Mid-Atlantic Chapter Meeting

Abstract Program

April 1, 2023

Schedule

9:00 - 9:30 AM - Lobby
Continental Breakfast
9:30 AM - 11: 45 AM - Room 128
Plenary Session
The Nature of Oaks, Doug Tallamy
Soil Biodiversity on the Urban Landscape, Katalin Szlavecz
11:45AM -12:00 PM - Lobby
Break and Pick Up Box Lunch
12:00 - 1:30 PM
MA Chapter Meeting - Room 110
Workshop I - Room 101B Career ecology: What's your story?
Workshop II - Room 119 The basics of "R" programming for ecological research
Workshop III - Room 120 Science Policy 101: ways an ecologist can engage in the policy process
1:30 - 1:35 PM
Transition to Sessions
1:35 - 3:05 PM
Session 1: Urban Ecology - Room 128
Session 2: Aquatic: Waterline & Shoreside - Room 101B
Session 3: Plant Ecology - Room 119
Session 4: Pollution - Room 120
3:05 - 3:30 PM - Lobby
Coffee Break
3:30-5:00 PM
Session 5: Invasion Ecology - Room 128
Session 6: Vertebrates - - Room 101B
Session 7: Managed & Agricultural - Room 119
Session 8: Social Science & More - Room 120
5:00 - 6:30 PM - Lobby
Poster Session and Reception

Plenary Speakers

Greetings from the MA-ESA Chair

Vince D'Amico is an Urban Ecologist with the Northern Research Station of the USDA Forest Service. He is the Team Leader of the Philadelphia Field Station and the co-founder of the FoRests Among Managed Ecosystems (FRAME) Program. Vince is also Affiliated Faculty in the College of Natural Resources at the University of Delaware.

Welcome from the Chair of Entomology & Wildlife

Ornithologist **Greg Shriver** is a Professor and Assistant Chair in the Department of Entomology & Wildlife Ecology at the University of Delaware. He is a co-founder of the FRAME and of the Saltmarsh Habitat & Avian Research Program (SHARP).

Welcome from the Chair of the Department of Plant & Soil Sciences

Erik Ervin is Professor and Chair at the Department of Plant & Soil Sciences at the University of Delaware. He is a recipient of the R.D. Cake Memorial Award for Career Achievement in turfgrass research.

The Nature of Oaks

Doug Tallamy is the T.A. Baker Professor of Agriculture in the Department of Entomology and Wildlife Ecology at the University of Delaware, where he has authored 111 research publications and has taught insect-related courses for 41 years. Chief among his research goals is to better understand the many ways insects interact with plants and how such interactions determine the diversity of animal communities. His books include "Bringing Nature Home," "The Living Landscape" (co-authored with Rick Darke), "Nature's Best Hope," a New York Times Best Seller, and "The Nature of Oaks," winner of the American Horticultural Society's 2022 book award. In 2021, he co-founded Homegrown National Park with Michelle Alfandari. His awards include recognition from The Garden Writer's Association, Audubon, The National Wildlife Federation, Allegheny College, Ecoforesters, The Garden Club of America and The American Horticultural Association.

Soil Biodiversity on the Urban Landscape

Katalin Szlavecz is a Research Professor in the Department of Earth & Planetary Sciences at Johns Hopkins University. Her research includes study of the diversity and ecology of soil invertebrates, soil biogeochemical cycling, urban ecosystems, and invasive species. She is a CoPI of the Baltimore Ecosystem Study LTER, a research associate at the Smithsonian Environmental Research Center, and a collaborator at the USDA Beltsville Agricultural Research Center Farming Systems Project.

Oral Session 1: Urban Ecology

1:35 - 3:05 PM

Schmitt - Effects of tree diversity on leaves: linking green leaf traits and leaf litter decomposition in a forest diversity experiment

Leopold - Understanding Shade Tree Growth Rates and Morphology by Site Design

Hurst Brubaker - Assessment of Collembola Community Composition in Anthropogenically Disturbed Forest Ecosystems

Becnel - Scarab Beetle Diversity in Urban Environments

Carr - Wetland proximity to urban areas relating to vegetation disturbance in the US

Luckenbaugh - Comparison of Two Eastern Milksnake (Lampropeltis triangulum triangulum) Populations in a Natural and Urban Environment

Effects of tree diversity on leaves: linking green leaf traits and leaf litter decomposition in a forest diversity experiment

Lauren Schmitt, University of Maryland

Co-Authors: John Parker, Smithsonian Environmental Research Center; Karin Burghardt, University of Maryland

Understanding how species diversity affects plant traits is important for predicting the impact of primary producer diversity on upper trophic levels and on ecosystem function. Leaf traits can correlate with herbivory while on the tree and after senescence they can alter decomposition dynamics. Importantly, local plant diversity can alter leaf traits by changing the physical and chemical traits of leaves. Here we use a large-scale forest diversity experiment, BiodiversiTREE, in Edgewater, Maryland, USA, assess the impact of plot diversity on green leaf traits, including leaf thickness, toughness, leaf mass area, and chlorophyll and leaf litter decomposition rates. To assess relative decomposition rates, we deployed 520 litterbags across locations of differing diversities with varying contents and mesh sizes.

Green leaf traits and decomposition trajectories varied both by tree species and with species diversity. Origin diversity, the species diversity of the plot where a leaf grew, affected decomposition in species-specific ways, with leaves of some species from monoculture plots decomposing more quickly than leaves from polyculture plots and other species showing the opposite trend. These preliminary results underscore the importance of considering the effects of local species diversity on community and ecosystem ecology dynamics in young forests.

Understanding Shade Tree Growth Rates and Morphology by Site Design

Richard Leopold, US Forest Service

With the urban sprawl continuing to grow there is a greater pressure applied to our urban forests to mitigate the consequences of living in such an environment. An often-overlooked component of the urban forest are the services, in the form of ecosystem services, provided by our street trees. As ecosystem services are determined by different morphological components, I assessed how these features grow and change based on the growing space of the street tree. Three common growing sites were identified, pits, strips, and lawns.

By analyzing growth rate of the diameter at breast height (DBH) and using allometry to relate DBH to various tree components (crown volume, leaf area index, and total leaf area) I was able to determine how these other, more difficult to measure, features change with time. Ultimately, I was able to determine how ecosystem services change over time based on the growing site.

I found that although the growing site does impact growth rate and allometric scaling the tree species often determines strength of that impact. Some tree species are relatively unaffected by the growing site while others greatly differ in growth based on their growing space. These finding show that when generating a schedule for planting and removals the species, site type, and the interaction between he two, must be taken into consideration to maintain consistent and predictable outputs of ecosystem services.

Assessment of Collembola Community Composition in Anthropogenically Disturbed Forest Ecosystems

Frances Hurst Brubaker, Chatham University

Acid rain deposition and forest clearance are long-term anthropogenic disturbances that have significantly impacted northern hardwoods forest ecosystems of New England. Acid deposition lowers soil pH and reduces bioavailable calcium. While forest clearance degrades soil fertility, stripping away nutrients and increasing erosion. We investigated the effects of calcium addition as remediation from acid rain and forest age post-clearance on the abundance, biodiversity, and community composition of soil Collembola, a dominant macroinvertebrate taxon of soils. We collected samples in three experimental watersheds at Hubbard Brook Experimental Forest, one that had calcium addition in the form of wollastonite pellets applied to the entire watershed in 1999, another which had a whole tree harvest and clearing in the 1980s, and a reference watershed. Leaf litter and Collembola samples were collected and extracted through Berlese-Tullgren funnels. Collembola were identified to family. Although abundance and biodiversity of Collembola did not differ significantly across watershed treatments, the family Tomoceridae had the highest abundance in the untreated reference watershed, while the families Isotomidae and Onychiuridae had the highest abundance in the previously clearcut watershed. Leaf litter mass per unit area also differed across watershed treatments, with the highest leaf litter mass per unit area occurring in the untreated reference watershed. Abundance of Tomoceridae, Isotomidae, and Hypogastridae were significantly correlated to the leaf litter mass within the samples. Abundance differences among Collembola families across the watersheds could indicate that calcium addition creates less nutritionally dense leaf litter. We found lowest abundance families Isotomidae and Onychiuridae and the second lowest abundance of Tomoceridae in the calcium addition watershed. The low abundance and family richness in the calcium addition watershed could lead to lower soil porosity and less circulation of nutrients from the soil surface into the subsoil.

Scarab Beetle Diversity in Urban Environments

Philip Becnel, Salisbury University

Co-Author: Dana Price, Salisbury University

Insect biodiversity helps maintain a healthy ecological balance in urban ecosystems. Beetles of the superfamily Scarabaeoidea (scarabs) are a diverse group of insects that act as indicators of biodiversity and environmental health. In addition, scarabs are valued for their role in recycling nutrients and pollination. Here we examined the scarab diversity on the campus of Salisbury University, Salisbury, Maryland, to determine the species diversity in this urban environment. We collected beetles during the summer of 2022 using a variety of methods. Active methods included hand collection, sweep netting, and digging through logs and litter. Passive methods were black lighting, hanging fruit traps, baited pitfall traps, and flight intercept traps. Across campus, we found 35 species, including Maryland's largest scarab, the Eastern Hercules beetle, and we have provided 3 new records for Wicomico County. We also found several species of flower beetles, the introduced Japanese and Oriental beetles, and 11 species of dung beetles (Scarabaeidae and Geotrupidae). This summer, we will examine the scarabs at the City Park and Salisbury Zoo. We intend to increase our species list and make comparisons with this urban area.

Wetland proximity to urban areas relating to vegetation disturbance in the US

Macy Carr, SUNY ESF

It is understood that urbanization has a significant effect on wetland health. I am most interested in how urbanization has affected wetland communities in the US and whether wetland proximities to urban areas have correlated effects on their vegetation. Vegetation is one of the most prominent indicators of wetland health. Using National Wetland Conditional Assessment (NARS 2022) data from both 2011 and 2016 surveys, vegetation presence and cover from over 2000 sites were utilized to evaluate disturbance from a categorical approach. Using US Census Urban Area polygons, each NWCA site was assigned a proximity based category using the polygons and buffers around these urban areas(categories: urban, 5 km buffer, 20 km buffer, extralimital). By examining metrics that include richness, nativity and coefficients of conservatism, impact of wetland vegetation disturbance was described for each of these wetland location categories. Significance of these proximities and their relationship to disturbance had diverse results depending on the metric. Most notably, the mean absolute cover and absolute cover of nonnative plants were significantly larger within urban wetlands compared to buffer and extralimital wetlands. Site mean C(non-weighted) had surprisingly non-significant results based on location category. Total species richness, native species richness, and high C species richness are significantly greater in extralimital sites compared to urban areas and their buffers. A study utilizing this widely comprehensive data set has not been utilized to evaluate these questions on a scale this large and comparing this many wetland types. This study is a testament to what can be done using government management data that are publicly available. These findings have significant implications on management strategies of wetlands near urban areas and what problems to expect in mitigation

Comparison of Two Eastern Milksnake (Lampropeltis triangulum triangulum) Populations in a Natural and Urban Environment

Emeleigh Luckenbaugh, Shippensburg University

The focus of my study was the demography of the Eastern Milksnake (Lampropeltis triangulum), which I sampled using cover boards in two south-central Pennsylvania locations: a natural site (Letterkenny Army Depot - LEAD) and an anthropogenically-disturbed site (Shippensburg University Campus - SU) in 2021. The disturbed site population at SU was composed primarily of large adults with an even sex ratio. At the natural site LEAD, relative abundance was higher, males outnumbered females among adults, and juveniles occurred in more size-classes than at LEAD. The different demographic responses in these two populations appear to be driven by differences in both prey availability and predator pressure, both of which were higher in the disturbed site.

Oral Session 2: Aquatic; Waterline & Shoreside

1:35 - 3:05 PM

Shriver - Estimating spatially explicit occupancy and density for a sharply declining marsh bird

Glasko - Using UAV to discover secretive marsh bird nests

Nelson - Can extended thermal acclimation prepare temperate fishes for climate change?

Harrison - Multimetric Analyses to Determine Water Quality of Streams

Reeves - Effect of environment on pigmentation in the grass shrimp, Palaemonetes pugio

Patel - Salt Spray Tolerance in the Genus Monarda

Estimating spatially explicit occupancy and density for a sharply declining marsh bird

Greg Shriver, University of Delaware

Co-Authors: Sam Roberts, University of Delaware; Zach Ladin, U.S. Fish and Wildlife Service; Chris Elphick, University of Connecticut; Whitney Wiest, U.S. Fish and Wildlife Service; Brian Olsen, University of Maine; Maureen Correll, U.S. Fish and Wildlife Service

Sea-level rise effects on tidal marshes pose an imminent threat to the specialist breeding birds dependent on these ecosystems to complete the annual cycle. A suite of tidal marsh specialist species is among the greatest conservation priorities in North America, including Saltmarsh (Ammospiza caudacuta) and Nelson's (A. nelsoni) sparrows. Saltmarsh and Nelson's sparrows are primarily restricted to salt marshes and hybridize where they co-occur from southern Maine to northern Massachusetts. Annual population trends for these taxa are negative with the Saltmarsh and Nelson's sparrows declining by 9% and 4%, respectively. Due to increasing threats to their habitat, limited geographic range, relatively low population estimates, and severe population declines, the Saltmarsh Sparrow is considered a Species of Greatest Conservation Need in all states from Maine to Virginia and is currently a candidate for listing under the Endangered Species Act with a high probability of extinction before 2050. Therefore, identifying marshes with relatively high occupancy and abundance across the Saltmarsh Sparrow's breeding range can provide valuable information for conservation. High-resolution, spatially-explicit occupancy and abundance predictions for the Saltmarsh Sparrow do not currently exist but could aid in site prioritization for conservation and management actions. To address this need, the USFWS Delaware Bay Coastal program and the Atlantic Coast Joint Venture partnered with the University of Delaware to use existing Saltmarsh Habitat and Avian Research Program (SHARP) survey data to develop models to generate spatially explicit occupancy and density maps. We included Saltmarsh Sparrow, the Acadian Nelson's Sparrow (A. nelsoni subvirgata), and where they are sympatric (southern Maine to northern Massachusetts), we added a third taxa; sharp-tailed sparrow (individuals that could be not identified as either Saltmarsh or Nelson's sparrow). The purpose of this project was to use the existing SHARP tidal marsh bird survey data from Virginia to Maine to estimate and predict the occupancy and density for the Saltmarsh and Nelson's sparrows using a fine-scale raster-based vegetation data layer. Specifically, we used the existing SHARP tidal marsh bird survey data to; 1) estimate Saltmarsh and Nelson's sparrow occupancy and density across suitable habitat in USFWS Region 5 and 2) predict sparrow occupancy and density using these established relationships and 3) provide spatial data and maps that can be used to identify priority tidal marsh sites for our focal species in the Northeast, particularly the Saltmarsh Sparrow.

Using UAV to discover secretive marsh bird nests

Hailey Glasko, University of Delaware

Co-Authors: Elisa C. Elizondo, University of Delaware; W. Gregory Shriver, University of Delaware

Unoccupied Aerial Vehicles (UAVs) provide new methods to study wildlife in a potentially more efficient manner than traditional methods. UAV methods could be particularly useful for studying secretive marsh birds, as marsh accessibility varies greatly, and UAVs can provide access to otherwise inaccessible areas. We used a UAV equipped with a thermal imaging camera to search for Clapper Rail (Rallus crepitans) and other tidal marsh birds nesting in salt marshes on the coast of Delaware, USA in 2021 - 2022. We conducted traditional ground-based systematic nest searches with a field crew at two intensive sites with different levels of accessibility and compared the number of nests detected between ground surveys and the thermal camera deployed on the UAV. Thermal imaging flights were conducted before sunrise for the greatest thermal contrast between the nests and the marsh vegetation. Suspected nest points were ground-truthed after each flight to confirm that the point was a nest and determine which marsh bird species it belonged to, as it is difficult to distinguish species from the thermal imaging alone. We found that the UAV detected fewer Clapper Rail nests than ground surveys in the accessible sites (17 and 28 nests respectively) and the UAV detected more Clapper Rail nests than the ground surveys where access was low (16 and 5 nests respectively). We also detected nests of much smaller tidal marsh passerines like Seaside Sparrow (Ammospiza maritima) and Red-winged Blackbird (Agelaius phoeniceus), indicating that thermal imaging flights with UAVs could be used to document species breeding in tidal marshes. Using the data collected in 2021 and 2022, we will compare the efficiency of each method of finding marsh bird nests (ground surveys vs UAV) to determine if one method is more efficient than the other at the two intensive study sites. Given the current conservation challenge associated with maintaining tidal marsh breeding birds during rapid increases in sea-levels, a less invasive and rapid survey method that can efficiently document and quantify breeding can aid in prioritizing marshes for conservation, management, or restoration.

