Coweeta LTER Summer Meeting Agenda

June 13-14, 2017

Tuesday June 13

8:00 Breakfast

Start at 8:30am

NSF Update – Rhett Jackson, 15 minutes
USFS Update – Kitty Elliott, 20 minutes

9:05 Hydrological effects of the Hemlock Woolly Adelgid infestation in New England, **JiHyun Kim**, Taehee Hwang, Crystal L. Schaaf, David A. Orwig, Emery Boose, and William J. Munger

9:25 Extending the Jolly-Seber model in a Bayesian framework to investigate population declines of Black-throated Blue Warblers at the trailing edge of their range, **Ryan Chitwood**, Richard Chandler, Joanna Hatt, Mason Cline, Kirk Stodola, and Robert Cooper

9:45 Interference or apparent competition at the warm-edge of species ranges, **Sam Merker** and Richard Chandler

10:05 Release from intraspecific competition allows dominance of a non-native invader, **Robert J. Warren**, Katelyn Reed, Abby Mathew, Kevin Krupp, and David Spiering

10:25 Break

10:40 Generating robust estimates of salamander vital rates to model population responses to climate change, **Jillian S. Howard**, Kira D. McEntire, and John C. Maerz

11:00 Groundwater flow at Coweeta, **Rhett Jackson**

11:20 Cloud-based hydrologic modeling: Rapid development and execution of RHESSys in Coweeta, **Charles Scaife**, Lorne Leonard, Laurence Lin, and Larry Band

11:40 Drought mortality observations in Macon County, Jason Love

12:00 Lunch (provided)

1:00 Poster session

1:45 Field trip to the fire experiment watersheds, Watersheds 31 & 32, led by Pete Caldwell

5:00 Social at dorm

6:00 Dinner

SAC meeting after dinner

Wednesday June 14 - **Working Groups**

8:00 – Breakfast

8:30 Working groups

WS31/32 experiment discussions focused on pre-treatment sampling
Continued discussion of FFE ideas?
Soil Carbon synthesis (may not have enough key players)
Possible field trip to a drought mortality site?
Rhodo/gap group
Field trip to see Black Locust (*Robinia pseudoacacia*) stands in WS7?
Modeling group
Who else wants to meet?

12:00 Lunch (provided)

Working groups continue meeting after lunch as needed

ORAL

Hydrological effects of the Hemlock Woolly Adelgid infestation in New England

JiHyun Kim[1, 2], Taehee Hwang[1], Crystal L. Schaaf[2, 3], David A. Orwig[4], Emery Boose[4], and William J. Munger[5]

[1]Department of Geography, Indiana University Bloomington, Bloomington, Indiana

[2]Department of Earth & Environment, Boston University, Boston, Massachusetts

[3]School for the Environment, University of Massachusetts Boston, Boston, Massachusetts

[4]Harvard Forest, Harvard University, Petersham, Massachusetts

[5]School of Engineering and Applied Sciences and Department of Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts

In the northeastern US, eastern hemlock (*Tsuga canadensis*) is known as a foundation species, playing a key role in controlling regional hydrological and biogeochemical cycles. The Hemlock Woolly Adelgid (HWA; *Adelges tsugae*) currently infests about half of the entire eastern hemlock forests in the region, causing a significant increase in mortality of eastern hemlock trees over the past decade. Although warmer winter temperatures are expected to promote its northward expansion, the effect of the ongoing hemlock declines on local hydrologic regime is not yet fully understood. Here, we first report the ongoing HWA infestation and its effect on the hydrologic fluxes at the Harvard Forest Long Term Ecological Research (LTER) site in central Massachusetts. For the last five years (2009-2014), the HWA infestation has increased from 17.2% to 96.5%, inducing foliar loss by 50%. Based on the eddy-covariance flux measurements, we estimated that the evapotranspiration (ET) flux over the hemlock-dominated area has decreased by 23-37%. The annual stream discharge of a mixed-forest headwater catchment has increased by 4.2-15.8 mm as compared to an adjacent catchment with 22.4% less hemlock cover. We used a mechanistic ecohydrological model (RHESSys: Regional Hydro-Ecologic Simulation System) to scale up the plot-scale HWA effect into catchment-scale hydrological changes, and assessed the net amount of the annual stream discharge changed due to the HWA infestation. This study highlights that the local hydrological regimes in the northeastern US will be significantly altered by the complete mortality of eastern hemlock forests.

