International Travel: No

Lawrence E. Band
Email: lband@email.unc.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Integrating measurement and modeling of watersheds in the southern Appalachians, including feedbacks between ecological, hydrological, geomorphic and climate processes. Partial support for activities from Coweeta LTER.

Funding Support: Other

International Collaboration: Yes, United Kingdom
International Travel: No

John E. Barrett
Email: jebarre@vt.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Soil microbes role in mobilization of nitrogen in the Coweeta watersheds.

Funding Support: Other

International Collaboration: No
International Travel: No

E. Fred Benfield
Email: benfield@vt.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Stream Ecology

Funding Support: Other

International Collaboration: No

International Travel: No

Paul Bolstad
Email: pbolstad@umn.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Organized spatial sampling for expanded soil moisture network, developed, implemented, and analyzed project on Coweeta Basin.

Funding Support: Coweeta LTER, Minnesota Agricultural Experiment Station

International Collaboration: No
International Travel: No

Brian Burke
Email: burkebj@appstate.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Political and social ecology and economics

Funding Support: Other

International Collaboration: Yes, France
International Travel: No

James S. Clark
Email: jimclark@duke.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Forest census and demographics, population ecology, modeling

Funding Support: DEB, LTER, DOE, ONR

International Collaboration: No
International Travel: No

Craig Depken
Email: cdepken@uncc.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Social science research focusing on applied economics and applied econometrics.

Funding Support: Other

International Collaboration: No
International Travel: No

Katherine Elliott
Email: kelliott@fs.fed.us
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: vegeatation dynamics to ecosystem, processes, climate change, land use and other organisms

Funding Support: USFS

International Collaboration: No
International Travel: No

Ryan E. Emanuel
Email: ryan_emanuel@ncsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Supervised data analyses, interpretation of results, and student writing.

Funding Support: UNC

International Collaboration: No
International Travel: No

Jennifer M. Fraterrigo
Email: jmf@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Biodiversity and ecosystem processes

Funding Support: Other

International Collaboration: No
International Travel: No

Jeff Hepinstall-Cymerman
Email: jhepinstall@warnell.uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Investigating the effects of land use, elevation, predator communities on avian communities and nest predation rates;and the interplay of spring greenup (vegetation phenology) and elevation. developed a 2006 land cover map for the southern Appalachian study region, and documented land

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cover and landuse change within Southern Appalachians. Partial support for activities from Coweeta LTER.

Funding Support: UGA

International Collaboration: No
International Travel: No

Steven Holloway
Email: holloway@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Supervise, develop protocol

Funding Support: UGA

International Collaboration: No
International Travel: No

Rhett Jackson
Email: rjackson@warnell.uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Helped plan and initiate the riparian rhododendron manipulation study. Installed water level sensors and temperature loggers in these streams. Also initiated a pilot study of the effects of riparian gaps on channel morphology and stream temperature.

Funding Support: Warnell school, NSF, McEntire Stennis, various

International Collaboration: No
International Travel: No

Jennifer D. Knoepp
Email: jknoepp@fs.fed.us
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Inputs to LTER research proposal. Research examining riparian restoration, including effects of rhododendron removal on soil nutrient availability and nutrient cycling processes.

Funding Support: USFS

International Collaboration: No
International Travel: No

David S. Leigh
Email: dleigh@uga.edu

Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Geomorphology

Funding Support: UGA

International Collaboration: Yes, France
International Travel: No

John Maerz
Email: jcmaerz@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Animal population studies.

Funding Support: UGA

International Collaboration: No
International Travel: No

Chelcy Ford Miniat
Email: cfminiat@fs.fed.us
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Administrative, scientific

Funding Support: USFS

International Collaboration: No
International Travel: No

Kim Novick
Email: knovick@indiana.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Carbon and nutrient fluxes, water cycling

Funding Support: Other

International Collaboration: No
International Travel: No

Scott M Pearson
Email: spearson@mhu.edu

Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: landscape, population, and conservation ecology

Funding Support: Other

International Collaboration: No
International Travel: No

Catherine Pringle
Email: cpringle@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Planning and coordination (with graduate student) of algal sampling, measure-ments of respiration and nitrate uptake, and in situ trophic experiments in four focal streams of CWT Rhododendron removal Project; Manuscript preparation (with graduate student) for CWT Hazard Site Project.