Can extended thermal acclimation prepare temperate fishes for climate change?

Jay Nelson Nelson, Towson University

Co-Authors: Helgi Thor Thorarensen,The Norwegian College of Fishery Science; Danielle C. Gruber, KCI Technologies Inc.

Urbanization causes streams to have higher and more varied temperatures just like climate change is projected to. Whether tolerance to these altered thermal conditions is a pre-requisite for a fish species to inhabit urban streams or if urbanization has altered the thermal physiology of those fish species that persist in urban streams is poorly known but could help predict climate disruption outcomes. Furthermore, places like Iceland have waters where geothermal heat sources vent and have exposed fishes to warmer waters for multiple generations. It is also poorly known how this extended thermal acclimation has changed these Icelandic fishes. To test whether residence in urban streams or geothermal effluent is associated with altered thermal tolerance, we compared thermal tolerance (CTMax) and phenotypic plasticity in five populations of an urban-tolerant cyprinid, the blacknose dace (BND) (Rhinichthys atratulus), from multiple watersheds along an urban/rural gradient in the greater Baltimore (MD USA) area. Thermal tolerance of these stream fish was tested while swimming and also in static water. To test whether BND as a species has unusual thermal tolerance or thermal plasticity, we also compared BND populations with two co-familiars (creek chub (Semotilus atromaculatus) and rosyside dace (Clinostomus funduloides), that don't persist in urban streams. We also raised cultured Arctic char from Holar Iceland from hatching under a 2 X 2 matrix of flow and temperature conditions in the laboratory for a single generation and compared them to wild char captured from environments naturally varying in flow and temperature. Thermal tolerance (CTmax) while swimming in char acclimated to 5°C and 13°C was measured. Thermal tolerance of blacknose dace was significantly repeatable across two levels of activity and did not vary with the urbanization of their watershed. The very urban-intolerant rosyside dace had significantly lower thermal tolerance than the other two species but creek chub had similar thermal tolerance to the more urban-tolerant BND. Our conclusions are that exceptional thermal tolerance is not a pre-requisite for a given cyprinid species to survive in urban streams, nor has thermal tolerance undergone directional selection in this urban environment. Wild Arctic charr from Iceland were more thermally tolerant than cultured fish at both acclimation temperatures and were more thermally plastic, suggesting that changes wrought through the breeding process rather than thermal acclimation were responsible.

Multimetric Analyses to Determine Water Quality of Streams

Makala Harrison, Mount St. Mary's University

Co-Author: Julianna Mariano, Mount St. Mary's University

Benthic macroinvertebrates can be used as bioindicators of healthy freshwater stream environments. Samples collected from local streams during June 2022 were used to calculate various community measures, elemental composition, and environmental health. Variables such as nitrate and phosphate levels, rainfall, land usage, DO, and temperature were analyzed in comparison to community measures. A portion of the samples were kept from each site to be analyzed elementally. It was found that rain and land use have an interactive effect on the EPT% in streams and streams can be similar in character despite differing land use classifications. After seeing the impact of community makeup and physicochemical variables on stream environments, it is concluded that the best way to measure freshwater stream health is through a multimetric analysis using both types of measures.

Effect of environment on pigmentation in the grass shrimp, Palaemonetes pugio

T'Kiyah Reeves, Hampton University

Co-Authors: Andrij Z. Horodysky; Cara C. Schweitzer

The grass shrimp (Palaemonetes pugio) is a highly transparent, tidal crustacean found in estuaries and intertidal zones. Little is known about the ecological role of transparency in benthic fauna. One hypothesis is that transparency is a form of camouflage that involves the entire organism and may be a mechanism to avoid predation. The level of organismal transparency is highly influenced by the number of pigment cells, i.e. melanocytes and xanthophores, and it is currently unclear if environmental factors can influence the number and color of pigment cells. Therefore, the goal of this study is to determine if the grass shrimp found in the Chesapeake Bay undergo changes in pigmentation when exposed to different optical surroundings. To study this phenomenon, we held grass shrimp in small tanks wrapped in colored material to simulate brown, green, or orange backgrounds that may correspond to different viable habitats occupied by the grass shrimp. Shrimp collected from the James River, VA, were exposed to a color background treatment for two weeks in two separate trials. Shrimp were then photographed over blue construction at 1X resolution using a Teclast microscope camera. The level of translucency was measured by assessing the level of blue background pigment showing through the grass shrimp. From captured images, melanocytes and xanthophores from each individual shrimp sample in each treatment were randomly quantified with a grid overlay using ImageJ software. Our preliminary results show there was a significant difference between backgrounds in melanocyte and xanthophore numbers, with shrimp in the brown tank exhibiting a significantly lower number of pigment cells. This may lead to a difference in shrimp transparency levels in shrimp exposed to different backgrounds. This raises the question of whether these camouflaging responses are adaptive physiological responses to environmental parameters.

Salt Spray Tolerance in the Genus Monarda

Manasiben Patel, Shippensburg University

Co-Authors: Leslie Taylor, Shippensburg University; Robert Markey, Shippensburg University; Tara Feltman, Shippensburg University; Heather Sahli, Shippensburg University

As the climate continues to change, the threat of increased sea levels poses new stresses that plants must adapt to. One such stress is that plants close to the coast are experiencing increased salt spray. We studied tolerance to salt spray across populations of Monarda citriodora and Mondara punctata. Plants grown from seeds from one inland population of M. citriodora, and two inland and two Atlantic coast populations of M. punctata were sprayed with either salt water or distilled water (control) for three weeks and salt tolerance was assessed. We hypothesized that M. punctata plants from coastal populations would have evolved greater tolerance to salt spray than those from inland populations. We also quantified three traits that might affect salt tolerance (succulence, trichome density, and stomatal density) to determine if there is phenotypic plasticity in response to salt spray, and which traits may play a role in increasing salt tolerance. Salt spray significantly reduced the number of leaves in inland M. citriodora populations. Inland M. citriodora and coastal M. punctata both showed significant increases in damage on leaves after salt treatment; surprisingly, this effect was not observed in inland M. punctata populations. Salt spray increased above ground biomass in coastal populations of M. punctata and had no effect on dry biomass in inland M. citriodora and inland M. punctata. The only trait showing phenotypic plasticity in response to salt spray was trichome density, which increased in plants exposed to salt spray. Pasticity was especially high in inland M. punctata populations. Coastal populations of M. punctata had the highest trichome density even when not exposed to salt spray, suggesting this trait may have evolved in coastal populations in response to salt spray. M. citriodara populations, native to dry habitats, had higher succulence compared to the populations of M. punctata, and stomatal density was highest in M. citriodora and coastal M. punctata. In conclusion, salt treatment had negative effects on some traits such as number of leaves produced and number of damaged leaves, but the impacts were not consistent across populations, and these negative impacts did not translate into reduced biomass. In fact, salt spray increased biomass in plants from coastal populations. Additionally, trichome density may play a role in providing salt tolerance, and populations with no prior history of salt exposure showed a plastic response to salt spray, which could explain the small effects of salt spray on these inexperienced populations.

Oral Session 3: Plant Ecology

1:35 - 3:05 PM

Kiger - Management timing affects milkweed growth, reproduction and population dynamics

Pecher - Comparing Reproductive Biology in Pennsylvania and Virginia populations of Iris verna

Hall - Effects of management timing on the growth, reproduction and the root microbiome of common milkweed (Asclepias syriaca)

Martinez - Virginia Sneezeweed Survival and Resilience

Golubski - Contrasting effects of different types of plant-soil feedback in a theoretical plant competition model

D'Andrea - Ecosystem function usually but not always increases with species diversity: insights from pitcher plant microbial community models

Management timing affects milkweed growth, reproduction and population dynamics

Emily Kiger, Mount St. Mary's University

Co-Authors: Abigail Kula, Mount St. Mary's University; Marissa Lawson, Mount St. Mary's University

The purpose of this research is to determine the effects of land management techniques (mowing) and the timing of application on re-sprouting, re-growth, and pod production of common milkweed (Asclepias syriaca). It is expected that timing influences these variables due to differences in abundance of nutrients, water, and time left in the growing season. Milkweed plants were established in plots at Gettysburg National Battlefield, Gettysburg, PA, in 2019. The plots were subject to four clipping treatments: unclipped control, clipped in May, clipped in June, and clipped in July, and plant measurements (stem length, number of leaves, number of stems, level of herbivory, and biomass collection) and observations of reproductive output (flowers and pods) were conducted every four weeks during the summers of 2019 and 2020. I analyzed the 2020 data in spring of 2023. The data show a significant difference in the average number of stems regrown by plant clipped in May versus those clipped in June. From May clipping and June measurement, there was no significant difference in the average number of leaves, apical height, and undamaged leaves (herbivory). This may be due to the plants allocating resources for the growth of leaves, production of defenses, and growing taller to access sunlight; regrowth of stems may not be a priority in comparison. The May cut plants had more time to regrow essential structures before allocating resources to stem regrowth, whereas the June cut plants did not. When comparing plants clipped in June versus July (measurements for both taken in August), the data showed no significant difference in any measured variables. I plan to use R to build a model to determine the impact of management timing on population growth rate. Studying how land management (mowing) affects reproduction and re-growth in common milkweed provides valuable insight for the conservation of a species experiencing significant population decline in some areas. This decline also concerns monarch butterflies (Danaus plexippus), which utilize the plant for egg-laying and as a primary food-source for larvae. As conservation and restoration programs are developed, having an understanding of the impacts of timing of management will assist land managers.

Comparing Reproductive Biology in Pennsylvania and Virginia populations of Iris verna

Elaina Pecher, Shippensburg University

Co-Authors: Kimberly Fogelsanger, Shippensburg University; Heather Sahli, Shippensburg University

Iris verna is a low-growing woodland plant that is endangered in Pennsylvania, Maryland, and Ohio. The populations in Pennsylvania are at the northern tip of I. verna's range, with the majority of its distribution spread throughout the Appalachian Mountains in more southern states. Although it is widespread in the southeastern United States, little is known about its basic biology. In 2020, we studied the reproductive biology of I. verna through pollinator observations, seed counts, and trait measurements in two Pennsylvania populations. Results showed low pollinator visitation rates, low fruit production, and low seed production. In response to these results, we wanted to know next if low reproductive output is unique to edge-of-range populations or if this trait is widespread throughout I. verna's range. To test this, we examined two populations in Pennsylvania at the northern edge of its range, and two populations in Virginia closer to the middle of its range. We compared plant size and reproductive output between populations and states. While our results did show variation in reproduction among the four populations, there was no significant difference between states. This research demonstrates that low fruit production may be common in I. verna across its range, not just in edge of range populations. In addition to comparing populations across its range, we expanded upon earlier research by testing for pollinator limitation in Pennsylvania and comparing growth and reproduction in a control-burned site and an unburned site. Hand pollination experiments in 2022 demonstrated marginally greater fruit production in flowers that were hand pollinated versus flowers that were open pollinated, indicating that this population may be pollinator-limited. We found no difference in fruit production, seed production, or plant size between the burned and unburned sites, suggesting that burning did not increase soil nutrient levels enough to cause a difference in reproductive output.

Effects of management timing on the growth, reproduction and the root microbiome of common milkweed (Asclepias syriaca)

Emily Hall, Mount St. Mary's University

Co-Authors: Abby Kula; Eric Sakowski

Common milkweed (Asclepias syrica), is the only resource monarch caterpillars consume and use to lay their eggs, so improving milkweed growth and management will be important to reverse monarch butterfly population decline. Management of milkweed is vital in providing habitats for the monarchs to lay their eggs. Since soil microorganisms influence plant nutrient acquisition and drought tolerance, we are investigating how the root microbiome of common milkweed is impacted by growth management strategies such as mowing. We clipped plants to simulate mowing at three times across the season: early and late June and late July. At each treatment period and once more in late August, we collected plant size and reproductive data. We also collected soil and root samples four times, one day after field data was collected. Plants across the three treatments and unclipped controls did not differ in any of the size measurements before the first treatment application. Plants after the first cut treatment in June were not able to recover their growth and were significantly smaller (stem length, number of leaves, P<0.05) with fewer flower umbels (P<0.05). Stem length of plants clipped in June was intermediate to control plants and July-clipped plants, thereby indicating some regrowth for early cut plants (P<0.0001). Plants clipped in July did not show re-growth potential but the treatments clipped in early and late June did demonstrate re-growth potential with some sprouts forming during July and August. Soil and root microbiome DNA was isolated, and sequence data will reveal the impacts of phenology and management on the microbiome. The microbiome community composition has been demonstrated to impact plant response to environmental changes, and for plants of conservation concern, understanding these impacts may help with conservation and restoration work.

Virginia Sneezeweed Survival and Resilience

Brandon Martinez, Old Dominion University

Virginia sneezeweed is a perennial aster that can be found in the Blue Ridge Mountains area of Virginia in a select few seasonally inundated sinkholes; an extremely unique and narrow habitat range. Since 1998, Virginia Sneezeweed has been listed as a threatened species on the Federal Register. However, a request for a 5-year review was submitted on the 8th of August 2018 to the Federal Register to review Virginia Sneezeweed populations and possibly delist the species. Virginia Sneezeweed collected from Mt. Joy and Lyndhurst Pond (two native Virginia populations) were used in germination experiments to determine the effects of different environments on germination and growth rate. Over the course of one year, the Mt. Joy population was observed and the leaf length of marked individuals were recorded approximately every two months. Population data provided by the Virginia Department of Conservation and Recreation was also used to estimate the current state of the local Virginia Sneezeweed population. The results of the germination experiments currently show a low germination rate while the bi-monthly observations may prove useful for future research. Despite their apparent resilience in their local habitats however, the data provided by the Virginia DCR shows that many Virginia Sneezeweed populations are either in decline or have completely disappeared. Given these results, more data should be collected on Virginia Sneezeweed and more experiments should be performed to explain these phenomena.

Contrasting effects of different types of plant-soil feedback in a theoretical plant competition model

Antonio Golubski, Delaware State University

Co-Authors: Gregory R. Houseman, Wichita State University; Bryan L. Foster, University of Kansas; Lauri Laanisto, Estonian University of Life Sciences

Plants affect the soil in which they grow, which in turn affects the fitness of those plants as well as their competitors. Numerous empirical studies have demonstrated the significance of such plant-soil feedbacks (PSFs) for plant community structure and dynamics, and various models have examined their theoretical implications. However, plants may affect both soil 'biotic' and 'abiotic' properties (e.g., abundances of pathogenic or mutualistic microbes vs. concentrations of nutrients or organic matter). The theoretical implications of PSFs arising from these different types of plant effects are not well explored. We compared the effects of such 'biotic' vs. 'abiotic' PSFs in a spatially-explicit simulation model in which plants coexisted via niche partitioning. In biotic PSF models, plants affected only the fitness of future conspecific occupants of their patch, as if by cultivating specialist pathogens or mutualists; in abiotic PSF models, plants altered patch niche parameters, thereby impacting the fitness of any future occupant of any species. The two types of PSF had similar effects when imposed by a single species, consistent with that species experiencing a supplemental competitive advantage or disadvantage caused by its modification of the environment. However, the two types of PSF had dramatically different consequences when all members of the community imposed them. Biotic PSFs imposed by all species had little consequence, because they essentially acted to boost or depress all competitors uniformly. By contrast, abiotic PSFs dramatically affected competitive outcomes and diversity. This is likely because the progression of environmental change did not require continual occupation by one species, but could be 'handed off' from one species to another as occupancy of a patch shifted. Our results suggest such multi-species environmental modification as a key factor for increasingly complex and mechanistic PSF models to consider.