Extending the Jolly-Seber model in a Bayesian framework to investigate population declines of Black-throated Blue Warblers at the trailing edge of their range

Ryan Chitwood[1], Richard Chandler[1], Joanna Hatt[2], Mason Cline[2], Kirk Stodola[3], and Robert Cooper[1]

[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia

[2]New Mexico Department of Game and Fish, Santa Fe, New Mexico

[3]Illinois Natural History Survey, Champaign, Illinois

Species' ranges are shifting poleward and to higher elevations in response to climate change, and populations at the trailing edge of a shifting range are expected to be greatly affected by this environmental change. Thus far, ecologists have primarily used correlative species distribution models based linking presence-absence data to environmental characteristics to investigate range shifts, largely ignoring the demographic processes (survival, reproduction, and movement) that underlie range shifts. By measuring the demographic rates of trailing edge populations, ecologists can gain further insight into how trailing edge populations respond to environmental changes like climate change. This study uses count data to describe trends in density of adult male Black-throated Blue Warblers (*Setophaga caerulescens*) from 2002-2016 observed near the trailing edge of their range across three sites of varying elevation near the Coweeta Hydrologic Laboratory in Otto, NC, USA. Capture-recapture data from these sites were used to estimate age- and sex-specific apparent survival and density-dependent recruitment rates using a modified Jolly-Seber model in a Bayesian framework. Male warbler density declined for all three sites from 2002-2016 with the low elevation site reaching near local extinction in 2008. Estimates of age- and sex-specific apparent survival rates reveal a weak trend across elevation but show that older birds have lower apparent survival rates. Density dependence in per-female recruitment rate was weakest at low elevation and strongest at high elevation, suggesting that more marginal sites are less likely to recover from stochastic decreases in population size. Further study should assess which component of the recruitment process result in decreased recruitment in this species (e.g. early life stage survival, reproductive output, or natal dispersal).

Interference or apparent competition at the warm-edge of species ranges

Sam Merker and Richard Chandler

[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia

Climate change is causing the ranges of many species to shift towards higher latitudes and elevations. These shifts have been observed worldwide across many taxa, and numerous hypotheses exist to explain how abiotic and biotic factors affect range shifts, yet little is known about the ecological processes involved. Information is particularly scarce for trailing-edge populations, which are predicted to be at high risk of extinction because of a changing climate. The southern Appalachian Mountains of the United States is a region with a high diversity of trailing-edge distributions, and we used observational studies and

manipulative experiments to assess the relative roles of abiotic factors and biotic interactions on the trailing-edge distributions of bird populations in this region. Using three years of point count data and co-occurrence models, we tested hypotheses regarding the effects of abiotic factors and the presence of a putative competitor on the occupancy dynamics of a cool-adapted species. We developed a manipulation to test for interference competition in a single species of migratory songbird, the Canada warbler (*Cardellina canadensis*). Although the point count data clearly indicated that cool- and warm-adapted species segregated over the climate gradient in our study area, neither our observational data nor our manipulative experiments supported the hypothesis that competition was responsible. Rather, our results indicated that abiotic factors, especially temperature and precipitation gradients and microclimatic conditions had the strongest overall effect on the spatio-temporal dynamics of trailing-edge populations.

Release from intraspecific competition allows dominance of a non-native invader

Robert J. Warren, Katelyn Reed, Abby Mathew, Kevin Krupp, and David Spiering

Biology Department, SUNY Buffalo State, Buffalo, New York

Species coexist through a balance of equalizing (similar fitness abilities) and stabilizing (different niche requirements) mechanisms. These forces maintain coexistence if intraspecific competition imposes more limitation than interspecific competition. Introduced species often de-stabilize coexistence, suggesting they bring either a fitness advantage or a distinct niche requirement. Native ants generally do not coexist well with invasive ants; whether invasive ant dominance is primarily caused by antagonistic interactions (greater fitness) or by exploiting novel conditions that do not support natives remains an unsettled question. We tested the competing hypotheses that strong fitness differences and/or niche differences would explain a North American invasion by the European *Mymica rubra* ant. We used monthly censuses from 1994 and 2015, abiotic and biotic habitat data, physiological fitness, isotope analysis and aggression bioassays to test these hypotheses. We found little evidence of competitive advantage or strong niche differentiation. Instead, we found exceedingly low intraspecific competition between *M. rubra* colonies relative to the putative dominant native ant, *Aphaenogaster picea*, which competed with itself as much as with *M. rubra*. Our evidence indicated that *M. rubra* colonies lacked intraspecific limitation and, as a result, populations exceeded local carrying capacity before season's end, resulting in the elimination of co-occurring native ants and other arthropods. Freed up from the costs and limitations of territoriality, invasive species may outcompete native species by not competing with themselves.