Funding Support: UGA

International Collaboration: No
International Travel: No

Jennifer L. Rice
Email: jlrice@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Social organization, environmental activitism, and climate change perceptions of citizens in SW North Carolina

Funding Support: UGA

International Collaboration: No
International Travel: No

J. Marshall Shepherd
Email: marshgeo@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Project and scientific leadership and analysis

Funding Support: UGA

International Collaboration: No
International Travel: No

Brian Strahm
Email: brian.strahm@vt.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Coupling hydrological and biogeochemical variability in order to better understand carbon fluxes

Funding Support: Other

International Collaboration: No
International Travel: No

Wayne T. Swank
Email: wswank@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Forest hydrology and ecology

Funding Support: USFS

International Collaboration: No
International Travel: No

Monica G. Turner
Email: turnermg@wisc.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Extending out long-term studies of climate and land use on plant and bird communities to biodiversity-based ecosystem services.

Funding Support: Other

International Collaboration: No
International Travel: No

Robert J. Warren II
Email: hexastylis@gmail.com
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: species interactions, exotic invaders, climate change shifts.

Funding Support: Other

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Appalachian State University	Academic Institution	Boone, NC
Cardiff University	Academic Institution	United Kingdom
Indiana University	Academic Institution	Bloomington, IN
Ladyss/CNRS	Academic Institution	France
Land Trust for the Little Tennessee	Other Nonprofits	Franklin, NC
Lyndon B. Johnson Job Corps	Other Nonprofits	Franklin, NC
Macon Middle School	State or Local Government	Franklin, NC
Mars Hill University	Academic Institution	Mars Hill, NC
Mountain View Intermediate School	School or School Systems	Franklin, NC
NC Division of Natural Resources	State or Local Government	Raleigh, NC
NC Division of Water Resources	State or Local Government	Raleigh, NC
NC Wildlife Resources Commission	State or Local Government	Raleigh, NC
Colorado State University	Academic Institution	Fort Collins, CO
Nantahala School	School or School Systems	Topon, NC
North Georgia College and University	Academic Institution	Gainesville, GA
Northeast Georgia - GA Youth Science and Technology Centers	Other Nonprofits	Ellaville, GA
Rabun Gap-Nacoochee School	School or School Systems	Raburn Gap, GA
SUNY Buffalo State	Academic Institution	Buffalo, NY
SW NC Resource Conservation and Development Council	Other Nonprofits	Waynesville, NC
Southern Appalachian Raptor Research	Other Nonprofits	Mars Hill, NC

Name	Type of Partner Organization	Location
Swain Middle School	School or School Systems	Swain County, NC
Trimont Christian School	School or School Systems	Franklin, NC
UNC Chapel Hill	Academic Institution	Chapel Hill, NC
Conservation Trust of North Carolina	Other Nonprofits	Raleigh, NC
UNC Charlotte	Academic Institution	Charlotte, NC
USFS Southern Research Station	State or Local Government	Knoxville, TN
USFWS	State or Local Government	Knoxville, TN
University of Illinois	Academic Institution	Chicago, IL
University of Illinois, Urbana-Champaign	Academic Institution	Champaign, IL
University of Minnesota	Academic Institution	Minneapolis, MN
University of Wisconsin	Academic Institution	Madison, WI
Université Paris Ouest	Academic Institution	France
Université de Toulouse	Academic Institution	France
Virginia Polytechnic Institute and State Univ.	Academic Institution	Blacksburg, VA
Duke University	Academic Institution	Durham, NC
Watershed Association of the Tuckasegee River	Other Nonprofits	Bryson City, NC
West Virginia University	Academic Institution	Morgantown, WV
Yale University	Academic Institution	New Haven, CT
Georgia Tech	Academic Institution	Atlanta, GA
Great Smoky Mountains National Park	State or Local Government	Gatlinburg, TN
Hayesville Middle School	School or School Systems	Haysville, NC

Name	Type of Partner Organization	Location
Highlands School	School or School Systems	Highlands, NC
Hiwassee River Watershed Coalition	Other Nonprofits	Murphy, NC

Full details of organizations that have been involved as partners:

Appalachian State University

Organization Type: Academic Institution
Organization Location: Boone, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Cardiff University

Organization Type: Academic Institution
Organization Location: United Kingdom

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Colorado State University

Organization Type: Academic Institution
Organization Location: Fort Collins, CO

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Conservation Trust of North Carolina

Organization Type: Other Nonprofits
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Duke University

Organization Type: Academic Institution
Organization Location: Durham, NC

Partner's Contribution to the Project:
Financial support
Collaborative Research

More Detail on Partner and Contribution:

Georgia Tech

Organization Type: Academic Institution
Organization Location: Atlanta, GA

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Great Smoky Mountains National Park

Organization Type: State or Local Government
Organization Location: Gatlinburg, TN

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Hayesville Middle School

Organization Type: School or School Systems
Organization Location: Haysville, NC

Partner's Contribution to the Project:
Financial support
Collaborative Research

More Detail on Partner and Contribution:

Highlands School

Organization Type: School or School Systems
Organization Location: Highlands, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Hiwassee River Watershed Coalition

Organization Type: Other Nonprofits
Organization Location: Murphy, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Indiana University

Organization Type: Academic Institution
Organization Location: Bloomington, IN

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Ladyss/CNRS

Organization Type: Academic Institution
Organization Location: France

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Land Trust for the Little Tennessee

Organization Type: Other Nonprofits
Organization Location: Franklin, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Lyndon B. Johnson Job Corps

Organization Type: Other Nonprofits
Organization Location: Franklin, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Macon Middle School

Organization Type: State or Local Government
Organization Location: Franklin, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Mars Hill University

Organization Type: Academic Institution
Organization Location: Mars Hill, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Mountain View Intermediate School

Organization Type: School or School Systems
Organization Location: Franklin, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

NC Division of Natural Resources

Organization Type: State or Local Government
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

NC Division of Water Resources

Organization Type: State or Local Government
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

NC Wildlife Resources Commission

Organization Type: State or Local Government
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Nantahala School

Organization Type: School or School Systems
Organization Location: Topon, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

North Georgia College and University

Organization Type: Academic Institution
Organization Location: Gainesville, GA

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Northeast Georgia - GA Youth Science and Technology Centers

Organization Type: Other Nonprofits
Organization Location: Ellaville, GA

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Rabun Gap-Nacoochee School

Organization Type: School or School Systems
Organization Location: Raburn Gap, GA

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

SUNY Buffalo State

Organization Type: Academic Institution
Organization Location: Buffalo, NY

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

SW NC Resource Conservation and Development Council

Organization Type: Other Nonprofits
Organization Location: Waynesville, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Southern Appalachian Raptor Research

Organization Type: Other Nonprofits
Organization Location: Mars Hill, NC

Partner's Contribution to the Project:

Facilities
Collaborative Research

More Detail on Partner and Contribution:

Swain Middle School

Organization Type: School or School Systems
Organization Location: Swain County, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

Trimont Christian School

Organization Type: School or School Systems
Organization Location: Franklin, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

UNC Chapel Hill

Organization Type: Academic Institution
Organization Location: Chapel Hill, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

UNC Charlotte

Organization Type: Academic Institution
Organization Location: Charlotte, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

USFS Southern Research Station

Organization Type: State or Local Government
Organization Location: Knoxville, TN

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

USFWS

Organization Type: State or Local Government
Organization Location: Knoxville, TN

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

University of Illinois

Organization Type: Academic Institution
Organization Location: Chicago, IL

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

University of Illinois, Urbana-Champaign

Organization Type: Academic Institution
Organization Location: Champaign, IL

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

University of Minnesota

Organization Type: Academic Institution
Organization Location: Minneapolis, MN

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

University of Wisconsin

Organization Type: Academic Institution
Organization Location: Madison, WI

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Université Paris Ouest

Organization Type: Academic Institution
Organization Location: France

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Collaborative, multi-sited research examining how people use observations of biodiversity change to make sense of environmental changes, climate change, and possibilities for adaptation.

Université de Toulouse

Organization Type: Academic Institution
Organization Location: France

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Comparative historical ecology of mountain landscapes.

Virginia Polytechnic Institute and State Univ.