Ecosystem function usually but not always increases with species diversity: insights from pitcher plant microbial community models

Rafael D'Andrea, Stony Brook University

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The relationship between biodiversity and ecosystem function (BEF) is a core concern of community and ecosystem ecology. A large body of experimental, empirical, and theoretical evidence suggests that species-rich communities can support higher levels of ecosystem functioning. This positive BEF relationship is at the base of conservation efforts recognizing that biodiversity is critical to the maintenance of fundamental ecosystem services. However, more recent work reveals that positive BEF relationships are not universal. Instead, many systems show functional redundancy at relatively low diversity levels, or even in a few instances negative BEF relationships where increased diversity leads to a decrease in function. Despite decades of studies linking diversity and function, we currently lack a clear understanding of why positive or redundant BEF relationships seem more common than negative ones, and what circumstances are likely to lead to a negative BEF relationship. Most empirical work has focused on primary production in terrestrial plants, whereas much less is known about the mineralization and decomposition functions, particularly in aquatic communities.

Here, we develop and explore a mathematical model to investigate the linkages between biodiversity and function in a microbial community of decomposing bacteria colonizing the liquid media inside the modified leaves of pitcher plants. Insects are attracted to and trapped inside newly opened pitcher plant leaves, which are colonized by bacteria capable of breaking down the nitrogenous compounds in the bodies of those insects, producing ammonia as a by-product which is then used by the plant. This is an ideal system for investigating biodiversity-function relationships both empirically and theoretically, as the leaves are self-contained microcosms, microbial diversity can be manipulated via controlled seeded colonization, and their function can be measured as total enzymatic or ammonia production. This system also allows us to study how BEF relationships are affected by cross-feeding, a process wherein bacteria release metabolites in the media which are taken up by other bacteria, and by co-regulation, i.e. conspecific and heterospecific inhibition of function due to the release of downregulating signals to the media. We investigate BEF relationships under different model scenarios of cross-feeding, resource specialization, and co-regulation. We find that most scenarios produce positive or redundant BEF relationships. However, heterospecific co-regulation can cause function to decrease with species diversity. Our results are consistent with the empirical data on the rarity of negative BEF relationships and provide insight into when those negative relationships are expected.

Oral Session 4: Pollution

1:35 - 3:05 PM

Willig - Links between land use and elevated chloride concentration in three Southeastern Pennsylvania streams

Lee - Aquaponic with Scavenging Materials to Support Life Off Earth

Baez - Mitigating the Impact of Scientific Inquiry on Plastic Pollution: Reapproaching Methods for Sampling Aquatic Macroinvertebrates

Horack - Antibiotic-Resistant Gene Expression in Water Quality Indicators, Escherichia coli, and Enterococci, Extracted from the Delaware River Basin

Di Liberto - Full Metal Sparrow: Behavioral Adaptation to Environmental Lead (Pb) Contamination in a Commensal Passerine

Winn - Integrating Community Science and Passive Acoustic Monitoring to investigate the Impact of Helicopter Noise Pollution on Bird Populations of Governors Island, NYC

Links between land use and elevated chloride concentration in three Southeastern Pennsylvania streams

Anna Willig, Willistown Conservation Trust

Co-Author: Lauren McGrath, Willistown Conservation Trust

Relationships between impervious surface cover, forest cover, and salt concentration in streams are well-known, though the dynamics of these relationships vary spatially. This study examines relationships between impervious surfaces, forests, and chloride concentration, an indicator of salt, through high-frequency monitoring of headwater streams in sub-basins of the Delaware River Watershed in Southeastern Pennsylvania. Ten sample sites in the headwaters of Darby, Crum, and Ridley Creeks in Willistown, PA were sampled every four weeks from January 2019 through December 2022 to elucidate water chemistry dynamics. Chloride concentration was analyzed in-lab. Impervious surface cover and forest cover of each catchment was estimated through mapping with GIS and related to chloride concentration to better understand relationships between land use and water chemistry.

During the study period, chloride concentration ranged from 27 to 247 ppm and varied seasonally, with maximum values generally occurring in winter months. Chloride concentration remained above estimated natural background levels throughout the year, indicating contamination of groundwaters and soils. There were significant differences in mean chloride concentration between sites ($p < 0.0001$). In the studied catchments, impervious surface cover ranged from 10% to 21% and forest cover ranged from 19% to 35%. Chloride concentration was significantly positively related to impervious surface cover ($p < 0.001$) and significantly negatively related to forest cover ($p = 0.0012$). These analyses highlight the importance of limiting development and protecting open space especially forested lands to prevent impairments to headwater streams.

Aquaponic with Scavenging Materials to Support Life Off Earth

Jonas Lee, University of the District of Columbia

Co-Authors: Hossain Azam, University of the District of Columbia; Matthew Richardson, University of the District of Columbia; Jose-Luis Izursa, University of Maryland College Park; Davis Rutayisire, University of the District of Columbia; Etochukwu Ofodile, University of the District of Columbia; Christine Hanna, University of the District of Columbia; Cedric Ouiya, University of the District of Columbia

Aquaponic systems can overcome challenges of traditional food production systems in limited space to support life off Earth by efficiently recycling water and providing a consistent supply of protein and other food ingredients. But, recycling of fish and plant waste, ammonium conversion to nitrate for plant uptake, adsorption of water contaminants, and adsorption of volatile organic compounds (VOCs) in closed aquaponics systems are minimally addressed. This project is extensively investigating the roles of six specific scavenging materials (zeolite, activated carbon, silica gel, turface, aerogel, and chitosan) to adsorb certain VOCs and promote nitrification together with water contaminants adsorption in batch and pilot scale aquaponic systems. These scavenging materials have been shown to have relatively high adsorption capacities for water contaminants and are expected to be able to significantly reduce the concentration of contaminants like ammonium (NH4+) in the aquaponic systems while providing a surface for nitrifying bacteria to grow due to their high surface area and porosity. Preliminary batch experiments showed low ammonium adsorption by the scavenging materials, with adsorption capacities of 0.0608 (mg NH4)/(g Silica Gel) for silica gel, 0.06304 (mgNH4)/(g Zeolite) for zeolite,0.0408 (mgNH4)/(g Turface) for turface, and chitosan having no effect on ammonium levels. The scavenging materials could be adsorbing less than expected due to having the wrong functional groups to adsorb the ammonium, which could be changed by chemically treating the materials. Different material characterization tests such as BET surface area analysis, Fourier-transform infrared spectroscopy (FTIR) analysis and Boehm titration are being incorporated to those materials before further pre-treatment (e.g. conditioning zeolite to a cationic form using chloride salts) to improve adsorption capacity, the pretreated materials will be tested in batch again to determine their improved ammonium adsorption capacities and will also be tested with other contaminants such as nickel, silver, and VOCs such as CO2, Benzene, and Methane. Finally, the systems have been designed and scavengers will be implemented into pilot-scale aquaponic systems where water contaminants will be constantly monitored as well as the essential water and air quality parameters will be determined alongside documenting fish and plant growth parameters. Research on the topic of these scavengers and their effects on the systems that they are in can not only benefit aquaponic systems for spaceflight, but also water treatment systems on Earth that require the balancing of various parameters and the removal of contaminants.

Mitigating the Impact of Scientific Inquiry on Plastic Pollution: Reapproaching Methods for Sampling Aquatic Macroinvertebrates

Rafael Baez, New York University

Co-Authors: Robert Ward, Bronx River Alliance; Gaia Rueda Moreno, New York University; Katie Schneider Paolantonio, New York University

This project aims to address environmental plastic pollution during the analysis of freshwater macroinvertebrates through the design and implementation of biodegradable mesh to replace plastic leaf packs conventionally used in surveys. Our study takes place in the Bronx River, NYC. Once heavily polluted, the action of community groups has helped rehabilitate this vital corridor for life. However, the presence of macro and microplastics in this freshwater ecosystem represents a critical threat to the organisms present in and around the river. In fact, a recent pilot study from NYC Baykeeper and NJCU suggests the presence of twice as many microplastic particles as plankton at the mouth of the Bronx River.

Studies of amphibian and macroinvertebrate diversity and genetics, leaf degradation rates and bacterial colonization often utilize leaf packs in their investigations, highlighting the widespread and versatile use of this sampling technique. Here, as per the Stroud protocol, a plastic mesh pack is filled with leaf litter and left submerged for a time period before being retrieved. Unfortunately, due to factors such as inclement weather, shifts in current, water depth, debris accumulation, human error and symptoms of urban stream syndrome, packs are often lost. Usually, this occurrence is offset through redundancy more plastic packs in the water accounting for potential loss. This pack loss contributes to the large-scale plastic pollution within the river as the plastic will eventually break down, introducing microplastic particles to the water. Studies with the intention of examining the structure of a vulnerable system should be conscientious of their contribution to the system's degradation. Steps must be taken to mitigate the impact of scientific inquiry on plastic pollution.

To address this, we tested six biodegradable alternative packs at three locations along the Bronx River between Fall 2022 and Spring 2023 at a site often visited by New York University's (NYU) Ecological Field Methods (EFM) course. We assessed these materials based on criteria including durability, portability, longevity, affordability and effectiveness at collecting invertebrate data compared to the plastic.

Although current research investigates the potential utilization of non-plastic resources in aquatic research, to our knowledge no one is currently investigating this question for leaf pack surveys. A viable biodegradable alternative will be applied in future EFM classes at NYU and shared with organizations like Stroud, encouraging school and research groups to employ sustainable methods. This will foster more environmentally conscious ecosystemic assessments anywhere a plastic mesh would otherwise be used.

Antibiotic-Resistant Gene Expression in Water Quality Indicators, Escherichia coli, and Enterococci, Extracted from the Delaware River Basin

Erin Horack, Penn State Berks University

Co-Author: Vihn Lu, Pennsylvania State University

The Delaware River basin is the water source for over 15 million people and a diverse ecosystem (USGS, 2019). Due to the impact of human activities, pollution within the watershed has increased, which caused microorganisms, such as bacteria, to become antibiotic-resistant. Microorganisms produce antibiotics to inhibit the growth of bacteria; therefore, resistant strains of bacteria may cause aggressive infections. Antibiotic-resistance occurs as bacteria can adapt to the environment when they encounter antibiotics and chemicals, rendering themselves resistant, meaning the bacteria may be able to grow in the presence of antibiotics. Antibiotic-resistant bacteria may encounter antibiotics through the misuse of antibiotics to treat infections, along with improper wastewater treatment for bacteria, which causes antibiotic-resistant bacteria to enter the environment, spreading antibiotic-resistance genes. These genes evolve when bacteria become resistant to other synthetic chemicals with a similar composition to antibiotics, such as fertilizers and pesticides, through a process known as cross-resistance. This study collected monthly water and sediment samples from three locations within the Blue Marsh Watershed, which contributes to the Delaware River Basin, in 2022. Each location had different environmental factors and potentially different pollutants. The downstream site is part of an industrial environment, while the upstream location is part of an agricultural environment, and the lake location is part of a recreational environment. Escherichia coli and Enterococci from the water and sediment samples were isolated via membrane filtration, and antibiotic susceptibility was assessed using Kirby-Bauer methodology. These tests measured the zone of inhibition formed by E.coli and Enterococci around various broad spectrum antibiotics; streptomycin, ampicillin, tetracycline, trimethoprim/sulfamethoxazole, colistin, ciprofloxacin, vancomycin, and erythromycin, which are widely used in a medical setting. Tetracycline and ampicillin resistance in E.coli were the highest at 88% and 85% of all E.coli cultures, respectively. Trimethoprim/sulfamethoxazole and streptomycin resistance were the highest in Enterococci samples at 25% and 24% of all Enterococci cultures, respectively. Additionally, genetic analysis of E.coli and Enterococci extracted from the samples was conducted to find the presence of StrA, StrB, and aadA genes that may contribute to the antibiotic resistance of streptomycin expressed in the Kirby-Bauer analysis. Results from this study illustrated an increased presence of antibiotic-resistance within the Blue Marsh watershed, which may put the public at risk of contracting antibiotic-resistant infections.

Full Metal Sparrow: Behavioral Adaptation to Environmental Lead (Pb) Contamination in a Commensal Passerine

Joseph Di Liberto, College of William and Mary

Chik, Hueng Ying Janet, Macquarie University; Griffith, Simon C., Macquarie University; Swaddle, John P., College of William and Mary

Lead (Pb) is a major anthropogenic pollutant known to cause a variety of deleterious health effects in exposed organisms. In the mining town of Broken Hill, NSW, Australia, a population of House Sparrows (Passer domesticus) that have been established in this heavily contaminated town for 120 years show signs of genetic adaptation to the leaded environment. While recent physiological assessments in the population have also demonstrated resilience by the sparrows to Pb poisoning, an assessment of likely shifts in behavioral responses was yet to be done. In summer 2022, over 600 sparrows were caught across Broken Hill's well-characterized soil and blood Pb gradient, and a series of fitness-associated behavioral assays were conducted (takeoff flight, movement activity, aggression). Despite growing evidence on metal pollutants causing shifts in avian behavior, our assays yielded few connections between Pb levels and behavior among these sparrows. Concurrent work in a US-based, dosing experiment on captive sparrows has found that Pb exposure decreases House Sparrow behavioral performance in our assays, further contextualizing the remarkable resilience seen in the Broken Hill population.

Integrating Community Science and Passive Acoustic Monitoring to investigate the Impact of Helicopter Noise Pollution on Bird Populations of Governors Island, NYC

Leila Winn, New York University

Co-Authors: Gaia Rueda Moreno, NYU; Tae Hong Park, NYU; Katie Schneider Paolantonio, NYU

Urban expansion results in habitat fragmentation (Hedbloom et al. 2019), placing greater strain on existing green spaces (Chang 2017) and removing natural buffers of noise pollution (Wood et al. 2018). In the NYC area, Governors Island is a 172 acre green space in New York Harbor that serves as a natural stopover for migratory birds. Although there is little car traffic on the island, there is significant noise pollution resulting from aircrafts (mostly helicopters), which provides a unique opportunity to study the direct effects of helicopter noise pollution on birds, an area that is lacking in current research (Madden 2020). This study aims to determine if avian responses to helicopter noise are consistent with observed responses to anthropogenic noise (e.g. singing at higher frequencies (Nemeth et al. 2013), and temporal shifts (Cruz et al. 2021)).

Of the 220 species of migratory and non-migratory birds found on GI (NYC Audubon), we monitored six target bird species (3 migratory and 3 year-round species) at nine sites (representing low, medium and high helicopter noise) using a combination of established field methods and passive acoustic technology. In this study, we asked 1) How can we utilize community science to observe avian behavioral changes in response to helicopter noise? and 2) Can deep neural networks be used to expedite pattern recognition when analyzing audio data of birds and helicopters?

To recruit community scientists to aid in our observational data collection, we utilized our working relationship with The Audubon Society, students at New York University, and outreach to the public through social media. After leading six, 20-minute online training sessions, the work of the community science component resulted in 146 observations of the nine GI field sites entered through Arc123 surveys. Audiomoth sensors were placed at these sites and gathered over 237 hours of recordings. These files will be processed with the Seasound Tool (in Matlab) to rapidly extract helicopter, airplane, and bird call sounds to expedite the identification process. This program will also train a deep neural network using bird call data to rapidly analyze pitch and frequency of calls.

This study provides a unique mixture of community engagement, computer science, and field methods to examine an understudied facet of noise pollution. The results give insight into this urban ecological effect, while providing a methodological framework for future research. It also promotes the empowerment of communities to investigate their ecosystems, especially in cities.