Generating robust estimates of salamander vital rates to model population responses to climate change

Jillian S. Howard[1, 2], Kira D. McEntire[2] and John C. Maerz[2]

[1]Integrative Conservation Program, University of Georgia, Athens, Georgia

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Population models are important for understanding how animals respond to environmental change. Informative demographic models must contain robust estimates of vital rates, which often requires long-term data. Consequently, demographic models are lacking for even well studied taxa. For example, salamanders within the *Plethodon* genus are abundant and influential in eastern deciduous forests, yet few estimates of vital rates exist. From 2010 ongoing, we conducted a robust design, capture-recapture study of *Plethodon* at the Coweeta Hydrologic Lab in North Carolina to (1) estimate size-class-specific survival and fecundity, (2) determine how survival varies with precipitation, and (3) create a population projection model for *Plethodon*. Annual survival estimates ranged from 0.941 for adults to 0.294 for hatchlings. Adult female fecundity was estimated at 3.63 offspring per year, based on our estimates of oviposition frequency (0.422) and clutch size (15 eggs), and on literature estimates of hatch rate (mean 0.610, range: 0.00 to 1.00). Model estimated 28-day survival increased with increasing temperature. We predicted 28-day survival for the real-time precipitation trends preceding each sampling occasion, and observed consistently high survival from late spring to fall, but a steep drop in survival for winter and early spring. We found year-specific annual survival was higher in years with greater total precipitation, and using stochastic precipitation-dependent annual survival values in a matrix model, we confirmed the threat faced by terrestrial salamander populations from reduced rainfall intensity and frequency in western North Carolina.

Jillian S. Howard, is a Ph. D Candidate at the University of Georgia in the innovative Integrative Conservation Program. She is studying the intersection of human land use values and salamander habitat identification to create a guide for conservation-oriented land acquisition in western North Carolina.

Cloud-based hydrologic modeling: Rapid development and execution of RHESSys in Coweeta

Charles Scaife[1, 2], Lorne Leonard[3], Laurence Lin[2], Larry Band[1, 2]

[1]Department of Geography, UNC-Chapel Hill, North Carolina

[2]Institute for the Environment, UNC-Chapel Hill, North Carolina

[3]Department of Civil and Environmental Engineering, Penn State, University Park, Pennsylvania

In an era of big data, national-scale spatial datasets offer several advantages for hydrologic modelers including the creation of consistent standards that alleviate custom, site-specific data requirements and allow rapid model generation across the US. Despite spatial consistency, data attributes still vary between product type, agency, and source restricting the speed of model development. Users of the Regional Hydro-Ecological Simulation System (RHESSys) surveyed in 2014 reported spending 29% of their time preparing model input data. Of those that responded, 9 out of 17 wanted to spend less time preparing input data and more time running model scenarios and analyzing output (Miles, 2014). Through the utilization of web-services, cloud computing, and custom python libraries like RHESSysWorkflows, the time required for data acquisition, preparation, and analysis has reduced dramatically. Using the online platform, Hydroshare, we're now capable of building, storing, and sharing models that incorporate both custom, local datasets and national-scale datasets. We've also operationalized RHESSys as a web application using Jupyter notebooks, which migrates computationally intensive data preparation from your local computer to the cloud. In our demonstration, we'll rapidly build and run a RHESSys model entirely in the cloud for a single watershed in Coweeta drawing from a mix of custom input data and national data products.

Riparian Buffer Width and Landowner Preference in Macon County, NC*

Anne Chesky Smith

Department of Anthropology, University of Georgia, Athens, Georgia

When aggregated, how individual landowners decide to manage their land can have dramatic implications for stream health regionally. In this study, I interviewed 31 western North Carolina landowners who had participated in a riparian buffer restoration program more than a decade ago. I compared the landowners' reported preferences for managing their riparian zones to the current average width of their riparian buffer. The results of this study show that even among those who invested in riparian buffer restoration work on their property, lack of understanding of how or why to maintain a riparian buffer as well as individual preferences for narrower buffers often outweighed the goals of the restoration. Narrower average buffer widths were generally attributed to management that met a personal aesthetic preference or allowed visual or physical access to the river. Among landowners who actively managed their land, the most successful buffers were under conservation easement.