Organization Type: Academic Institution
Organization Location: Blacksburg, VA

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Watershed Association of the Tuckasegee River

Organization Type: Other Nonprofits
Organization Location: Bryson City, NC

Partner's Contribution to the Project:
Facilities
Collaborative Research

More Detail on Partner and Contribution:

West Virginia University

Organization Type: Academic Institution
Organization Location: Morgantown, WV

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Yale University

Organization Type: Academic Institution
Organization Location: New Haven, CT

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

What other collaborators or contacts have been involved?
Nothing to report

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The specific objectives of this project center on examining how hydroclimate variability and the human-modified landscape separately and interactively alter southern Appalachian Mountain ecosystem processes and biotic communities that, in turn, affect the vulnerabilities of regional socio-ecological systems. Long-term studies in permanent plots address issues pertaining directly to the spatial and temporal distribution of populations selected to represent trophic structure; the pattern and control of organic matter accumulation in surface soils and sediments; and the patterns of inorganic inputs and movements of nutrients through soils and waters. We are determining how the performance of individual herb species and plant functional types (phenological guilds) vary with soil moisture; investigating trade-offs between plant functional traits, herbivory, and pathogen infection along a gradient of soil moisture; and evaluating how interspecific competition, herbivory and pathogens affect the

performance of transplanted individuals of Hepatica nobilis along a soil moisture gradient. Some plot-level work is designed to understand how tree species and their mycorrhizal type determine the exchange of C and N between plants and soils, why deep soil carbon is declining over the last several decades at CWT, and how reductions in rainfall affect tree species growth and nitrogen fixation. Plot-level work is complemented by quantification of primary controls on forest structure, particularly height, biomass, and overstory species composition. Finally, quantification of rainfall interception along a forest age chronosequence is used to estimate landscape variation and controls on surface soil moisture, that helps in scaling from plot-level to the region.

This work relates to our large-scale riparian rhododendron manipulation experiment examining pattern and control of primary production, as well as patterns, frequency and effects of disturbance. At the reach scale, our objective is to understand how Rhododendron removal alters algal accrual, decomposition, nutrient cycling, respiration and stream trophic dynamics including shifts in top-down consumer control of algal accrual and decomposition. We are also determining whether riparian rhododendron cutting increases stream temperatures to determine: if increases persist downstream of the treatment reach; whether hydrologic behavior is similar and consistent among the four streams; and, if we can predict the rate of diurnal temperature damping of water flowing through the hyporheic zone. Answering these questions requires quantifying stream temperature increases within riparian gaps and temperature attenuation downstream of gaps; it also entails quantifying the rate of channel narrowing within riparian gaps and channel expansion downstream of gaps. Other aspects of this experiment include examining the influence of changes in vegetation on soil nitrogen cycling and mobility on the composition of soil microbial communities. It also involves testing the effect of rhododendron removal on terrestrial and stream ecosystems particularly crayfish abundance and fish communities, and the changes in taxonomic and functional diversity of stream macroinvertebrate communities.

The integration of LTER core research areas comes in part through our modeling efforts. By incorporating species-level differences in stomatal behavior into our RHESSys model we seek to determine landscape partitioning of stomatal behavior over ridge to hollow gradients. This supports our investigation into determining the influence that downslope subsidy has on biodiversity by creating structured gradients in resource availability subject to inter-annual hydroclimate and availability of surplus water. Through our investigation of the existence and dynamics of watershed rainfall-moisture storage-runoff threshold behavior, our objective is to determine the impact of biotic drivers of potential evapotranspiration on runoff threshold dynamics and the existence of a runoff signal of interannual variability in these biotic controls. By coupling our terrestrial ecohydrology model with an aquatic metabolism model we will evaluate and deconvolve the role of the two environments in processing carbon and nitrogen in streamwater. Such efforts are central to incorporating sources of uncertainty into the developing models. Other regional work relates directly to measuring pattern, frequency and effects of disturbance unique to the So Appalachian domain and the refinement of the models. Developing a methodological framework for conducting downscaled regional climate modeling using NARCCAP analyses and the WRF Model will make it possible to conduct experiments on CONTROL and NO-URBAN footprints to assess spatio-temporal trends in extreme precipitation in the region. This links to our objective to understand the human role in changing physical properties of soil, and specifically soil hydrology, through activities including deforestation, cultivation, reforestation, and urbanization. The objective in this case is to inform hydrologic models so they can capture the temporal and spatial dynamics of soil properties as mediated by human activities and so determine how productivity varies spatially in function of edaphic factors and climate across a mountainous landscape at present and under future climate scenarios.