Oral Session 5: Invasion Ecology

3:30 – 5:00 PM

Senthilnathan - Does plant-soil feedback promote coexistence or competitive exclusion?

Grant - Lepidopteran Megadiversity at the Uyuca Biosphere Reserve in Honduras: Zamorano University at the Nexus of Biodiversity Conservation and Sustainable Development

Poddar - Rule followers or rule breakers? Successional assembly of native and exotic plants

Diedrich - Non-native plant abundance and composition varies across urban forest soil seed banks

LeClair - Spotted lanternfly use of and performance on native forest trees

Anderson - When to scout: Integrating community science, invasion phase, and volunteer effort to leverage spatial data collection for adaptive management of invasive species

Does plant-soil feedback promote coexistence or competitive exclusion?

Athmanathan Senthilnathan, Stony Brook University

Co-Author: Rafael D'Andrea, Stony Brook University

Predicting when species can coexist and what processes affect coexistence are foundational questions in ecology. Plant ecologists primarily focus on competition as a mechanism to understand coexistence. Among other relevant ecological processes, plant-soil feedback is recently being considered to play an outsize role. This is due to the recognition that most plants condition the soil by accumulating microbial mutualists and pathogens, and by modifying soil stoichiometry. Theory and empirical evidence suggest that only negative plant-soil feedback---when plants condition soil to their own detriment, can allow coexistence. By contrast, under positive plant-soil feedback---when plants favorably condition the soil, the most abundant species dominates the conditioning process and can drive the other species extinct. However, the effects of plant-soil feedback when acting in concert with competition are not currently understood. In particular, the conditions under which soil conditioning promotes or undermines coexistence among competing plants have not been explored. To address this, we propose a trait-based plant-soil feedback model in which plants condition the soil to match its trait (soil preference) to which we add competitive interactions. Using the model, we contrast the coexistence conditions when plants condition the soil against coexistence conditions when they do not.

We find that positive plant-soil feedback among species with similar soil preference promote coexistence by conditioning harsh soil to be mutually beneficial to both. This is akin to legumes persisting in infertile soil by forming mutualisms with nitrogen fixing bacteria: the weaker competitor avoids competitive exclusion by taking advantage of the improved soil condition. On the other hand, when plants have dissimilar soil preference, positive plant-soil feedbacks provide an additional advantage to the stronger competitor, which becomes dominant. This drives the less abundant species extinct even though they could coexist if those species did not condition the soil. Overall, plant-soil feedback will favor coexistence when species have similar soil preference, and cause competitive exclusion when species have dissimilar soil preference. We also connect these results to modern coexistence theory, which says that fitness differences should be smaller than niche differences for two species to coexist. Since species with similar soil preferences will always have a small fitness difference, they are more likely to coexist due to plant-soil feedback. Finally, by adding more species to our model, we can move beyond pairwise coexistence and explain the effects of plant-soil feedback on trait structure and spatial abundance patterns.

Lepidopteran Megadiversity at the Uyuca Biosphere Reserve in Honduras: Zamorano University at the Nexus of Biodiversity Conservation and Sustainable Development

Bruce Grant, Widener University

Co-Authors: Julianna Munoz-Hackett, Widener University; Emily Mills, Widener University; Maura Kopaczynski, Widener University; Owen Price, Widener University; Joshua MacPherson, Widener University; Lily Kelleher, Widener University Faculty sponsors: Eric Van Den Berghe, Zamorano University; Bruce W. Grant, Widener University

We report on our findings during a 12 day trip (spanning our spring break, March 2023) to explore the unique and amazing biodiversity of the Uyuca Biosphere Preserve, Zamorano University, Honduras, which is a tropical cloud forest in east-central Honduras and is an internationally recognized biodiversity "hot-spot". We conducted original biodiversity research on nocturnal Lepidoptera in the heart of the Uyuca cloud forest in close collaboration with Faculty and students at Zamorano University. This represents an ongoing collaboration between Zamorano & Widener University for over a decade. During our trip, we photographed and uploaded hundreds of observations to iNaturalist, and we collected, pinned, and prepared hundreds of specimens for permanent accession at the Zamorano University Entomology Lab and at the Academy of Natural Sciences in Philadelphia. Our trip was book-ended by stays on Zamorano's main campus where we learned from the amazing and culturally diverse community at Zamorano about their dedication and action to promote biodiversity conservation and sustainable development in Honduras and throughout Latin America. In addition to reporting on some of the basic natural history features of Uyuca (including its charismatic endemic fauna), our presentation will summarize our preliminary photographic and collection results (family-level summaries, and unique species identified).

Rule followers or rule breakers? Successional assembly of native and exotic plants

Urmi Poddar, Stony Brook University

Invasive species are a well-known conservation issue, but the rules governing their establishment into resident communities are not well-understood. In particular, the question of whether introduced species in a community follow the same assembly rules as native species has not yet been answered. Some have suggested that native and introduced species do follow the same assembly rules (parallel dynamics hypothesis). Others believe that introduced species do not follow the rules (differential performance hypothesis) and assemble through processes different from the ones determining native composition. Successional studies are particularly useful for testing these hypotheses, as they allow one to view community assembly in action. They also put all species on an equal footing in terms of initial abundance and rarity, since all species must start out as colonizers in succession. This is unlike established communities, where established native residents have an initial advantage over newly-arrived invaders. Therefore, we tested these two above-mentioned hypotheses using long-term data from 50+ years of old field vegetation succession. We used a combination of taxonomic composition-based approaches (such as rate of change in composition) and functional composition-based approaches (such as trends in community-weighted means and trait-abundance relationships). We also accounted for species pool differences, which are expected due to the differential evolutionary and dispersal history of native and introduced species. We found both similarities and differences in the assembly of native and introduced assemblages. On one hand, native and introduced species showed similar rates of change in taxonomic composition and similar trends in spatial beta diversity, indicating similar succession rates. They also showed similar responses to trait-based filtering on maximum height and seed mass, with increasing selection for taller and larger seeded species in late succession. But, the responses of introduced species were somewhat limited by species pool differences. On the other hand, the two groups differed in their responses to trait-based filtering on specific leaf area. These results suggest that both parallel dynamics and differential performance act in concert, allowing some exotic species to become unexpectedly dominant or rare, while others coexist with native species. Based on these results we expect tall, large-seeded exotic species to become particularly invasive in this site in future. Thus, our approach can also be used for predicting future local-scale invasions.

Non-native plant abundance and composition varies across urban forest soil seed banks

Jack Diedrich, University of Delaware

Co-Authors: Tara Trammell, University of Delaware; Vince D'Amico, U.S. Forest Service

Soil seed banks are living reservoirs that structure plant communities across both space and time in urban forest ecosystems. While a large body of literature exists on the dynamics and composition of soil seed banks in temperate deciduous forests, relatively little is known about soil seed banks in urban forested natural areas within these same regions. Urban forests are generally considered to have a greater amount of non-native and invasive species, especially in their understories, than their rural counterparts. To what extent this aboveground invasion can be explained by recruitment from the seed bank is not well understood. Previous studies have restricted analyses to urban forest seed banks of single cities or single spatial scales. A better understanding of how non-native composition in the seed bank varies across cities and urban forest gradients will allow us to more successfully prioritize interventions for restoration.

To survey seed bank composition, we collected soil samples from 25 urban forests across five east coast cities between North Carolina and Massachusetts. We took five soil cores from each urban forest and conducted seedling emergence trials from these samples in greenhouses at the University of Delaware. Throughout the 2022 growing season, all emergents from soil samples were counted and identified to species.

We observed averages greater than 50% non-native emergents in six of the 25 forests included in our study, while an additional five forests had averages above 25%. While the most invaded seed banks occurred in Philadelphia and Baltimore, models suggests that non-native plant abundance in the seed bank varies most at the forest-level, rather than at city or within-forest levels. Our results suggest that non-native seeds are a major component of many urban forest seed banks but vary widely across the spectrum of urban forest gradients observed in our study. While this may mean that the seed bank may be a prominent pathway for invasives to become established in urban forests, the success of these species will likely be a product of both their competitive ability and forest disturbance events.

Spotted lanternfly use of and performance on native forest trees

Chris LeClair, Temple University

Co-Authors: Brent J. Sewall, Temple University; Joshua Caplan, Temple University; Sasha Eisenman, Temple University; Mark T. Swartz, Pennsylvania Department of Military and Veterans Affairs; Matthew Banks, Pennsylvania Department of Military and Veterans Affairs; Daniel Taratut, Commonwealth University of Pennsylvania; Jack Collins, Temple University; Lindsey Hoover, Temple University; Amy L. Freestone, Temple University

Since the introduction of the spotted lanternfly (SLF, Lycorma delicatula) to Pennsylvania from its native range in Asia in 2014, this leafhopper insect has expanded its range to encompass a large portion of the Mid-Atlantic. Prior research has documented SLF presence on diverse plant host species, including invasive plants and agricultural crops. In this study, we assessed SLF use of and performance on a diverse set of native tree species and on the tree of heaven (Ailanthus altissima), which is an invasive tree in North America and a plant host for SLFs in their native range. Field research was undertaken at the Temple Ambler Field Station (outside of Philadelphia, Pennsylvania) from late spring to early fall in 2021 and 2022. To evaluate tree use by SLFs, we visually surveyed their abundance on fifteen tree species (14 natives and tree of heaven). At five of these species (tree of heaven, northern red oak Quercus rubra, red maple Acer rubrum, black cherry Prunus serotina, and black gum Nyssa sylvatica), we also captured SLFs in circle traps as an alternate measure of tree use. Numbers of SLFs at each developmental stage were recorded at regular intervals on trees and in traps throughout the season. At the same five tree species, we also conducted a no-choice experiment, enclosing captive SLFs in mesh sleeves on branches of focal trees and tracking SLF survival over time. We found that SLFs were more abundant and had lower mortality on tree of heaven than any of the native species we observed. Preferences for tree of heaven by SLF were especially pronounced on larger trees and during the early adult stage. These findings suggest that while SLFs used a diversity of native tree species, tree of heaven was most used and most beneficial for SLFs. Thus, control of populations of this invasive tree species may be highly effective in reducing the abundance of SLFs, and could limit the effect of SLFs on native forests. Among the native trees, SLFs were the most abundant and had the lowest mortality rate on red maples. Thus, special conservation attention should be paid to red maples, an economically important tree that is common both in native forests and human-dominated landscapes across the mid-Atlantic.

When to scout: Integrating community science, invasion phase, and volunteer effort to leverage spatial data collection for adaptive management of invasive species

Kristie Lane Anderson, Longwood Gardens

Co-Authors: Lea Johnson, Longwood Gardens; Joe Thomas, Longwood Gardens; Evan Horne, University of Vermont

Non-native invasive plants are a major challenge to biodiversity. Protecting and restoring native communities under invasive plant pressure requires species-specific approaches to invasive species management, including attention to timing of plant life cycles and management action prioritization. Mapping invasive species populations is key to management planning, but staffing for field observation is often in short supply. Volunteers can provide important support to land management organizations but may lack advanced skill in plant identification necessary to assist with invasive species mapping. To test whether volunteers could produce actionable information if provided with optimal observation times based on highly visible key identifying features, we used community science data from iNaturalist to develop a calendar of phenology of key identifying features (e.g. early spring leaf-out of Rosa multiflora) for 75 invasive species of the U.S. Mid-Atlantic region, developed a mapping application for use on smart phones, and created and implemented tutorials for volunteers.

Volunteers were able to rapidly identify focal invasive species using phenological cues. Review of initial mapping revealed a tendency for volunteers to map either broadly (designating a large area as containing a species) or granularly (mapping individual plants). To address this variability, we categorized species according to management priority by invasion phase (prevention, eradication, containment, or long-term management) and specified mapping granularity based on priority phase (e.g. mapping all individuals of recently arrived species that might be eradicated from the site, while mapping population boundaries of widespread species). Once creation of the key feature phenology table and tutorials was complete, staff time investment decreased to occasional maintenance of the table and weekly communication with volunteers. Mapped populations are now being integrated with management planning and used in concert with a complementary project identifying optimal treatment phenology to focus invasive species management effort.

Oral Session 6: Vertebrates

3:30 – 5:00 PM

Keller - The importance of patch shape at threshold occupancy: Functional patch size within total habitat amount

Rudge - Full Annual Cycle Grassland Bird Assessment in Harpers Ferry NHP, WV

Spence - Is Diversity Dammed? Analysis of Fish Diversity in Dammed and Undammed Estuary Streams within the Virginia Peninsula Using Environmental DNA (eDNA)

Revenis - Tall glacially deposited boulders provide a refuge from browsing and reveal a legacy of over-browsing in an old-growth forest in the Upper Peninsula of Michigan

Vulinec - Bat Activity in a Puerto Rican Coastal Landscape

Lynch - Disentangling Directed Dispersal: Seed Traits and Squirrel Caching Decisions

The importance of patch shape at threshold occupancy: Functional patch size within total habitat amount

Jeff Keller, HABITAT by DESIGN

Co-Author: Patrick J. Sullivan, Cornell University

The habitat amount hypothesis (HAH) stresses the importance of total patch amount over the size of individual patches in determining species richness within a local landscape. However, the absence of some species from patches too small to contain a territory would be inconsistent with the HAH and would underscore the importance to conservation of understanding composition and natural history of assemblage members, not simply richness. Using the association of territory size with body size and the circle as optimal territory shape, we tested several HAH predictions of threshold patch occupancy and richness of 19 guilds of primarily insectivorous breeding birds. We characterized 16 guild-associated patch types at high spatial resolution and assigned one type to each guild. We measured functional patch size as the largest circle that fit within each patch type occurring in a local landscape. Functional patch size was the sole or primary (i.e., explained the largest proportion of variance) predictor in regression models of species richness for 14 of the 19 guilds. Total patch amount was the sole or primary variable in only 3 models. Quantifying patch size at high resolution also demonstrated that breeding birds should be absent from patches that are too small to contain a single territory and larger species should occur only in larger patches. Functional patch size is a readily interpretable metric that helps explain the habitat basis for differences in species composition and richness between areas. It provides a tool to assess the combined effects of patch size, shape and perforation on threshold habitat availability, and in combination with total patch amount can inform design and/or evaluation of conservation, restoration or enhancement options for focal taxa or biodiversity in general.

Full Annual Cycle Grassland Bird Assessment in Harpers Ferry NHP, WV

Leah Rudge, University of Delaware

In the mid-Atlantic, National Battlefield Parks provide habitat for grassland birds and an opportunity for grassland bird management and conservation. Harpers Ferry National Historical Park supports 165 ha of hayfields situated in a mosaic of forest patches, hiking trails, and roads. The National Park Service is currently undertaking a planning process to determine how best to manage grassland habitats for biodiversity across the full annual cycle. In 2022, we conducted distance sampling surveys during spring and fall migration and monitored nesting success during the breeding season to inform future grassland management plans. In spring and fall migration we calculated occupancy and abundance for grassland obligate species. In the breeding season we monitored 15 Eastern Meadowlark (Sturnella magna) and six Grasshopper Sparrow (Ammodramus savannarum) nests. We determined that Eastern Meadowlark nests (p<0.05) and Grasshopper Sparrow nests (p<0.05) were further from the forest edge than random locations. We estimated daily nest survival and the effects of distance to forest edges, trails, and roads on nest survival. Eastern Meadowlark nest survival (0.99 +/-0.01) was negatively associated with distance to forest edge. Our results support the importance of cultural parks in maintaining grassland bird breeding habitat in the mid-Atlantic.

