GREAT SMOKY MOUNTAINS NATL PARK SCIENCE COLLOQUIUM

Co-hosted by Great Smoky Mountains National Park and Discover Life in America

THURSDAY, MARCH 3, 2022 — 9 AM TO 4 PM — VIRTUAL VIA ZOOM

SCHEDULE

9:00 **WELCOME AND INTRODUCTIONS**
Superintendent's Office (GSMNP) & Will Kuhn (Discover Life in America)

9:10 **The African American Experience in the Smokies: Making the Invisible, Visible**
Antoine Fletcher (GSMNP) & Atalaya Dorfield

9:30 **Ground-Penetrating Radar mapping of historic African American Cemeteries in GSMNP**
Blair Tormey (Western Carolina Univ) & Paul S Martin

9:50 **Current status of *Brachyponera chinensis* (Hymenoptera: Formicidae) invasion into GSMNP highlights opportunities for prevention**
Daniel Malagon (Dept Biol Sci, Clemson University) & Sharon Bewick

10:10 **15-MINUTE BREAK**

10:25 **Fog interception in spruce-fir forests of GSMNP**
Sarah Praskievicz (Dept Geography, Environ & Sustainability, Univ of NC at Greensboro)

10:45 **Examining shifts in biochemical processes from long-term monitoring of water quality in GSMNP**
John Schwartz (Dept Civil & Environ Engineering, UTK), Matt A Kulp & Jim Renfro

11:05 **Soil moisture mapping**
Jason Fridley (Dept Biol, Syracuse Univ) & Jordan Stark

11:25 **LUNCH BREAK**

12:25 **Public perceptions of salamanders in GSMNP**
Savannah Blackman (Dept Ecol & Evol Bio, UTK) & Adam Willcox

12:45 **Hybridization and species boundaries in *Plethodon* salamanders in relation to elevation and climate**
Benjamin Fitzpatrick (Dept Ecol & Evol Bio, UTK) & Rebecca Smith

1:05 **Fuel and vegetation dynamics following the 2016 Chimney Tops 2 Wildfire**
Brayden Williams (Forestry & Environ Conservation, Clemson University) & Donald L Hagan

1:25 **15-MINUTE BREAK**

1:40 **Terrestrial life with lichens**
Angelia Romano (Museum of Natural History, Boulder, CO), Erin Tripp & Jes Persinger

2:00 **Atmospheric deposition lowers fungal diversity in an endangered spruce-fir ecosystem**
Chance Noffsinger (Dept Ecol & Evol Bio, UTK)

2:20 **Post-fire oak seedling mycorrhiza**
Karen Hughes (Dept Ecol & Evol Bio, UTK), Jennifer A Franklin, Jennifer Schweitzer, Matthew Aldrovandi, Alexis Case, P Brandon Metheny & Andrew N Miller

2:40 **15-MINUTE BREAK**

2:55 **Integrating social and ecological predictors to understand variation within ecosystems: a case study of the GSMNP PACE**
Clare Aslan (Earth & Sustainability, Northern Arizona Univ), Sam Veloz, Rebecca Epanchin-Niell, Mark Brunson & Ben Sikes

3:15 **Contrasting field-measured microclimatic conditions in three forest types and in successional forest after a high severity fire**
Monica Papeş (Dept Ecol & Evol Bio, UTK)

3:35 **Sensing NEON in the Smokies**
Sarah Szito (National Ecological Observatory Network Program, Battelle) & Marie Faust

3:55 **CONCLUSIONS AND FAREWELL**

HOW TO PARTICIPATE:

Information: dlia.org/science-colloquium-2022
Register: bit.ly/3Lx2Zw1
Speakers: don't register; you'll get link via email

* Presenting author bolded, full author information below. UTK = University of Tennessee, Knoxville. GSMNP = Great Smoky Mountains National Park.