Knowledge of human decisions, behavior, and actions contribute directly to LTER research and our social science research objective is to examine questions of socio-ecological connections among organisms, biological processes, and the abiotic environment as they pertain to social responses to future environmental change. By documenting seasonal changes in the spatial distribution of nature viewing opportunities we are developing a spatial model of those spatiotemporal patterns. Measuring the effect of habitat fragmentation caused by residential development contributes to determining its relation to the population dynamics and trophic structure of resident bird species. Determining the relation between human activities on the land, topography and canopy

structure contribute to determine ecosystem carbon and water cycling. By illustrating values, worldviews, and patterns of social connection and division that result from exurbanization we are able to provide baseline data for long-term research on regional landscape modification as well as perceptions of and responses to vulnerability. Research on knowledge of environmental and climate change will provide insights into the diverse ways that people inhabit, engage with, and observe the southern Appalachian landscape and factors that give rise to this diversity. It also contributes to our understanding of the diverse theories of environmental change (including theories of causes, effects, timescales, spatial scales, and likely consequences) in the region and how they compare with one another and with scientific theories of environmental change. Such knowledge is central to understanding the ways that people conceptualize and enact responses to environmental change. Research on environmental journalism reveals the media landscape that shapes people's perceptions of and responses to environmental change, and helps determine the discursive and cognitive frameworks through which people consider socio-environmental issues such as climate change, exurbanization, landscape conservation, species-specific conservation, and water-related issues. In short, it can both encourage new conceptual frameworks and theory that can advance understanding of site-specific dynamics while serving to relate such results to other ecosystems and different spatial scales.

What is the impact on other disciplines?

CWT is an interdisciplinary research program that involves biologists, ecologists, geographers, anthropologists, and modelers. Methods we have developed for investigating tree demography using Bayesian Hierarchical Modeling have had substantial impact on statistical science, and our scientists are routinely invited to present analyses of this work at statistical conferences.

Our integrated research on Rhododendron Removal contributes to hydrology. We have determined that heat exchange between water and sediments is extremely rapid and that heat exchange rates decrease with increasing particle size. Even in large gravels, however, water and sediments with initial temperature differences of 6oC equilibrated within 200 seconds. The exchange rate is much lower than the transport rate through the system. Thus, the advective Damkohler number for hyporheic heat exchange is very large, meaning that heat exchange is rapid relative to transport times through the hyporheic zone. Over relatively short hyporheic flow paths, diurnal temperature variations will be nearly completely damped.

Our social science research expanded knowledge of how Appalachian communities are thinking about contemporary socio-environmental challenges. We have also illustrated how discourse analysis can be used for applied research on environmental decision-making and social responses to socio-environmental issues. We have provided empirical support for claims that research on human dimensions of climate change and climate communication can profitably shift from seeking to convince, manipulate, and change behavior to understanding and take seriously local, non-scientific perspectives on and responses to environmental challenges. Finally, it has advanced scholarship on science communication and provided concrete communication strategies for multi-disciplinary scholarly teams.

Hydrological models often simplify contributions of baseflow while emphasizing detailed processes associated with short-term stormflow responses to precipitation. Our empirical studies link baseflow variability and watershed characteristics (e.g. topographic variables), and highlight the importance of baseflow. In addition, it contributes to the need for improved representation of processes associated with baseflow in models of terrestrial and aquatic ecosystem processes.

We have developed remote-sensing methods for using airborne LiDAR in deciduous forest canopies that underlie improvements in higher-resolution data and leaf-on acquisitions.

What is the impact on the development of human resources?

This past year we had 12 undergraduate students, 25 graduate students and one REU students associated with

the Coweeta LTER project. CWT LTER investigators provide the framework, data, funding and supervision for students learning to develop experimental design, carry out field sampling, process and analyze data, and prepare manuscripts for publication. Numerous instructional and experiential opportunities were created for undergraduate and graduate student learning in ecology, geomorphology, hydrology, biology, forestry, geography, and anthropology leading to the development of collaborative research groups.