Is Diversity Dammed? Analysis of Fish Diversity in Dammed and Undammed Estuary Streams within the Virginia Peninsula Using Environmental DNA (eDNA)

Melinda Spence, William & Mary

Co-Author: James Skelton, College of William and Mary

Anthropogenic activities are the leading cause to biodiversity decline worldwide. It has been well documented that large dams disrupt dispersal and alter local habitat often leading to less diverse aquatic systems. Yet, it is not well known how much more numerous smaller dams impact fish communities in estuary systems where dispersal is a critical part of the ecosystem. Here we used eDNA (environmental DNA) to assess the alpha, betta, and gamma diversity of fish species within the Virginia Peninsula in the lower Chesapeake Bay to compare diversity between sites with an undammed connection to the estuary to diversity within dammed sites. More than 500 2-Liter samples of water were collected from 35 total sites, 16 undammed creeks and 19 dams. We hypothesized that dams cause a local decrease in fish species richness by degrading local habitat and reduce dispersal by creating barriers. 75 species of fish were documented. Linear regression analysis showed undammed sites had significantly higher alpha diversity by about 10 species per site compared to dammed sites, meaning more species were found in undammed sites. We hypothesized that community composition (beta diversity) of the fish communities between dammed sites and undammed sites would be different due to limitations on dispersal and disconnection from the regional network. Beta dispersion testing showed undammed sites have higher variability in species from site to site. We hypothesized that beta diversity between dammed sites would be low due to biotic homogenization (i.e., all dam ponds species compositions are similar due to similar habitat characteristics of dam ponds). Dammed sites showed similar species composition when compared to one another. Gamma diversity across the landscape showed a lower average of species within dammed sites compared to the average of species within undammed sites. These results suggest that even small dams can disrupt dispersal in estuary networks leading to decreased local diversity within areas of the estuary that would otherwise be connected to the estuary.

Tall glacially deposited boulders provide a refuge from browsing and reveal a legacy of over-browsing in an old-growth forest in the Upper Peninsula of Michigan

Gillian Revenis, Chatham University

Co-Authors: Ryan Utz, Chatham University; Rose-Marie Muzika, Carnegie Museum of Natural History; Thomas P. Diggins, Youngstown State University; Walter P. Carson, University of Pittsburgh

Overabundant white-tailed deer (Odocoileus virginianus) cause substantial declines in the biodiversity of North American temperate deciduous forests, often resulting in depauperate understories and extirpations of browse-sensitive species. Natural barriers, such as treefall tip-up mounds, rocky terrain, and steep slopes, may serve as browsing refugia, thus allowing populations of vulnerable species to persist. We estimated the cover of all species over six years on the top of ten large boulders, within adjacent fenced exclosures, and in adjacent control plots in an old-growth forest in the Upper Peninsula of Michigan. We tested the hypothesis that boulders would have higher species cover, richness, and diversity than control plots. We also predicted that the cover and diversity of plant species inside exclosures would be intermediate between that on top of boulders and control plots. Boulder tops had significantly higher plant diversity and species richness compared to both inside exclosures and control plots. Multiple browse-sensitive species were much more abundant on boulders, including, Sambuscus pubens, Ribes cynosbati, Acer spacitum, Acer pensylvanicum, and Streptopus roseus,. Within exclosure and control plots, species such as Acer saccharum, Aralia nudicaulis, Dryopteris intermedia, and Rubus parviflorus, were dominant, suggesting that browsing created a community composed primarily of browse-tolerant or unpalatable species. Our study demonstrates the importance of refugia in preserving plant diversity in habitats impacted by the ghost of herbivory past, and may have long-term delays in the recovery of browse-sensitive plant species using exclosures alone.

Bat Activity in a Puerto Rican Coastal Landscape

Kevina Vulinec, Delaware State University

Co-Author: Luis Sanoguet Rodriguez, Delaware State University

Coastal lands have been under threat for years due to overdevelopment and newly recognized threats from sea level rise and climate change. As the habitat changes, the accompanying fauna will also change, potentially suddenly and disastrously for certain rare or habitat-restricted species. Bats are mobile and adaptable to several habitat types. Changes in bat community structure or the loss of particular species may be a reality in highly disturbed coastal zones. On islands, these changes may be dramatic given the ratio of coastline to inland habitats compared to mainland regions. Puerto Rico has a substantial bat fauna although like most islands, is depauparate in species numbers. Using recorded calls, we assessed differences in insectivorous bat abundance and community structure across environmental gradients and land use (coastal-developed-forested) and elevation gradients across the Southwestern part of the island. Our main question was: Does habitat (proximity of the coast, amount of development, habitat type, elevation) change species composition and level of activity?

In Cabo Rojo and environs, we recorded 66 unit-days of bat calls. Through analysis of these recordings and through mistnetting, we found five species (of the 13 found on Puerto Rico): Noctilio leporinus (Fishing Bat), Pternotus parnellii (Parnell's Mustached Bat), Pternotus quadridens (Sooty Mustached Bat), Lasiurus borealis (Eastern Red Bat), and Molossus molossus (Velvety Free-tailed Bat). The average number of bat calls/night was significantly different among sites. We recorded Eastern Red Bats predominantly around mangroves, yet the Velvety Free-tailed Bat was the most common bat in the mangrove habitat. At an inland shallow lake, the most common bat is the Sooty Mustached Bat, followed by Parnell's Mustached Bat. This locality also had the most bat activity. The mangrove islands and the mountains had fewer calls per night, but there was still considerable (> 100 calls per night) activity in some sites. Because so little is known about the numbers and status of Puerto Rico's bats, this project represents an important step in increasing our knowledge base. Further work that would be important to bat conservation on the island includes determining the status of bats at wind farms and in the rainforests. In addition, resampling our sites after both hurricanes and the recent earthquakes is paramount to determine the effects of natural disasters on bats.

Disentangling Directed Dispersal: Seed Traits and Squirrel Caching Decisions

Patrick Lynch, College of William and Mary

Co-Author: Harmony J Dalgleish, College of William and Mary

Nearly half of plant species globally rely on animals to disperse their seeds. However, the complex and sometimes obscure factors which drive the interaction between trees and seed dispersers are still not fully understood. The eastern gray squirrel (Sciurus carolinensis) is one such important disperser in the temperate, deciduous forests of North America. Previous research has shown that squirrels preferentially cache larger, higher value seeds further from the parent tree. Additionally, to minimize conspecific pilferage, squirrels may cache higher value seeds in more open locations where the risk of pilferage by other squirrels is low because the risk of predation is higher. Tree species with seeds that have higher value to squirrels may be more likely to be cached in such risky, open locations. We hypothesize that this behavior by squirrels has provided a selective pressure on trees such that seeds with traits that are more valuable to squirrels will have seedlings that are less tolerant of shaded conditions. Following the stress-tolerance hypothesis, shade tolerant plants are characterized by fewer, thicker leaves to resist predation where-as light demanding plants favor higher leaf area to maximize light interception.

To determine the relationship between seed value and seedling shade tolerance we grew 9 species of broadleaf trees in the William and Mary greenhouse during the Summer of 2022 under three shade treatments (2%, 20%, and 100% sunlight). Shade tolerance was determined by measuring morphological responses such as leaf area ratio (LAR) , leaf mass area (LMA), leaf mass fraction (LMF), stem mass fraction (SMF) and root mass fraction (RMF). Principle component analysis of these responses across harvests and treatments generally showed a division of root:shoot allocation along the first axis and leaf thickness/leaf area on the second. The first two axes of our final full sun harvest explained 61% and 22% of variation, respectively. Supporting the stress-tolerance hypothesis, we found an association on the second axis of shade tolerance with thicker leaves (high LMA) and, conversely, light demanding leaves with higher LAR. A linear regression of this axis against seed mass showed a significant negative relationship between mass and shade tolerance ($P < 0.005$, $r2 = 0.30$) supporting our hypothesis that seeds with higher value to squirrel have seedlings that are less tolerant of shade.

Oral Session 7: Managed & Agricultural

3:30 – 5:00 PM

Beidler - Exploring the interactions between herbivory and resource augmentations on forest herbaceous communities

Kelly - A tale of two forests: comparing primary and post-agricultural forest conditions in northern NJ

Randall - Impacts of nitrogen-fixing rhizobia on resistance to herbivory and drought stress in soybean

Pouyat - Developing Soil Best Management Practices for Climate Resilience in Urban Landscapes

Arnold - Triple Yield System: Combining Sustainable Agriculture and Rainwater Harvesting with Solar Energy Generation for Next Generation Urban Farming Practices

Jameson - More runners choose Honeoye, bigger strawberries choose San Andreas, faster fruit choose hydroponics.

Exploring the interactions between herbivory and resource augmentations on forest herbaceous communities

Jacob Beidler, Lebanon Valley College

Over the last few centuries, herbaceous plant communities have been facing consistent pressures as a result of anthropogenic activities (i.e., habitat loss and fragmentation, frequent introductions of exotic diseases, pests, and competitor species). These widespread disturbances have resulted in increased extinction rates of several native plant species. The main purpose of this study was to explore three of the primary drivers that impact herbaceous community structure; those being deer herbivory, light availability, and competition from invasive species. These drivers, as well as the interactions between these drivers, were examined for their impacts on native herbaceous community diversity and structure, and as to whether the life cycle of an organism lessened or further exasperated these impacts. Within a mature, Oak-Hickory woodlot, eight 20 x 20 m experimental plots were constructed with the intent to represent all possible combinations of the primary drivers focused on in this study. The native herbaceous communities within each plot were assessed via annual observations for species presence and abundance across each experimental plot. The current results are the product of five years of observations, and they seem to suggest that differing combinations of deer, light, and invasives do indeed have a differential impact on influencing plot diversity. Invasive species presence was found in all cases to have a significant negative effect on how diversity and community structure changed over the course of 5 years. The results also seem to suggest that unlike in woody plant communitiesdeer is not a as substantial a driver of diversity and structural change in herbaceous plant communities.

A tale of two forests: comparing primary and post-agricultural forest conditions in northern NJ

Jay Kelly, Raritan Valley Community College

Co-Author: Jessica Ray, Raritan Valley Community College

We studied the changes in forest conditions resulting from agricultural land use history in northern New Jersey, documenting the spatial extent of forest change based on historical forest maps from the late 1800s, aerial imagery and other sources. We also collected measurements from 72 forest stands to compare the vegetation structure, canopy composition and soil conditions in post-agricultural forests relative to adjacent primary forests with no such agricultural history. Although forest cover increased 25% since the late 1800s overall, we found a 26% decline in primary forest cover during that time, and post-agricultural forest types now comprise at least 46% of present-day forest cover. Forest vegetation and soils were dramatically different in the two forest types, with significant increases in invasive shrub and liana cover in post-ag forests, lower levels of tree regeneration, and major shifts in canopy composition. Soil conditions differed across two-thirds of the variables studied, with post ag forests having higher pH and associated base mineral concentrations (Ca, Mg), lower nutrients (NH4, %N), cation exchange capacity, and organic content (%C, % organic matter), and changes in soil texture (lower % sand, higher % silt and clay). We found few to no relationships between these changes and geology/soil types, topography, forest age, area or distance to edge, indicating the robustness of these changes across a wide variety of environmental contexts. These results underscore the importance for recognizing land use history as a driver of forest conditions and for distinguishing between these major forest types in the future in order to better inform ongoing efforts to preserve, manage and restore forests in the region.

Impacts of nitrogen-fixing rhizobia on resistance to herbivory and drought stress in soybean

Brendan Randall, University of Maryland

Co-Authors: Kim Komatsu, University of North Carolina-Greensboro; John Parker, Smithsonian Environmental Research Center; Kelsey McGurrin, University of Maryland; Sarah Alley, Smithsonian Environmental Research Center; Karin Burghardt, University of Maryland

Increasing variability in field conditions, and its subsequent effects on insect pest complexes, poses a significant challenge for crop management strategies in agricultural systems. Rhizobia bacteria are facultative legume mutualists that infect the roots of their host plant and form root nodules. From these nodules, rhizobia fix atmospheric nitrogen (N2) into plant-available ammonia (NH3) utilized for plant growth. This study aimed to test the role of bacterial mutualists in driving resilience and stability of ecosystem functioning in soybean cropping systems. In addition, we tested the hypothesis that altering the nodulating rhizobia community will directly impact soybean yield through increased N availability and indirectly mediate plant trait responses to herbivore and drought stress. In a greenhouse, we manipulated the soil rhizobial community under drought and well-watered conditions using 24 unique rhizobia strains collected from field soils along an environmental and regional gradient in Maryland. We predicted that herbivores on ambient watered plants will have higher growth rates and herbivory but that rhizobia strain identity would mediate this effect across ambient and drought conditions. We also predicted that plants would express higher levels of resistance traits (trichome density) on ambient watered plants, but that rhizobia strain identity would mediate this effect across ambient and drought conditions. We performed greenhouse feeding assays in which we reared the generalist legume pest, Chrysodeixis includens, on a commercial soybean variety. We quantified herbivore damage on soybean foliage, herbivore growth rates, root nodulation, and plant fitness traits throughout the vegetative stages of soybean when soybeans are generally most susceptible to pest damage that impacts yield. Plants inoculated with rhizobia had higher trichome density relative to plants not inoculated with rhizobia or grown under drought conditions. In addition, there was a trend towards higher caterpillar growth rates in plants grown under ambient conditions. However, we found a significant interaction effect of watering treatment and strain identity on caterpillar growth rates, indicating that specific rhizobia strains play an active role in mediating herbivore feeding behavior. We propose that understanding how soil microbial communities mediate plant-insect interactions under variable environmental conditions offers novel insight into how management strategies can promote the stability of soybean yields. Future work will address the effects of rhizobia strain diversity in mediating soybean-rhizobial interactions. In particular, we will examine the functional role of rhizobia diversity as a buffer against leaf-chewing herbivory and drought stress in greenhouse and field settings.

Developing Soil Best Management Practices for Climate Resilience in Urban Landscapes

Richard Pouyat, USDA Forest Service (Retired)

Co-Authors: Dustin Herrmann, TreePeople; Mary Hillemeier, TreePeople; Susan D. Day, University of British Columbia; Yujuan Chen, Tennessee State University; Lia Soorenian, TreePeople

Historically, urban communities have failed to sustainably manage the health of their soil. This oversight has resulted in a loss of an array of ecosystem services, urban forest health, and climate resilience that would otherwise be available to these communities through relatively simple soil health improvement strategies. Additionally, with the expected changes in climate and other environmental stressors, the traditional focus on expanding or enhancing existing built infrastructure needs to be balanced with investments in nature-based solutions, which are now underway in many cities. But nature-based solutions to infrastructure needs, or green infrastructure, require the restoration and maintenance of healthy urban soil, or brown infrastructure. Essentially, green infrastructure and urban forests in general, can never realize their full potential without the support of a healthy soil system.

Thoughtfully selected soil management practices relevant to a given context are key to maintaining and restoring soil health in the urban landscape. But soils and their urban contexts are complex, making broad scale interventions to improve soil health challenging. We present a strategy for using urban soil best management practices (BMPs) to create soil interventions that are tailored to specific contexts. An urban soil BMP is a documented effective and pragmatic means of promoting urban soil health. BMPs can be either short or long-term in realizing their impact, and they are designed to be cost efficient, simple as possible to implement, while also effective and environmentally sound. Practitioners should approach urban soil management as guiding a regenerative process intended to influence naturally occurring soil building processes that over time will yield more healthy urban forests that have greater resilience to climate change and urban impacts.

We present a set of resources or tools for soil and urban forest practitioners, communities, and municipalities to utilize BMPs in service of optimizing urban soil health and the development of nature based infrastructure. These include 1) an adaptive loop process for situating the iterative use of urban soil BMPs into governance systems and 2) a decision matrix to guide users to categories of BMPs based on their goals. Additionally, we will provide an overview of existing urban soil BMPs, including case studies showing their applicability to urban communities.