2022 SCIENCE COLLOQUIUM ABSTRACTS

(by last name of bolded presenting author)

Integrating social and ecological predictors to understand variation within ecosystems: a case study of the Great Smoky Mountains National Park PACE

Clare Aslan *(clare.aslan@gmail.com)[1], Sam Veloz[2], Rebecca Epanchin-Niell[3], Mark Brunson[4], Ben Sikes[5]*
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Most large landscapes today are subdivided among multiple jurisdictions, with the result that they are affected by a diversity of management decisions and activities. Ecological conditions may track jurisdictional boundaries if distinct management practices sufficiently influence natural systems. We collected data on land cover, disturbance evidence, and tree communities in randomized sampling sites located in National Park, US Forest Service Wilderness, and US Forest Service Non-wilderness distributed across the Great Smoky Mountains National Park Protected Area-Centered Ecosystem (GRSM-PACE). We examined how present-day values for these responses were linked to both biophysical site characteristics (as the foundation for ecological communities) and jurisdiction type (as categories that integrate the combination of social decisions and management practices since initial designation). Jurisdiction type was an important predictor of groundcover, tree diversity, and wildlife sign at sites across the GRSM-PACE. More data are needed to explore the mechanisms driving these relationships, but these initial findings show that understanding the social system on this landscape may help researchers better track ecological factors across the PACE.

Public perceptions of salamanders in Great Smoky Mountains National Park

Savannah Blackman *(sblackm3@vols.utk.edu)[1], Adam Willcox[2]*
[1]Dept Ecology & Evolutionary Biology, University of Tennessee, Knoxville; [2]Dept Forestry, Wildlife & Fisheroes, University of Tennessee, Knoxville

Though amphibians are some of the most diverse vertebrates, they receive little attention when it comes to public appreciation or outcry for conservation. Despite their ecological importance, salamanders are often little known and overlooked by the general public. To better conserve their rapidly declining populations, it is important to understand and consider public knowledge and attitudes toward salamanders and certain behaviors that negatively affect them—like rock stacking. Great Smoky Mountains National Park is referred to as the "Salamander Capital of the World!" as it is home to more than 30 different species of salamander. One issue facing salamander populations within the park is the altering of waterways through damming and rock stacking. Our questionnaire sought to understand park visitor knowledge of and attitudes toward salamanders as well as feelings toward rock stacking and potential management actions to mitigate damages to local salamander populations. We surveyed 817 visitors (response rate was around 85%) and discovered that visitors had little, if any previous knowledge of salamanders within the park and generally had neutral feelings toward them. Most visitors also had positive or neutral feelings toward rock stacks before being given a small amount of additional information about the negative side effects of stacking or moving rocks from the water. After the additional information, responses were more negative toward rock stacking. Overall, visitors support the idea of park staff managing areas of streams or trails for salamander conservation. The strongest support was for signs along streams and trails as well as the addition of ranger talks.

Hybridization and species boundaries in *Plethodon* salamanders in relation to elevation and climate

Benjamin Fitzpatrick *(benfitz@utk.edu)[1]*
[1]Dept Ecology and Evolutionary Biology, University of Tennessee, Knoxville

The iconic Red-cheeked Salamander (*Plethodon jordani*) is endemic to the higher elevations of the Great Smoky Mountains. Although its geographic (and elevational) range has been surprisingly consistent through decades of climate change, a more subtle change has been proceeding in some parts of the mountains. *P. jordani* sometimes hybridizes with slimy salamanders (*P. glutinosus* and *P. teyahalee*) and while hybrid zones in some locations have been stable for decades, we are finding new locations where extensive hybridization appears to be changing the face of *Plethodon* populations. Here we present evidence from DNA and color patterns that hybrid populations are expanding in the western part of the park. This expansion might be a consequence of climate-associated changes in seasonal activity patterns and the composition of high elevation forests.