*Note – Anne had a work conflict and is unable to present.

POSTERS

The response of understory herb communities to variations in topoclimate and edaphic conditions

Matt Candeias[1] and Jennifer Fraterrigo[1, 2]

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Plant functional traits reflect species ecological tolerances and strategies for obtaining resources, and thus provide a framework for predicting how species are likely to respond to climate change. Most studies use fixed trait values, however, overlooking the potential for phenotypic plasticity in functional traits to mediate plant response to environmental variation. The overall objective of our research is to determine the role of intraspecific variation in plant functional traits in mediating plant response to environmental variation. Our specific objectives are to: (1) evaluate the relative importance of interspecific and intraspecific variation for determining community-level trait patterns along topoclimate and edaphic gradients; and (2) quantify the amount of phenotypic plasticity exhibited by confamilial small-range and large-range plant species in response to environmental change using a transplant experiment. Preliminary results indicate that interspecific variation is relatively more important than intraspecific variation for explaining patterns in the plant functional traits that we measured. Additionally, variation in functional trait values is largely driven by variation in soil nitrogen availability, soil temperature, and soil moisture. These findings suggest that changes in both microclimate and nutrient availability will alter functional trait composition, mainly through species turnover. These and other data will be used in an integral projection model to predict how variation in environmental conditions will affect the demographic rates of the southern Appalachian endemic Oconee bells (*Shortia galacifolia* - Diapensiaceae) in novel habitats.

Effects of lysimeter characteristics and seasonal variability on stable isotope composition

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Lysimeters are used as an indicator of plant water availability and to infer physical characteristics of soil water related to source and age through stable isotope analysis. Lysimeter characteristics, such as the soil depth and duration of sampling interval, can influence the isotopic composition (18O and 2H) of the soil water sample. Additionally, seasonal variability of precipitation and temperature affects sample isotopic composition. Both of these factors should be considered when using stable isotope analysis to detect water

age and movement. We analyzed samples from an array of falling tension lysimeters representing a full factorial of two depths (20 and 60 cm) and three sample intervals (1, 7, 14 days) at Coweeta Hydrologic Laboratory. We sampled soil solution monthly and used precipitation samples from one year to better understand (1) the effect of lysimeter characteristics on stable isotope composition and (2) annual soil water isotope composition dynamics. Results indicate that deeper soil water is generally isotopically heavier than shallow soil water. The duration of sample interval minimally affected isotope composition. Lysimeter samples at greater depth and longer sample duration had less variability in isotope composition across the sampling period. The isotopically heaviest soil water occurred in summer, and the lightest water occurred in winter, reflecting natural seasonal changes in precipitation. Overall, results suggest that the two lysimeter depths sampled distinct pools of water whose physical characteristics evolve through time and reflect new inputs of precipitation and mixing of existing soil water.

Examining potential changes in stream algal communities in the Southern Appalachians, pre- and post-hemlock die-off

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Eastern hemlock (*Tsuga canadensis*) function as an important foundation species throughout eastern North America. However, widespread death of hemlock over the last decade has occurred in the southern Appalachians as a result of the invasion of hemlock woolly adelgid (*Adelges tsugae*). Hemlock was once abundant along streams and its death has likely caused significant changes to stream processes. Little is known about how the loss of hemlock affects stream algae. We hypothesize that diatom communities may be affected by enhanced light levels and decreasing pH following hemlock die-offs. In 2005-2006, prior to hemlock die-off, we collected baseline data on algal biomass (chlorophyll-*a* and AFDM) in eight stream reaches throughout the Coweeta Hydrologic Lab/Forest in western NC. We also analyzed diatom communities in those streams, identifying 89 species including several taxa endemic to the southern Appalachians. Densely shaded streams were characterized by low algal biomass dominated by adnate diatoms (*Eunotia* spp., *Achnanthidium deflexum*). In 2016-2017, post hemlock die-off, we are re-sampling the eight study reaches to evaluate how diatom communities have changed. We hypothesize increased algal biomass, loss of endemic taxa, and an increase in upright diatoms (*Gomphonema* spp., *Synedra* spp.).