Triple Yield System: Combining Sustainable Agriculture and Rainwater Harvesting with Solar Energy Generation for Next Generation Urban Farming Practices

Annabelle Arnold, University of the District of Columbia

Co-Authors: Hossain M Azam, University of the District of Columbia; Mamatha Hanumappa, University of the District of Columbia; Nazia Nowshin, University of the District of Columbia; Kibria Roman, State University of New York; Harris Trobman, Montgomery County Public Schools

Urbanization and population growth are building resource strain while urban development and climate change are impacting environmental resiliency and complicating resource production. Agriculture is the largest consumer of freshwater resources and uses over 25% of the energy expended globally. Urban and peri-urban agricultural production is being threatened by competition over land use, increasing profitability of solar farming, and rising demand for renewable energy farming in urban areas The food-energy-water nexus concept brings awareness to the relationships between food security, energy security, and water security and calls for integrated production. Integrating production can protect ecosystems and ensure sustainable synergy. The implementation of such innovative agricultural systems can help build community and environmental resiliencies. As a solution, University of D.C. researchers have developed a triple yield (food, water and energy) system that incorporates solar panels and cisterns into an agricultural system to capture energy and water while producing high-value specialty crops in protected microclimates. This innovative system is economically and environmentally self-sustained and has the potential to be energy neutral or positive. Constructed at Firebird Farm on a half-acre site, this system includes four treatment groups, each with six replicate plots: 30° solar panels, 45° solar panels, 60° solar panels, and no solar panels. We hypothesize that such a system is feasible in urban areas by using solar energy to pump water for drip irrigation and cisterns to collect rainwater from the panel surfaces. A range of crops have been grown in the system, predominantly leafy greens, including arugula, collard greens, kale, mustard greens, spinach, and swiss chard. Current field scale experiments determine overall productivity with respect to the different treatments. Ongoing data collections include plant size and health, solar energy collection in kWh/m2, and rainwater collection quantity. Preliminary results indicate that crops grown beneath solar panels were on average 40% taller, 124% heavier, had 36% more leaves and 112% higher leaf area than crops grown without solar panels present. Additionally, that the crops grow best beneath the panels, particularly the 30° and 45° solar panels, and that the 30° solar panels capture the most solar energy and rainwater. More specific findings to be shared at the conference. Thus, our research is generating recommendations for a novel food-energy-water system that can increase farmer income, improve agricultural and eco-engineering integration knowledge, and reduce land competition while aiding in meeting growing resource demand.

More runners choose Honeoye, bigger strawberries choose San Andreas, faster fruit choose hydroponics

Austin Jameson, Old Dominion University

Co-Author: Lisa Horth, Old Dominion University

The rapid rate of human population growth, combined with the effects of climate change, and decreasing yield per acre on farmland, mandate that we find new ways to produce food now. Globally, hydroponic production of crops is increasing rapidly, with an estimated valuation of ~ USD 53 billion annually, by 2027. The vast majority of hydroponic food production is leafy greens. The major reasons for this are that leafy greens grow rapidly and do not require pollination. However, fruits often require pollination, and out-crossing increases fruit size. Berries are highly nutritious and fiber-rich. Strawberries are the second most valuable non-citrus fruit in the USA, with an annual value of USD 3.4 billion in 2021. We grew 150 strawberry plants (30 plants/ variety) using a hydroponic (soilless) nutrient film technique system. Additionally, 80 plants (20 plants/ variety) were grown in soil. We compared hydroponic berry traits (weight, sucrose, firmness, and runner production) for five berry varieties. We also compared time to first ripe fruit in hydroponics relative to soil, for four berry varieties. In hydroponics, San Andreas (SAN) produced larger berries (xl„=6.60g, CI=5.45-7.66) than all other varieties (DAR xl„=4.12g, CI=3.19-5.05; WEN xl„=4.06g, CI=3.39-4.74; HON xl„=3.47g, CI=3.10-3.84; and FLA xl„= 3.54g, CI=2.66-4.41). San Andreas were also firmer (xl„=346.81g CI=285.53-408.18) than other varieties (DAR xl„=155.82g, CI=144.53-167.11; WEN xl„=159.72g, CI=140.34-179.10; HON xl„=151.87g, CI=129.70-174.03; and FLA xl„=166.55g, CI=149.45-183.65). However, Honeoye (HON) produced more runners (xl„=12.50, CI=8.98-16.02) than three varieties (SAN xl„=5.79, CI=3.93-7.65; WEN xl„=5.30, CI=3.50-7.11; and DAR xl„=4.48, CI=2.13-6.83). Time to first ripe fruit was 11 days shorter in hydroponics relative to soil production for the four varieties tested (DAR, WEN, FLA, and HON). We conducted our study using hydroponic growing techniques that farmers employ. Our work warrants replication but results suggest that strawberry varieties demonstrate different economically valuable reproductive traits when grown hydroponically.

Oral Session 8: Social Science & More

3:30 – 5:00 PM

Nielson - Incorporating Student Voice and Student Choice into a Lab Activity

Shifflett - A specialized Borrelia burgdorferi outer surface protein C (ospC) allele may mitigate Lyme disease risk in humans

Dahms - Restoration and Ecological Uplift of Teaneck Creek Park within Bergen County's Overpeck County Park - From an Abandoned Rubble Fill to a Sand Seepage Wetland

Hamilton - Ecological genetics of clonal plants, estimating the rate of clonal reproduction using spatial genetic data, and an application in the salt marsh plant Spartina patens

Williamson - Marker gene analysis reveals novel viral genetic diversity in unsaturated soils

Boucher - Preserving the landscape or climate justice? The community solar fight in a suburban Maryland county

Incorporating Student Voice and Student Choice into a Lab Activity

Patrice Nielson, Trinity Washington University

Incorporating student voice and student choice into courses can be an effective inclusive learning practice. To address the needs of students from different prerequisite pathways, I restructured a lab activity in a STEM-majors biology course. For an early-semester lab, there was initially one activity scheduled, but based on student feedback it was clear there was a need for further practice in three areas. We therefore ran three labs concurrently and students chose which lab best supported their learning needs. While time available in the lab room and amount of materials and setup required for the labs limited the options students had to choose from, students reported a positive experience in the lab, feeling more empowered over their own learning, and feeling better prepared for the exam. Open communication with students was also important for the success of this lab. This approach could be used in a variety of lab-based science courses, or for students to have input on the direction that the curriculum of the course takes in exploring different lecture topics.

A specialized Borrelia burgdorferi outer surface protein C (ospC) allele may mitigate Lyme disease risk in humans

Scarlet Shifflett, University of Delaware

Co-Authors: Francisco Ferreira, Texas A&M University; Julia Gonzalez, Rutgers University; Alvaro Toledo, Rutgers University; Dina M. Fonseca, Rutgers University; Vincenzo A. Ellis, University of Delaware

Negative interactions between pathogen genotypes during infection are likely to have consequences for overall transmission dynamics in multi-host systems, particularly if the pathogen genotypes vary in host specificity. Borrelia burgdorferi is a tick-transmitted bacterium that causes Lyme disease, but most human infections, particularly those that disseminate across human tissues, are caused by bacteria with specific alleles of the outer surface protein C (ospC) gene (human infectious allelesâ; HIAs). We tested 272 individuals of 10 mammalian species for B. burgdorferi and sequenced ospC alleles. HIAs were common and most often found in mice (Peromyscus spp). Allele U was confirmed to specialize on eastern chipmunks (Tamias striatus). Chipmunks were infected with more ospC alleles, including HIAs, than expected by chance. While U was the most common allele in chipmunks, it never occurred with other alleles, despite such mixed infections being common in chipmunks and other hosts. This result is consistent with allele U excluding other alleles, perhaps through indirect host-immune mediated mechanisms, thereby reducing the capacity of chipmunks to act as reservoirs for HIAs. This suggests that specialized pathogens may be able to mitigate infection risk of hosts they do not infect.

Restoration and Ecological Uplift of Teaneck Creek Park within Bergen County's Overpeck County Park - From an Abandoned Rubble Fill to a Sand Seepage Wetland

Kevin Dahms, Biohabitats, Inc.

Co-Authors: Adam Strobel, Bergen County Department of Parks; Ted Brown, Biohabitats, Inc.; Joe Berg, Biohabitats, Inc.

Teaneck Creek Park is a low-lying site surrounded by residential and commercial development. Planned to be a landfill in the 1950s, the site was used as a rubble fill and as a place for the surrounding urban development to discharge uncontrolled stormwater. Under the direction of the Bergen County Department of Parks, with community partners The Teaneck Creek Conservancy, The Bergen County Audubon Society, and Rutgers University, the County of Bergen decided to contract with a team led by Biohabitats to design this project, which involved excavating the rubble mounds and 1-ft of the surface soils dominated by Phragmites. A stormwater best management practice called regenerative stormwater conveyance (RSC) was used to repair the eroded stormwater flowpaths and attenuate the delivery of stormwater. Using readily available sand and woodchips supplied by Bergen County, an approximately 20-ac sand seepage wetland was designed. The system uses the stormwater supply from the surrounding urban and commercial landscape as the basis for wetland hydrology, storing runoff in more than 20 shallow wetland pools. The water in these pools slowly drains through vegetated carbon-rich sand seepage berms on its ultimate path to Teaneck Creek. The RSCs, wetland pools, and seepage berms treat the stormwater runoff, reducing quantity and reducing peak discharge, while improving water quality through physical, chemical and biological treatment processes, delivering cleaner, cooler water to Teaneck Creek. Construction was substantially completed in the Fall of 2022 and tremendous increases in habitat, wildlife, and community interest have been observed and documented. This presentation will walk through the project design, construction and future management efforts as a model for innovative, urban habitat restoration. Lessons learned from design through implementation will also be shared.

Ecological genetics of clonal plants, estimating the rate of clonal reproduction using spatial genetic data, and an application in the salt marsh plant Spartina patens

Matthew Hamilton, Georgetown University

A large proportion of plant species are capable of some form of vegetative reproduction in addition to sexual reproduction. Plant sexual mating systems (i.e. rates of self-fertilization versus outcrossing) have long been studied as a critical parameter in plant population biology. Yet, the rate of clonal reproduction, a fundamental characteristic of reproduction in many plant species along with sexual mating system, has often been overlooked as a mechanism shaping plant population biology and ecology. An outstanding challenge has been the simultaneous estimation of mating system and clonal reproduction rates in plants. Spatial models predict that vegetative clones will exhibit spatial patterns that can be estimated with suitably powerful genetic markers. I report on an approximate Bayesian computation (ABC) approach that utilizes spatially structured observed genetic data to simultaneously estimate rates of clonal reproduction along with rates of selfing and outcrossing. ABC training data is based on individual-scale, genetically and spatially explicit simulations that vary rates of cloning and selfing/outcrossing, spatial patterns of survival, and mating and dispersal parameters and to predict patterns of genetic variation in clonal populations. Spartina alterniflora and S. patens are foundation plant species in Atlantic coastal salt marshes and are known to reproduce clonally. Few quantitative estimates of clonal genetic patterns in S. alterniflora, and none in S. patens, have yet been made and in neither species have rates been estimated for reproduction vegetative cloning versus sexual reproduction. This leaves numerous fundamental questions about salt marsh plant populations unanswered. For example, are clonal individuals clumped or widely dispersed in marsh populations? Are open habitat patches colonized by clonal spread of a few clonal genotypes or by establishment of sexually reproduced seeds? Do ecosystem patterns (e.g. amount and rate of biomass production) or ecological community properties (e.g. diversity of herbivore species) vary with the spatial patterns of clonal genetic variation of S. patens and S. alterniflora? Improving estimates of clonal reproduction will advance our mechanistic understanding of the distribution of genetic polymorphism in plant foundation species that can act as strong drivers of community abundance and diversity.

Marker gene analysis reveals novel viral genetic diversity in unsaturated soils

Kurt Williamson, College of William & Mary

Despite significant advances in knowledge regarding phages in aquatic systems, viruses in soil remain poorly characterized. Particularly, little is known regarding the presence and biogeographic distribution of various phage families in unsaturated soil environments. Marker genes, which are indicative of a specific viral group, are an established, efficient, and cost-effective method of investigating phage diversity in environmental samples. This study utilized three marker genes to study the genetic diversity of viruses in 42 different soil samples. Two of the marker genes, the major capsid protein of the Gokushoviruses, and DNA polymerase of the T7-like phages failed to amplify in any of the soil samples. The third marker gene, g23, successfully amplified in 15 of the 42 soil samples (35.7%), and positive samples were selected for further analysis. Amplicon sequencing produced 335 amplified sequence variants from 7 soils. Amplified g23 sequences from unsaturated soils were compared to sequences from local freshwaters, as well as previous studies in freshwater, marine, paddy field, and upland black soil environments. Our results suggest that geographic distance may be more important than environmental source in explaining sequence-based differences across samples. Further, our analysis revealed novel genetic diversity within the T4-like phage family in temperate, unsaturated soils from this study.

Preserving the landscape or climate justice? The community solar fight in a suburban Maryland county

Doug Boucher, White Acres Farm

The fight over whether to allow small community solar projects in the Agricultural Reserve of Montgomery County, MD a suburban area with 1 million residents and a government long dominated by Democrats -- shows the contradictions of environmentalism today., I will describe the course of this (not-yet-concluded) political struggle. As of now, solar has been de jure legalized but de facto made impossible.

Proponents of changing zoning to allow community solar in the county's Agricultural Reserve emphasized the county's commitment to reducing emissions 80% by 2027, the inability of solar on roofs and structure to achieve that goal, the small percentage of the county's land that would be needed (2%), the value of solar income to small landowners, and the issue of climate justice.

Opponents emphasized the 40-year history of prohibiting development in the Agricultural Reserve, putting panels on structures rather than farmland, local food security, and the possibility of carbon sequestration from regenerative agriculture and reforestation.

Since the passage of supposed compromise legislation permitting solar in 2021, not a single solar project has been built, and only one application for a project has even been submitted.

While the debate can be seen as simply another NIMBYism fight, it is also a clash of two opposing strands in environmentalism. It pits a pastoral vision of agricultural landscapes and dedication to preserving them from development and industrialization, against an emphasis on climate justice, racial inequality in the control of farmland, and the need to fundamentally transform our economy by 2050. So far, the pastoral side is winning

Poster Session

5:00 – 6:30 PM

1 - The impact of ground cover characteristics on the subsurface pupation and survival of Lepidoptera

Emma Jonas, University of Delaware

Co-Author: Douglas Tallamy, University of Delaware

North American caterpillars predominately feed on tree hosts, and subsurface pupation among arboreal Lepidoptera is widespread. Therefore, such species are vulnerable to the microhabitat conditions near the base of host trees during wandering and subsequent pupation. This susceptibility may help explain recent declines in Lepidopteran diversity and abundance, especially in compacted urban environments. Compaction occurs during development and can be mitigated by decreasing traffic, planting species with extensive root systems and leaf cover, and allowing the natural decay of detritus. I hypothesize that ground cover characteristics impact wandering behavior and overwintering survival due to cover-type-associated changes in soil compaction, moisture, litter depth, and canopy cover. In preliminary investigations, five caterpillar species were observed during their wandering phase on six different ground covers. Overall, average substrate compactions beneath tree canopies are negatively correlated with the pupation success rate of all focal species combined (# of burrowing successes/ # of attempts, n = 123). Individuals were significantly less likely to burrow within an hour and a half at sites with higher compaction. Additionally, google earth surveys show that turfgrass is the dominant ground cover of choice under landscaped trees in front yards east of the Mississippi. Overwintering survival and ground cover choice tests are underway to further investigate factors that impact survival and how caterpillars navigate urban environments.

2 - Bats & Rockreation: Pseudogymnoascus destructans at Devils Tower National Monument and Recreation as a Potential Vector

Monique Metza, William & Mary

White-nose syndrome (WNS) is a disease that causes mass mortality in North American hibernating bat species through a fungal pathogen called Pseudogymnoascus destructans, Pd. Humans, via travel and recreation, and bats, via hibernation and migration, have spread and continue to spread this disease west since its arrival to New York in 2006. WNS was recently found on two bats at Devils Tower National Monument (DTNM) in Wyoming. In addition to DTNM having suitable rocky features for bats to roost, it is also a popular location for visitors to hike, scramble, and rock climb. Use of both humans and bats could create the potential for these recreational activities to contribute to the spread of Pd, which is a relationship that has yet to be studied. In this project, I will assess the presence of Pd within the environment at DTNM, and the impact that rock climbing and scrambling may have on the spread of the disease. This research intends to help land managers implement methods to protect future bat populations by reducing the risk of spreading WNS through anthropogenic recreation. Alternatively, this research could prevent unnecessary closures to recreators if it is found that recreators do not contribute to the spread.