The African American Experience in the Smokies: Making the Invisible, Visible

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Do you remember the time when you were sitting on the front porch with your grandparents, and they told you a story? Not just any story, but a story that made you ask more questions, read more books, or share those stories that you learned as a child with your grandchildren. In 2018, Great Smoky Mountains National Park realized that there was a missing piece to its rich puzzle of history, which led to the park's new project, the African American Experience Project. This project is a collaborative effort with park partners and the community to document and share the untold stories of African Americans in and outside the Smokies. These stories have been shared by many African Americans around crackling campfires, sun-beaten front porches, and the lamp lit bedrooms, but they have yet to be shared with the world. To tell this story, the park is conducting research into African American experiences in the Great Smoky Mountains region of Appalachia from constructed 1540s to the present-day. Research topics in this framework include slavery, the American Civil War, social dynamics, laws and policies, careers, recreation, and oral histories. These are a few of the many key topics that will help park visitors understand this important, yet untold story.

Soil moisture mapping

Jason Fridley *(jdfridley@gmail.com)[1], Jordan Stark[1]*
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A network of 100 soil moisture sensors (0-15 cm deep) were deployed across Great Smoky Mountains National Park in 2020-2022. I'll discuss general patterns of soil moisture along main topographic gradients in relation to supply (rain frequency and event size) and demand (local drainage, evapotranspiration), our approach to spatial predictive modeling, and the sensitivity of soil moisture gradients to changes in regional precipitation and temperature.

Post-fire oak seedling mycorrhiza

Karen W Hughes *(khughes@utk.edu)[1], Jennifer A Franklin[2], Jennifer Schweitzer[1], Matthew Aldrovandi[?], Alexis Case[?], P Brandon Metheny[?], Andrew N Miller[?]*
[1]Dept Ecology & Evolutionary Biology, University of Tennessee, Knoxville; [2]Dept Forestry, Wildlife & Fish, University of Tennessee, Knoxville

Acorns dropped in the fall of 2017 germinated in the spring of 2018, approximately 15 months after the 2016 Chimney Tops 2 wildfire. We collected seedlings from both unburned and burned sites within the Great Smoky Mountains National Park. We examined roots and excised putative mycorrhizal root tips. We extracted DNA and used PCR to amplify the fungal barcode (nuclear ribosomal Internally transcribed spacer region). From 238 Oak seedling roots, 118 putative mycorrhizal taxa were identified. Overwhelmingly, *Russula* sp. was the most speciose genus (23 taxa/118 or 19.5%) followed by the *Thelephora* /*Tomentella* clade (19 taxa/118 = 16.1%) and *Lactarius*/ *Lactifluus* (12 taxa/118 = 10.1%). *Russula* and *Lactarius*/*Lactifluus* are closely related genera in the family Russulaceae. The diversity of taxa recovered does not give the whole picture, however. Some *Russula* species are common on Oak roots, and some are rare. In contrast to the taxonomic diversity of *Russula*, only two species of *Laccaria* (Hydnangiaceae) were identified as ECM on Oak roots, *Laccaria laccata* (19 roots/236=8.05%) and the sister species *Laccaria trichodermophora* (8 roots/236=3.38%) yet sporocarps of *L. laccata* were common in low/medium fire zones; *L. trichodermophora* sporocarps were common and persistent only in high fire zones. There were distinct ectomycorrhizal species differences between burn categories and between oak species. but fungal species distributions may be patchy and such differences may reflect the distance between collection sites in addition to other factors.

Current status of *Brachyponera chinensis* (Hymenoptera: Formicidae) invasion into Great Smoky Mountain National Park highlights opportunities for prevention