Coweeta LTER 2017 Summer Meeting Notes

13 June 2017

PIs present: John Maerz, Nina Wurzburger, Rhett Jackson, Nik Heynen, Cathy Pringle, Bob Cooper, Jeff Hepinstall-Cymerman, David Leigh, Amy Rosemond, Robert Warren, Chris Oishi, Pete Caldwell, Jennifer Knoepp, Kitty Elliott, Jack Webster (Emeritus), Wayne Swank (Emeritus), Jason Love (Ex-Officio), Brian Herndon (Ex-Officio). Larry Band, Taehee Hwang, Brian Strahm, and Jennifer Fraterigo were represented by their graduate students/post-docs Charles Scaife, JiHyun Kim, Raymond Lee, and Matt Candeias, respectively.

NSF Update (Jackson)

- The Seviellta LTER was terminated in 2014 but a reconstituted SEV group was awarded the recent LTER competition for a new arid site, so SEV is now back online
- There are three new LTER marine sites: one off Martha's Vineyard, one on north shore of Alaska, and one in Gulf of Alaska
- LTER's are funded through different divisions within NSF; Coweeta is funded by Division of Environmental Biology (DEB)
- Both NSF and the Program Officer has said that the Coweeta LTER should be headed by an ecologist; Jackson has met with appropriate Deans to discuss the possibility and value hiring a big name ecologist to lead the Coweeta LTER if another RFP comes out
- Saran Twombly was our Program Officer; she retired last year; John Schade is her replacement; Our PO, Lou Kaplan, is a rotating Program Officer and his term ends in December, but he may become permanent at NSF
- Currently it is unknown whether there will be an RFP for an eastern deciduous site; budgets are too uncertain at this time
- Groffman is the Chair of the Executive Board; his term will likely end soon; there was discussion about whether NSF should pay the Chair or not; currently the Chair is not compensated
- NSF is still committed to the LTER program and wants to keep it going

Coweeta Hydrologic Lab update (Elliott)

- Ongoing Studies
    - Riparian restoration following hemlock mortality: *aka* Rhodo removal study
    - Long-term network (climate, weirs, veg perm plots)
    - Eddy Flux Tower – Net Ecosystem Exchange
    - Long-term watershed studies (WS6, WS7, WS13, WS17, etc.)
    - USGS gages + FIA data
    - AFRI Sustainable Bioenergy Program (Savannah River site)
    - JFSP Wildland fire effects on water quantity across the US: modeling effort
- New Studies
    - NIFA/AFRI proposal funded for WS31 treatment, WS32 reference
        - Similar to FFE3 in unfunded LTER proposal
        - Treatment: shrub removal + Rx fire (repeated)
        - Relevant to land managers

        - Water supplies, productivity, and biodiversity
        - Measurements
            - Weirs & climate stations (Q, ET, PET)
            - Soil and stream chemistry
            - Microclimate (SM, Soil T, PAR)
            - Vegetation (permanent plots- herbs, shrubs, trees)
            - Tree water use (sapflux)
            - Subcanopy eddy-covariance systems
            - Aquatic (insects)
    - Quantifying the role of National Forest system lands in providing surface drinking water; and State & Private lands across the south
    - Fall 2016 Wildfires (Camp Branch & Tellico Wildfires)
        - Coweeta Hydrologic Lab research focus: Streams (*Q*, T, sediment, chemistry), soils; synoptic stream chemistry
        - Vegetation (herbs, shrubs, trees), birds
        - Other SRS units working on other Wildfire sites
- Elliott presented an overview of how the plots were laid out on the Tellico and Camp Branch fires; chose fires that were moderate to severe
- WS6 paper just came out; WS6 had a decline in water yield following disturbance, in part because of fertilization and grass that precluded oak and hickory; dominated by ring-diffuse species such as tulip poplar and red maple
- Nature Conservancy interested in effects of prescribed fire and wildfires and is funding some of the fire research
- First burn in WS31 will burn in spring 2018 after rhodo is cut in the fall; likely burn will occur the following year and thereafter every 5-8 years

Seven researchers gave oral presentations of new research. Researchers (mostly graduate students) presented posters in the early afternoon. About 20 researchers participated in the afternoon field trip to Watersheds 31 and 32.

Wednesday morning was used for informal working groups and field trips.

Notes submitted by Jason Love, 26 June 2017