3 - Multi-method sampling of ground and canopy-dwelling insects in temperate deciduous trees

Brianna Hoffman, Washington & Jefferson College

Co-Author: Jason Kilgore, Washington and Jefferson College

Individual trees provide a range of niche habitats from the ground into the canopy. Research conducted in temperate forest canopies suggests that biodiverse insect communities do exist but remain understudied, especially when compared to tropical regions. Therefore, we are investigating the change in insect community from the ground to the canopy in temperate deciduous trees.

As part of a developing collaboration called ARBOREAL between faculty members, undergraduate students, and professional arborists dedicated to temperate forest canopy research, we developed and piloted protocols to survey canopy- and ground-dwelling insect biodiversity in deciduous trees. In Fall 2022, we used a large pin oak (Quercus palustris) on a college campus to practice stationary-rope climbing and maneuvering, to perform diurnal sweep net surveys, and to conduct nocturnal surveys using a suspended blacklight bucket trap. We also selected a large northern red oak (Q. rubra) in a mesophytic forest in southwestern Pennsylvania to survey ground-dwelling insect communities using a modified NEON pitfall trap protocol. Pitfall traps were located at randomly selected spots within the canopy dripline surrounding the base of the tree at each cardinal direction. All insects were identified to the lowest possible level of taxonomy.

A diversity of ground beetles, field crickets, and little black ants were collected in the pitfall traps, while moths, grasshoppers, katydids, crickets, and beetles were captured in the nocturnal blacklight trap; due to recent cold weather, no insects were captured during the diurnal sweep net survey. Pitfall traps were the most consistent and easily deployed method, with no climbing skills required. Diurnal sweep net surveys require training, practice, and supervision in tree climbing and maneuvering; however, lower branches and smaller trees could be more accessible with a telescoping net from the ground. Suspended bucket or panel traps, whether diurnal or modified with blacklights for nocturnal use, could be implemented from the ground with accurate throwline placement, sturdy branches, and bark/cambium protection, yet these systems should focus on minimizing total weight for ease of transport, deployment, and retrieval. Further, selection of lures and material color are important considerations for diurnal and nocturnal suspended insect traps. A combination of methods will be required to adequately survey and thus demonstrate the stratification and biodiversity of insect communities in temperate forest trees.

4 - Oh Deer! Do white-tailed deer reduce woody seedling density in a mixed mesophytic forest?

Jonathan Grabowski, Washington & Jefferson College

Co-Author: Jason Kilgore, Washington and Jefferson College

Eastern forests of North America have been impacted for decades by the overabundance of white-tailed deer (Odocoileus virginiana). Consequently, woody plant regeneration is limited due to deer overbrowsing. Evidence for impacts of deer are commonly observed through exclusion of deer by fencing (exclosure) in comparison to open areas (control).

We used paired exclosure control plots to detect differences in density of woody plant seedlings (< 1.37 m in height) due to white-tailed deer browsing. In Summer 2009, eight paired 25-m2 plots were installed in an uneven-aged mesophytic forest at Abernathy Field Station (AFS) in Washington County, Pennsylvania. In Summer and Fall 2022, we identified and measured heights for woody seedlings in the northern quarter of seven sets of paired plots. Given the recent loss of ash (Fraxinus spp.) overstory due to emerald ash borer-induced mortality, we were specifically interested in deer effects on ash seedling density. Densities are provided as means, but Wilcoxon signed-rank test was used to test for differences.

Combined, as well as specific, woody seedling densities were consistently lower when deer were excluded than in the control plots, which was not expected. In the Summer, combined density was significantly (P=0.0469) higher in control (7.18 m-2) than exclosure plots (3.89 m-2); sugar maple density was also significantly (P=0.036) higher in control (11.18 m-2) than exclosure plots (3.89 m-2); and ash (all F. americana but one F. pennsylvanica) density was nonsignificantly (P=0.078) higher in control (0.79 m-2) than exclosure plots (0.31 m-2). In the Fall, densities were nonsignificantly higher in control plots for combined (P=0.156), sugar maple (P=0.142), and ash (P=0.078) seedlings.

We observed that the exclosure plots contained more mid-level (2-3-m high) vegetation, while the control plots had little to no mid-level vegetation. These established plants in the exclosure plots create a canopy cover above the small woody seedlings, which would increase competition for resources like light and water and thus lead to a reduced woody seedling density in the exclosure plots. Future studies should include measurements of abiotic variables like light availability and soil moisture and indicators of plant health like chlorophyll content and net photosynthesis, as well as individual seedling tracking over time. Our study suggests that deer browsing leads to reduced understory vegetation canopy, which allows germination but not survival of woody seedlings in exposed plots.

5 - Isolation of Antibiotic-Resistant Superbugs in the Blue Marsh Watershed

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Emerging contaminants such as chemical pollutants within water resources can be detrimental to water supplies and impact human health. Chemical pollution can result in toxic algae blooms and high microbial counts causing a decrease in quality of water supplies and close recreational areas thus limiting access to water for many communities. Chemical pollution creates environmental conditions that promote selective pressure on microorganisms allowing for adaptation to antibiotic resistant, in a process known as cross-resistance. Cross-resistance and the increased prevalence of antibiotic usage has been linked to an increase in environmental antibiotic resistance. Superbugs are microorganisms resistant to multiple antibiotics. This study will focus on identifying antibiotic resistant Escherichia coli for the Blue Marsh Watershed in Berks County, Pennsylvania. Three sample sites were chosen based on anthropogenic activities in the watershed. Each sample site may be affected by different human activities: the upstream area is surrounded by agricultural lands, the lake is used for fishing, boating, swimming, and the downstream sample site may be influenced by industrial non-point pollution. Water samples from each sample site were collected monthly for a one-year period. E. coli was isolated using the Environmental Protection Agency's membrane filtration methodology for recreation water. Approximately 10% of the colonies isolated were evaluated for antibiotic resistance using Kirby Bauer diffusion techniques for six common antibiotics, streptomycin, ampicillin, tetracycline, trimethoprim/sulfamethoxazole, colistin, ciprofloxacin. Ampicillin resistance was found in 85% of the samples, and tetracycline resistance was found in 88% of the E.coli isolated from the Blue Marsh Watershed. Of those colonies evaluated, colonies with resistance to at least five antibiotics suggesting emerging superbugs within the watershed during this study period.

6 - Duckweed Microbiota Isolated and Assessed for Influence on Plant Growth and Biofilm Formation

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Duckweeds are small, fast-growing, aquatic plants that can remediate the water they inhabit by accumulating nutrients and breaking down environmental pollutants. Duckweeds are currently utilized in constructed wetlands to remove excess nitrogen from agricultural, municipal, and factory wastewaters. Duckweeds also have a demonstrated potential to take up polluting antibiotics. Laboratory experiments suggest that the relationships between duckweeds and their microbiomes can be harnessed for improved bioremediation. This possibility can be explored by characterizing natural duckweed microbiomes, developing synthetic duckweed microbiomes, and challenging duckweed-microbiome systems with pollutants of concern to select for a maximally remediating community. We are interested in remediating agricultural wastewaters and urban runoff contaminated with excess ammonia and the antibiotic sulfamethoxazole. We aim to establish a duckweed-microbe community that remediates these pollutants with high efficiency. The first steps in this process are to isolate bacteria from duckweed microbiomes and to develop synthetic communities that stably colonize duckweed. We have isolated more than 70 bacterial strains from duckweeds collected in and near New York State. Here we present our initial investigation of the impact of these bacteria on duckweed growth.

7 - Clonal structure and landscape genetics of Long Island, NY populations of the salt marsh plant Spartina patens

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Intertidal salt marsh habitats support diverse communities that act as a buffer and filtration system for estuaries, provide valuable ecosystem services such as coastal protection, water treatment, fisheries recruitment, carbon sequestration, and recreation. Spartina patens is a foundation plant found at higher tidal elevations in mid-Atlantic salt marshes that reproduces sexually and via vegetative growth. In plant populations, especially grasses, rates of clonal versus sexual reproduction may change over time, and different genotypes may vary in rates of sexual and clonal reproduction. We seek to address several questions: 1) is clone area and clonal richness correlated with contemporary landscape variables like habitat area or the change in landscape variables over time? 2) is genetic diversity and clonality correlated with landscape changes over time? 3) What are the effects of anthropogenic landscape disturbance (e.g. changes in high marsh habitat area, changes in development of adjacent landscape) on genetic diversity and clonality? In 2018-2019, ten salt marsh locations along the coast of Long Island, NY were sampled for S. patens (ca. n=1000). Within each location, five grid transect patches were sampled at one-meter intervals. Using DNA isolated with a rapid chelex-based method, samples were genotyped for 12 novel microsatellite loci (developed from genomic sequences) using multiplex PCR and fragment analysis. Genotypes are used to assign each sample within locations as distinct multilocus genotypes (genets) and vegetative tillers (ramets) of the same genet. We will collect landscape data for each location by classifying aerial survey imagery using Google Earth Engine, to quantify landscape variables such as high marsh area and development adjacent development, and the magnitude of change in these landscape variables 1974 - 2019. Multilocus genotypes completed at several locations to date showed high polymorphism, clearly identifiable clonal ramets, and spatial aggregation of clonal patches. From preliminary landscape data, we observed that sites near denser population centers had the highest proportions of highly developed land area and that marsh vegetation for many sites decreased over the past 45 years. We predict that sites that experienced greater degradation over time, as well as those smaller and more degraded initially in 1974, will be associated with lower genetic diversity and higher clonality. These findings will inform salt marsh conservation and restoration efforts, and elucidate potential impacts of landscape change and sea level rise on genetic variation within and among S. patens populations.

8 - Quantifying salt-impacted farmlands in Delmarva using satellite images

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Co-Author: Pinki Mondal, University of Delaware

Coastal landscapes represent a complex network of natural and managed ecosystems. The rising rate of global sea levels, changing frequency of coastal storms, and evolving agricultural management strategies have notable consequences for coastal farmlands, including visible salt patches. One-fifth of the world's irrigated farmland witnesses an annual economic loss of USD 27.3 billion as a result of crop yield reduction or abandonment due to soil salinization. We utilized high-resolution satellite imagery (Sentinel-2; spatial resolution: 10m) to capture the spectral signatures of these salt patches, a consequence of saltwater intrusion (SWI), and quantified its spatial extent of the coastal farmlands for summer 2022 using spectral unmixing. Understanding the spatial-temporal evolution of salt patches and its links to physical characteristics and processes will allow us to better understand and predict risk to crops, and the future extent of farmland loss and its consequences.

9 - Pollinator identity affects microbial communities in an artificial nectar model: implications for nectar chemistry and plant fitness

Hannah Machiorlete, College of William and Mary

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Microbial communities in nectar alter its chemical composition, affecting its value as a reward in the plant-pollinator mutualism. Microbe-induced changes to nectar chemistry may directly influence plant fitness if pollen contacts nectar during germination, such as for common milkweed (Asclepias syriaca). This research aimed to investigate the potential for nectar microbes to affect common milkweed pollinia germination success. To test this, we first inoculated artificial nectar with surface microbes from four milkweed pollinators, as pollinators are the primary vector of nectar microbes. Then, we cultured bacteria and fungi from these cultures on solid media and characterized their microbial diversity and abundance. Using nectar cultures, we quantified sugar composition and concentration with high performance liquid chromatography (HPLC) and performed pollinia germination assays following the hanging drop method. Microbial abundance and diversity of nectar cultures differed among pollinator species and among individuals. These unique microbial communities likely change nectar sugar chemistry, and may lead to decreased pollinia germination success and vigor. Lower germination, or lower reproductive success, may prompt selection against pollination services from particular species if their microbes substantially reduce lifetime fitness. This would underscore microbes as a mediator between plants and pollinators, adding a third player to this two-way interaction.

10 - A good neighborhood to raise a brood: Tree neighborhood diversity reduces periodical cicada oviposition and damage

Kristin Jayd, University of Maryland

Co-Authors: Zoe Getman-Pickering, George Washington University; John Lill, George Washington University; Martha Weiss, Georgetown University; John Parker, Smithsonian Environmental Research Center; Karin Burghardt, University of Maryland

Natural systems contain diverse neighborhoods of plants and trees that provide a matrix of potential hosts for herbivores to navigate. The patterns of insect-plant host choice are key to understanding the dynamics of these interactions, and could provide deeper understanding of insect outbreaks and consequences for their plant hosts. We follow a Brood X periodical cicada mass emergence event in the BiodiversiTREE forest diversity experiment at the Smithsonian Environmental Research Center (SERC) in Edgewater, MD to learn how tree diversity influences cicada oviposition preferences and tree response (flagging). We measure 15 tree species grown in single- and mixed-species plots and find that the tree neighborhood plays an important role in determining oviposition preference and tree flagging responses. Cicadas were more likely to oviposit in trees grown in single species plots versus diverse plots. While overall we find a concomitant decrease in tree flagging in diverse plots, we also document that species flag at different rates in response to equal oviposition density. This study creates a richer understanding of the importance of tree context, specifically tree neighborhood diversity, in shaping the ecological impacts of a mass insect emergence event.

11 - Shell damage reveals differences in predation patterns on the marine snails Oxymeris maculata and Neoterebra dislocata

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Common predators of marine snails include crabs, turtles, octopuses, and other marine snails. Evidence of predation can be observed on snail shells as circular holes with or without beveled edges, oval or irregular shaped holes, and cracks on the shells. Predator type can often be determined based on the type of shell damage observed. Oxymeris maculata and Neoterebra dislocata are marine snails in the Family Terebridae. Neoterebra dislocata is found in shallow sand flats of the Atlantic Ocean from Virginia to Brazil, while Oxymeris maculata can be found in the coastal waters of the Indian and Pacific Oceans. These species have similarly shaped conical shells that differ greatly in size and robustness. As an adult, Oxymeris maculata is significantly larger in length and width than Neoterebra dislocata. In this study, we examined evidence of predation in the shells of Oxymeris maculata and Neoterebra dislocata. Specimens from the Delaware Museum of Nature and Science were measured and evidence of predation including holes and cracks on the shells were assessed for size, shape, and location on the shell. Preliminary evidence indicates differences in the types of predators and in the location of the shell damage between the species of snails. This study will increase our understanding of predator prey relationships in marine gastropods, and how snail morphological diversity may play a part in these interactions.

12 - Effects of Urbanization on Blacknose Dace Morphology

Jastine Honea, Towson University

Co-Authors: Jay Nelson, Towson University; Christopher Oufiero, Towson University

Human activity is currently a driving force that is altering biodiversity and modifying selective processes around the world. Urbanization is the alteration of the natural landscape to better suit human needs; this includes streams and bodies of water, where urbanization has been shown to reduce biodiversity in aquatic systems. As variation in habitat alters fitness requirements, previous studies have shown that these changes can influence external body morphology. It has been documented that in Maryland, USA, biodiversity in waterways plummets in the wake of urbanization. Despite this, blacknose dace (Rhinichthys atratulus) exist in highly urbanized streams and have been used in previous studies attempting to understand how they adapt to anthropomorphic changes. In order to better understand the effect urbanization is having on these fish, we examined the morphology of blacknose dace from multiple sites across a gradient of impervious surface coverage as a proxy for urbanization. Our samples date from 1965 to 2022, providing temporal scope to this study. We predict that blacknose dace morphology will become more streamlined with an increase of impervious surface cover, as increased flashiness of stream flow paired with higher water velocity during storm surges is expected to result in a more fusiform animal shape. Initial results will be presented.

13 - Hybridization as a tool for rapid adaptation in Virginia Aslecpias

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Hybridization is a powerful mechanism used by plants to cope with widespread, environmental change, providing them with a wealth of novel genetic variation. In the eastern United States, anthropogenic-caused canopy loss has created natural hybrid zones between sunny and shady-adapted species, facilitating gene flow.