Daniel Malagon *(dmalago@clemson.edu)[1], Sharon Bewick[1]*
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The Asian Needle Ant, *Brachyponera chinensis*, (Emery) (Hymenoptera: Formicidae) is one of many nonnative ant species invading North America. First introduced in 1932, *B. chinensis* has spread throughout the southeastern United States, where it has primarily invaded low elevations. This contrasts with its native range, where *B. chinensis* has been reported as high as ~2400m. Recently, *B. chinensis* was observed along the Northern and Southern foothills of Great Smoky Mountains National Park (GSMNP). The potential for *B. chinensis* to spread further into GSMNP, including into sensitive high elevation sites with a range of endemic plants and animals, is concerning. Notably, this species has invaded intact forests in other regions of the Southeast, where it has decreased native ant diversity and disrupted ant-plant seed dispersal mutualisms. Previous studies suggest that, although *B. chinensis* can invade intact forest, disturbance strongly facilitates *B. chinensis* penetration into ecosystems. Consequently, the catastrophic GSMNP wildfires of 2016 may have served as a catalyst for accelerating *B. chinensis* spread within the park. Simultaneously, increased park visitation, particularly during the pandemic, may also be enabling *B. chinensis* colonization of new areas within GSMNP. To better characterize both the potential for and ongoing state of the *B. chinensis* invasion within GSMNP, we surveyed the park for *B. chinensis* at 10 sites that were burned during the 2016 fires, 15 sites that feature intense human visitation, and 17 undisturbed sites across a range of different forest types. We did not find *B. chinensis* at undisturbed sites. We did find *B. chinensis* at 3 high-visitation, and 1 moderately burnt sites, including 3 new records in the park. Intense surveys at the 5 sites where *B. chinensis* was detected indicate limited spread. However, combining presence data from our sampling efforts with previous presence data from *B. chinensis* native and invasive ranges yields MaxEnt models that suggest high suitability for *B. chinensis* across a sizable portion of GSMNP, including at medium-high elevations where it has not been detected. Based on our finding of *B. chinensis* at limited low elevation sites, invasion of this ant species into GSMNP appears to be in an early phase and appears to be occurring relatively slowly. This suggests that with ongoing surveillance and targeted eradication, it may be possible to prevent *B. chinensis* invasion within the park.

Atmospheric deposition lowers fungal diversity in an endangered spruce-fir ecosystem

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[1]Dept Ecology & Evolutionary Biology, University of Tennessee, Knoxville

The spruce-fir ecosystem in the southern Appalachian Mountains is considered one of the most endangered in North America and the largest communities of spruce-fir are found in the Great Smoky Mountains National Park. Fraser fir (*Abies fraseri*) is only found in this region and has experienced massive decline due to the invasive woolly adelgid and atmospheric deposition. Spruce-fir forests improve watershed quality and provide important habitat for endemic species, some of which are poorly understood and may be at risk of extinction. Soil fungi play a dynamic role in the spruce-fir ecosystem and many mutualistic fungi are specifically tied to tree survival. The two major ecological guilds of fungi, biotrophs and saprotrophs, respond differently to the changing edaphic conditions caused by atmospheric deposition. The goal of this work was to understand how atmospheric deposition and other edaphic factors vary across the spruce-fir ecosystem and how these will affect fungal community diversity. The fungal community present in the spruce-fir ecosystem has been characterized using high-throughput sequencing of the ITS2 gene region. Preliminary results indicate that fungal diversity decreases with increased levels of lead, which is being used as a proxy for understanding rates of deposition. The most important edaphic factors controlling fungal community diversity are lead, ammonium, and nitrate. Lead and ammonium have negative effects on fungal diversity, whereas nitrate has a positive effect. Analyses are currently underway to determine how increased levels of deposition affect the major guilds of fungi present in the soil. This research has provided valuable baseline information on the fungal communities present in the spruce-fir ecosystem and has the potential to identify regions where the soil fungal communities are at risk or contain rare species.

Contrasting field-measured microclimatic conditions in three forest types and in successional forest after a high severity fire

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Forecasting biodiversity patterns relies on predictors that capture broad-scale, coarse-resolution climatic conditions. However, organisms respond physiologically and behaviorally to microclimatic conditions, thus microclimate predictors could be important to refine projected species' distributions. One possibility to estimate microclimatic conditions at broad scales is to create a predictive model of the relationship between habitat structure and microclimatic conditions measured in the field. The aim of this study was to address the first step in creating the microclimate-structure model, that of quantifying field microclimatic conditions. We measured solar radiation, temperature, and leaf wetness at twenty sites in the Smoky Mountains National Park between June and December 2021. Our sites sampled microclimatic conditions in three forest types (cove, high hardwoods, pine-oak) and in successional forest recovering from a high severity fire. We calculated daily, monthly, and seasonal minima, maxima, and coefficient of variation of microclimatic conditions. We found differences between the three forest types, and higher temperature and solar radiation at successional sites. Next, we will use NEON airborne LIDAR data to derive vegetation structure metrics and build a microclimate-structure model to estimate microclimate conditions at the landscape scale.