What is the impact on physical resources that form infrastructure?

The CWT LTER has installed a regional network of environmental sensors within the Little Tennessee and the French Broad watersheds that collect soil moisture and soil temperature measurements. Some stations are on USFS property including Coweeta Hydrologic Laboratory and Bent Creek Experimental Forest, while others are on university properties including Mars Hill and University of Georgia. Soil moisture stations measure and record at 5-minute intervals, creating datasets with 12 times greater resolution than previously established soil moisture and soil temperature stations. Daily, data from all established stations are retrieved, processed, harvested, and made publicly available online through the Coweeta LTER streaming data portal.

What is the impact on institutional resources that form infrastructure?

The CWT LTER maintains several field vehicles and equipment including aquatic samplers and survey-grade GPS units, at the Coweeta Hydrologic Laboratory for use by researchers, students and technicians during their fieldwork in the region. The Coweeta dormitory is run jointly between the U.S. Forest Service and the University of Georgia. Its primary purpose is to provide comfortable accommodations for researchers, graduate students, and summer students. It can accommodate up to 20 people in five four-person bedroom arrangements, and has two fully furnished kitchens with complete food preparation areas, appliances, and utensils that can each seat 12 people. Additional amenities include internet connection as well as washers and dryers. The USFS Coweeta Chemical Analytical Laboratory supports studies of watershed-scale ecosystem responses to natural and human disturbances of southeastern forests including samples directly related to CWT LTER.

What is the impact on information resources that form infrastructure?

The CWT LTER sensor network provides public access via a website to near-real-time data from stations across the region. This distributed field network serves as a regional resource for measurements of soil moisture. It also serves as the basis for analysis of regional to continental patterns and controls. Collaborations with landowners from this project have resulted in the data being used by the public for unforeseen purposes, including the updating of weather information with highly localized data by an emergency management agency, the use of the data in guiding irrigation decisions toward greater water conservation and cost savings, and the local near-term confirmation of more spatially and temporally extensive trends to inform farmers deciding when to plant crops. The increased data availability connects long term datasets and study plots, serves as an example of successful environmental network measurements, and contributes to the mandate that federally funded research results be available in a format that is both useful and minimally constrained.

What is the impact on technology transfer?

The ‘Shade Your Stream’ educational campaign seeks to educate landowners about the importance of riparian vegetation so that they might adopt practices that promote riparian vegetation, thus improving stream water quality and both in-stream and riparian habitat. Funding from other sources supports landowner workshops, billboards, and a website across the Little Tennessee, the Hiwassee, and the Tuckasegee watersheds. The ‘Shade Your Stream effort is an example of how Coweeta LTER research is being used by non-profits to try and educate landowners about the importance of maintaining vegetated riparian buffers, as Coweeta research has shown that vegetated buffers keep streams cool, stabilize stream banks, increases habitat heterogeneity, decrease sedimentation, and provide leaves and woody inputs to the stream that act both as food and habitat for stream organisms.

What is the impact on society beyond science and technology?

The CWT website is used to disseminate publications, reports, research data, photographs and other products of research. CWT scientists regularly give seminars and public presentations, use CWT LTER data in their classes as well as the basin as a class laboratory. They also contribute articles to newsletters including a regular column in a local newspaper, the Franklin Press. Our Schoolyard program brings K-12 teachers and students from north Georgia, western North Carolina and eastern Tennessee together for several science learning events each year that also involve representatives from US Fish and Wildlife, NC Division of Water Quality, NC Wildlife Resources Commission and Mainspring - a local NGO. Over 1,500 students were engaged on 20 different occasions this past year.

Our work also shows the need for CWT scientists to supplement the environmental narratives that residents are presented with in the local media, which helps understand how scientific knowledge is (or is not) taken up and used by a community to make decisions about the environment. For example, there is the potential to adapt the developing CWT LTER ecohydrologic modeling systems to landslide prediction, forest management to reduce natural hazard risk for downslope populations. Our work also seeks to understand the ways in which informal and experiential knowledge held by non-scientists might enhance ecological inquiry, which is important for making science relevant and useful for social applications, and in particular policy-making.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.