Fog interception in spruce-fir forests of Great Smoky Mountains National Park

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When rain falls on a forest canopy, some of the precipitation is intercepted by vegetation. Water that collects on vegetation surfaces may be lost to evapotranspiration or may eventually fall to the ground as throughflow (water that drips from leaves and branches) or stemflow (water that flows down tree trunks). In addition to precipitation, another potential input of water to the vegetation canopy is fog droplets. These droplets can also collect on vegetation surfaces and then drip down as throughfall or stemflow to the forest floor. Because this is water that would not have otherwise made it to the soil, fog interception can be considered an additional input to the local water budget. Different tree species vary in their ability to intercept fog. Needleleaf conifers – including the Fraser fir and red spruce of Great Smoky Mountains National Park – are expected to be more effective fog interceptors than broadleaf deciduous trees. The Southern Appalachian spruce-fir ecosystem is endangered by the balsam woolly adelgid and by encroachment of hardwood trees from lower elevations. The project uses open-site and below-canopy electronic recording rain gauges to quantify interspecific differences in fog interception between spruce-fir and northern hardwoods. The results indicate the significance of fog interception to the overall water budget and the potential hydrologic implications if there is widespread replacement of spruce-fir by hardwoods.

Terrestrial life within lichens

Angelia Romano *(angelia.romano@colorado.edu)[1], Erin Tripp[1], Jes Persinger[2]*
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Lichens are an incredibly diverse group of composite organisms with a biodiversity hotspot in the southern Appalachian Mountains. Given their unique structure, ability to hold water and varied growth substrates, lichens are an ideal host habitat, and food source, for many micro invertebrates such as mites, springtails, nematodes and tardigrades. Due to the particularly small scale of these biotic interactions, the relationship between lichens and their invertebrate associates is rather understudied. This research aims to explore patterns and drivers predicting terrestrial invertebrate diversity and abundance in the lichens of Great Smoky Mountains National Park.

Examining shifts in biochemical processes from long-term monitoring of water quality in Great Smoky Mountains National Park

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Throughfall (TF) deposition of sulfate (S) and inorganic nitrogen (N as NO_3^- + NH_4^+) are key drivers to stream acidification in base-poor regions of eastern United States (US). Significant declines in S and N deposition in the past 20 years have been observed in this region, including the Great Smoky Mountain National Park (GRSM). GRSM has been intensively studied since 1991, however the last spatial TF survey was conducted in 2000. A substantial decline in S and N deposition occurred in 2008 and the decline quantified at the Noland Divide Watershed (NDW) high-elevation monitoring station. Park-wide data for TF deposition was collected in 2016-2017 and compared with 2000 data. Results from the 2016-2017 study found that S deposition ranged between 1.6 and 5.5 kg ha^{-1} yr^{-1} compared to 6.5 and 33.6 kg ha^{-1} yr^{-1} in 2000; and N deposition ranged between 2.6 and 11.6 kg ha^{-1} yr^{-1} compared to 4.8 to 25.0 kg ha^{-1} yr^{-1} in 2000. Annual TF S and N depositions significantly increased with increasing elevation; however, TF deposition base cations (BC) did not. TF BC and N (mostly NH_4^+) were influenced by forest canopy exchanges. This finding may partially explain why stream pH and acid neutralizing capacity remains relatively unchanged from the 2000s to the present. Precipitation volumes were also strongly correlated with TF ion depositions. Shifts in biogeochemical processes were assessed through the review of long-term watershed ion input-output budgets at NDW, where prior to 2008, S was retained annually in the watershed and recent budgets shown annual mass S export. BC and N budgets have also shifted between pre- and post-2008 periods. The role or organic S in retention and export was also examined in 2018, where a dominant S sink was quantified as organic S in the A/O soil horizon. This research demonstrated the important role of carbon dynamics and possible soil BC depletion are dominate factors to continued stream acidification in GRSM. In 2020, because of the potential effect of organic acids on stream acidity, a survey of dissolved organic carbon was conducted in the GRSM and data are reported here within. Continued long-term research in the GRSM provides necessary data to support biogeochemical modeling efforts to predict the recovery period of stream water quality from acidification and has implications to the possible environmental effects of climate change.

Sensing NEON in the Smokies

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The National Ecological Observatory Network (NEON) provides open ecological data from 81 field sites across the United States, including one site at Great Smoky Mountains National Park (GSMNP). NEON data cover a wide range of subject areas within ecology, including organismal observations, biogeochemistry, remote sensing, and micrometeorology. Many datasets already span several years of data collection. In addition to open data, NEON also provides many resources that support land managers, researchers and educators, including sampling protocols, data skills training, and classroom-ready lesson plans. This talk will provide a brief introduction to resources for access and working with a variety of NEON data for your research. It will also highlight case studies of researchers using NEON data from the GSMNP field site, as well as other field sites to show how NEON science can be an integral co-benefit of protecting and preserving natural communities. Lastly, it will showcase NEON's sensor data by providing a live data portal walk through of instrumentation and remote sensing visualizations.

Ground-Penetrating Radar mapping of historic African American Cemeteries in Great Smokies National Park

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Ground penetrating radar (GPR) is a valuable non-invasive resource in archaeological investigations, particularly in mapping historical cemeteries. Throughout the American South, African American cemeteries, both during and after slavery, possess little to no written records, and need to be validated and preserved.

A new mapping effort by Western Carolina University, in cooperation with Martin Archaeology Consulting, the African American Experience Project, and Friends of the Smokies, aims to complete the first detailed surveys of African American cemeteries in the Great Smoky Mountains National Park (GRSM). In addition to GPR surveys, searches by human remains detection (HRD) canines will aid the

mapping of these historic sites.

Enloe Cemetery is located on a hillside north of Mingus Mill in the GRSM and contains five marked burials. The burials are oriented roughly east-west, mounded and troughed on both sides, and marked with headstones and footstones fashioned from native rock slabs. The graves, dating to at least 1860, are reported to be those of African Americans enslaved by the Enloe and Mingus families, who owned the nearby land.

A GPR survey of Enloe Cemetery was completed in July 2020. A total of eight graves were mapped – five previously known and marked graves, and three potential unmarked graves. There is some evidence that coffins may still be present in at least four graves. The locations of these graves were marked with survey flags in the field, photographed, and mapped with the goal of providing the GRSM with the means to further document and preserve the graves. Additional GPR surveys and HRD canine searches are planned for the Ravensford and O.E. Kerr cemeteries during 2022.

Fuel and vegetation dynamics following the 2016 Chimney Tops 2 Wildfire

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[1]Forestry and Environmental Conservation, Clemson University

The Chimney Tops 2 Fire burned roughly 11,000 acres within the Great Smoky Mountains National Park in late November 2016. The fire spread quickly due to high winds and dry fuels and burned at varying intensities across a complex landscape. This created an excellent opportunity to evaluate the effects of mixed-severity fire in the Southern Appalachians. Our study, conducted in summer 2021, focuses on post-fire fuel loading and vegetation succession. We used modified Brown's Planar Intercept and Carolina Vegetation Survey protocols in 120 plots that we established across a fire severity gradient. Unburned sites within and near the fire perimeter were used as controls. Here, we present preliminary fuels and vegetation results and speculate on their implications for future forest and fire dynamics.