Here in Virginia, we've identified two milkweed species hybridizing in areas of high disturbance, such as powerlines and roads. Asclepias syriaca (common milkweed) thrives in the open disturbed patches whereas Asclepias exaltata (poke milkweed) typically remains under the forest canopy. Strangely, near A. syriaca, distinct intermediate phenotypes between the two species have been observed. Upon further investigation, we found evidence of prolific gene flow between A. exaltata and A. syriaca in these areas. Within this hybridization, it was clear that there is further introgression of alleles, particularly sweeping into the A. exaltata genome. This finding suggests that there is something adaptive about having A. syriaca alleles. This phenomenon raises the question: can hybridization aid in a plant's tolerance to light?

Here, we surveyed native populations of milkweed in the Virginia Appalachians. This included Naked Creek and South River Picnic area at Shenandoah National Park (SNP) and one site near Cole Mountain, VA (SLG).

To investigate the effect of hybridization on light tolerance, we used a portable photosynthesis system to measure both assimilation (photosynthesis) and transpiration (stomatal conductance). This generated light response curves across Qin levels (0-1800 Âµmol/m2/s) at SNP. A secondary experiment modeled data from SLG and SNP, where assimilation and transpiration were measured at Qin 1000 (a moderately high light level). Our findings suggest that hybrids can show an intermediate tolerance to light, possibly enabling A. exaltata-like individuals to adapt to the open canopy.

These results have important implications for plant adaptation to climate change. As plants are unable to migrate quickly, they are particularly vulnerable to environmental disruptions. The hybridization and introgression observed in our study suggest that plants can develop intermediate physiological responses, enabling them to better adapt to changing light conditions. In conclusion, our findings demonstrate the adaptive potential of hybridization in plants and highlight its importance in facilitating their response to environmental changes.

14 - Redefining American ginseng harvest regulations: Using size rather than age as a conservation-minded harvest criterion

Sage Forsythe

Co-Author: Jennifer Chandler, West Chester University of Pennsylvania

American ginseng is North America's leading wild-harvested herb, and provides millions of dollars of yearly supplement income to individuals throughout Appalachia. Ginseng's viability, however, is currently being threatened by overharvest. The current enforceable harvest regulation is the 5-year rule, which sets a 5-year age minimum for harvest. The 5-year rule is not sufficient to prevent population decrease and potential extirpation, because this age-based regulation does not consider the high variability of ginseng developmental rates across heterogeneous habitats where ginseng grows. By five years, most plants have not replaced themselves in a population. Leaf area, a measure of plant size, best predicts reproductive success, growth, and survival in American ginseng along with the probability of self-replacement. However, leaf area is difficult to measure in the field, requiring expensive equipment or mathematical training, and is not verifiable at the point of sale. The purpose of this work was to identify easily-measured morphological traits that accurately predict leaf area and that remain verifiable when ginseng is sold. We collected age, leaf area, seed count, and morphological data on the stems and roots of fresh plants (n=90) and a subsample of dry plants (n=30). Dry measurements were necessary to account for changes in morphology during the drying process since most ginseng is sold to dealers dry. We performed regressions to determine the best predictors of leaf area, which serves as our best size-based estimate of survival and reproduction. We regressed leaf area on age and confirmed that age is not a good predictor of plant size. Among the numerous shoot and root traits measured, stalk height is the best simple predictor of leaf area and replacement probability, and is verifiable at sale since stalk height did not change significantly when dried. Prior studies clearly indicate that the continued use of age-based harvest protocol will further damage ginseng populations across its range. The development of impactful, size-based harvest regulations is vital in the protection of this ecologically, economically, and culturally-valuable medicinal herb. We propose that an easily-measured, verifiable size-based morphological trait like stalk height be considered when developing conservation-oriented, size-based harvest regulations. Such a trait will allow harvesters and ginseng dealers to quickly evaluate if a plant is harvestable and sellable and will go far in moving the needle toward conservation. A similar size-based approach has been utilized successfully in fisheries science and is likely to provide similar levels of protection in wild-harvested ginseng.

15 - Ecosystem Change Following Disappearance of Submersed Aquatic Vegetation from a Shallow Embayment of the Tidal Potomac River

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Since 2013 we have been monitoring a wide array of water quality and biotic variables in Hunting Creek, shallow embayment of the Potomac River just south of the City of Alexandria. This embayment is quite shallow with a mean depth of about 1-2 m. It is located just downstream from the Alex Renew sewage treatment plant outfall and across the river and slightly downstream of the Blue Plains sewage treatment plant. During the early part of the 21st century this embayment regained diverse and luxuriant beds of submersed aquatic vegetation (SAV). Correlated with the very wet year of 2018, the embayment lost its entire SAV population and it has not become reestablished. This has provided the opportunity to examine the changes in water quality and biotic variables in the embayment from the perspective of "state changes" that have been observed in a variety of shallow lakes and estuaries. To examine the potential for a state change in our system, we grouped our data into two periods 2013-2017, a period of lush vegetation, and 2018-2021, a period of no vegetation. Indicators of light transparency, Secchi depth and light attenuation coefficient have show a clear decrease between the two periods. This was attributable mainly to a substantial suspended solids, but chlorophyll a also increased. While significant changes in phytoplankton biomass as measured by chlorophyll have been observed, no obvious consistent patterns have been found in taxon composition. Several zooplankton taxa have been impacted by the change in state. Some initially decreased for several years, but later recovered. The fish community has shifted from one dominated by Banded Killifish to one dominated by white perch. The changes observed are consistent with a shift from a "clean water" state to a "turbid water" state observed in many shallow lakes. We continued the study in 2022 and are planning to be back in 2023 to examine further changes.

16 - Does caffeine consumption affect the diversity of the oral microbiome?

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Coffee is a widely consumed beverage containing organic compounds with antibacterial activity. To investigate its possible effect on the diversity and taxonomic composition of the oral microbiome, orals swabs from 44 subjects were collected and the DNA extracted using a Qiagen DNeasy Mini-prep. The 16SrRNA gene amplicon was sequenced in an Illumina Miseq instrument. The amplicon sequences were analyzed in Qiime2 using the DNA Subway purple line. We focused on the alpha diversity of the samples and the taxonomic composition. A metadata file was also imported including the participants' responses to an anonymous survey for dietary and hygiene habits. Participants consuming at least two cups of coffee a day had a significantly higher Pielou Index (PI) of alpha diversity value (ANOVA with Krukal-Wallis pairwise $p \leq 0.04$). Approximately 15 phyla were identified. More than 95% of the bacteria found in all the samples belong to the phyla Proteobacteria, Firmicutes, Bacteroidetes, Actinobacteria and Fusobacteria. The percentage abundance for these five were not significantly different in subjects who consumed coffee versus those who didn't. Proteobacteria was the most abundant in the oral microbiota with 37% (± 4.3) abundance in those who consumed coffee and 35% (± 4.5) in subjects who did not. Bacteroidetes had an abundance of 11% (± 1.9) in those who did not consume coffee and 9% (± 1.5) in coffee drinkers. The phylum Firmicutes abundance was 18% in those who drank at least one cup of coffee a day whereas students who did not drink coffee had 66% abundance. The alpha diversity was significantly different between individuals who had at least two cups of coffee a day, compared to those who didn't drink coffee, (p-value = 0.04). These results suggest that exposure to coffee affects the composition of the oral bacteria. Coffee consumers had fewer oral bacteria overall compared to subjects who did not drink coffee.

17 - The antidepressants, sertraline and fluoxetine, have opposing effects on aggression in subordinate rusty crayfish (Faxonius rusticus)

Alexander Petrocelli, Elizabethtown College

Pharmaceutical compounds invade aquatic ecosystems through private and industrial pollution and improper disposal. Trace amounts of these pharmaceuticals end up in aquatic environments and have various non-lethal behavioral and physiological effects on aquatic invertebrates. Crayfish establish social status through agonistic encounters, where winners and losers of these interactions are remembered, decreasing aggression intensity in future bouts. These agonistic behaviors are modulated by serotonin and its derivatives. In subordinates, serotonin treatment decreases their propensity to retreat from an agonistic encounter, increasing overall aggression intensity. The most commonly prescribed antidepressants, sertraline and fluoxetine, have been detected in the ng/L to Âµg/L concentration in the environment. Fluoxetine and sertraline inhibit the reuptake of the neurotransmitter serotonin, increasing its concentration in the synaptic cleft. It is unknown how agonistic interactions alter serotonergic processes in crayfish and how environmental exposure to antidepressants affects their social behavior. Our study examined the effect of fluoxetine, sertraline, and serotonin in modulating subordinate behavior in the rusty crayfish (Faxonius rusticus). After a 7-day isolation period, same-sex crayfish were placed in a 10-gallon tank for a status establishment interaction. The subordinate crayfish were injected with 0.1 mL of either fluoxetine (100 mg/L), sertraline (0.1 mg/mL), serotonin (2 mM), or a saline control. Dominant crayfish were injected with 0.1 mL of saline solution to control for handling effects. Following injection, both individuals were reintroduced to a clean tank for a second fight. Both interactions were recorded, and the videos were used to determine the change in offensive and defensive behaviors in both individuals across all treatment groups. Preliminary analysis showed no statistical difference in mean aggression scores of subordinates following any serotonergic treatment. Interestingly, subordinate aggression increased in response to sertraline and decreased in response to fluoxetine. This finding is intriguing, as these antidepressants would be expected to elicit similar responses, given their shared mechanism of action.

18 - Phenology of Two-horned Water Chestnut (Trapa bispinosa Roxb. var iinumai Nakano) in Northern Virginia Ponds

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Co-Author: Dr. Chris Jones, George Mason University

Species of water chestnut, specifically Eurasian water chestnut (Trapa natans), have plagued the northeastern US, including the tidal Potomac for over 100 years. In 2014, a new species of invasive water chestnut identified as two-horned water chestnut (Trapa bispinosa Roxb. var iinumai Nakano) was discovered in the Potomac River and in subsequent years it has spread to nearby water bodies. The purpose of this study is to describe the phenology of T. bispinosa to assist managers in developing a multijurisdictional early detection and rapid response (EDRR) plan. Structured observational studies were conducted at two ponds in northern Virginia in 2019 and 2020. T. bispinosa initiated growth in late April, increasing rapidly to maximum of 100% cover in June. Rosette diameters increased gradually from late April to maximum in August and September. This increase in rosette size was strongly correlated with degree days and calendar days and is consistent among ponds and between years. Flower counts were zero from April through June, then increased rapidly to maximum in late August. Fruit counts were zero from April through June, fruit started to appear in July, and counts increased to maximum in early September. In order to effectively control T. bispinosa it is necessary to initiate treatments before fruits are produced. Based upon our data, in the mid-Atlantic region, May would be an ideal time to begin as rosettes should be observable, but flowers and fruit should not appear until late June. These studies indicate aquatic managers may have a four-to-six-week window in the late spring to prevent seed production and should focus resources on management during that time period.

19 - Monitoring the Relationship Between Species Richness in Fish and Invertebrates Along a Salinity Gradient in the Chesapeake Bay

Reese Register, Hampton University

Understanding species distribution along the salinity gradient of the Chesapeake Bay is important from an ecological and fisheries management standpoint. Monitoring the fish species richness and other diversity indices are important indicators of ecosystem condition. Species richness relates to the number of species in an ecosystem. This research will focus on three sites along a salinity continuum in Chesapeake Bay where abundance data for the various species collected will be analyzed. We hypothesize that varying salinity conditions will support different fish species richness at different sampling locations. In addition to species richness, we will explore functional diversity across the Bay to see whether salinity is a variable that exerts important influence from a functional diversity standpoint. Functional diversity helps us tell how the species interact in an ecosystem. We will use GIS and statistical regressions to identify variations in species richness along identified gradients. We aim to provide up-to-date information regarding the conditions of the Chesapeake Bay ecosystem that researchers and managers can use to prioritize managed areas across the Bay ecosystem.

20 - Caterpillar host use in a forest diversity experiment

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The spatial arrangement of host plants can change herbivore use patterns. Generalist and specialist herbivores may also respond differently to the concentration of host plants. The resource concentration hypothesis predicts that specialists will quickly colonize monocultures of spatially grouped hosts. We test this hypothesis by tracking herbivore host use patterns within BiodiversiTREE, a large-scale forest diversity experiment planted in 2013 at the Smithsonian Environmental Research Center near Edgewater, MD. BiodiversiTREE plots are composed of either a single tree species (monoculture), 4, or 12-species mixtures. To track the caterpillar community in this experimental forest as it establishes, we visited a subset of approximately 540 trees in early and late summer each year. Sampling consisted of visually searching leaves for 4 minutes, and all caterpillars (external feeders and leaf miners, Lepidoptera and sawfly larvae) were collected for identification. We here report on trends observed over the summers from 2016-2021, years 3-8 of the experiment. We used linear mixed models to compare abundance and richness trends and a bipartite network analysis to track metrics of specialization within the experiment over time. Within a given year, plots with higher tree species richness support higher caterpillar abundance and morphospecies richness. This trend has become weaker over time. The prevalence of dietary specialists versus generalists within the caterpillar community also seems to be changing as the forest matures. Specialization across all diversity treatments has gradually declined over time. Among diversity treatments, the 12 species plots started off with higher specialization than monocultures. However, this trend reversed and from 2017 onwards the monocultures have had consistently higher specialization than mixed species plots. These later years support the resource concentration hypothesis. Our work is ongoing, and we expect that host use patterns may continue to change as canopy closure proceeds.

21 - Window strikes and age structure of migratory songbirds in an urban greenspace

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Bird-window collisions are a major cause of mortality for birds in populated areas, with migrating birds being particularly susceptible. Inexperienced young birds are especially vulnerable, and it is predicted that predominantly young birds will use the more risky coastal migration route that passes through heavily urbanized regions in the Mid-Atlantic. Therefore, it is expected that migratory songbirds in urban areas will be mostly young birds and more prone to higher rates of window collisions. To test this prediction, we conducted a study at the urban Rutgers Newark Campus, where we determined the age structure of migratory birds that use this site as a stopover habitat and frequently collide with windows. We analyzed data for several common songbird species from both a systematic mist-net capture study and systematic collections of window mortalities. We used molt conditions to determine the age structure of stopover birds communities. By comparing the age structure of mist-net captured birds and window mortalities, we found that young birds do indeed dominate in this urban stopover site and are more likely than older birds to die due to window strikes. Our findings on the use of urban stopover sites by migratory birds contribute to our understanding of how urban ecosystems affect bird migration and can inform conservation efforts in such areas.

22 - Upstream Migration of the Rusty Crayfish, Faxonius Rusticus

Connor Bird, Hood College

Co-Authors: Eric Annis, Hood College; Jay Killian, Maryland Department of Natural Resources

The rusty crayfish, Faxonius rusticus, has invaded many of the United States freshwater ecosystems including the Monocacy river in North-Western Maryland. The downstream displacement of other crayfish species by F. rusticus occurs at a rate of 4.2 km yr-1 within the Monocacy river. This displacement has taken place over the past 14 years and prior to this study, has only been analyzed in a downstream direction. We hypothesize that F. rusticus is also capable of spreading upstream within the Monocacy river-system. In order to test this hypothesis, nine tributaries of the Monocacy river were sampled at road crossings. When compared to sampling conducted in the early 2000's, F. rusticus moved upstream at a rate of 0.5 km year-1 and 0.7 km yr-1 in Piney Creek and Tom's Creek respectively. Faxonius rusticus was also documented for the first time in Owens Creek, Israel Creek, Big Pipe Creek, and Little Pipe Creek. Of these four tributaries, the presence of F. rusticus in Israel creek is of particular interest given its position farther down the Monocacy from the point of invasion than the other three tributaries. The study also sought to compare the kick seine and quadrat sampling methods for possible biases. The kick seine method utilized a 3 m long net held on either end with two individuals disturbing the substrate upstream of the net. The quadrat sampling method consisted of a 1 m2 frame, with netting around the frame, that was placed over the sample area and used to catch crayfish as the substrate within the frame was disturbed. Our findings show that the quadrat sampling method is more capable of catching smaller crayfish than the kick seine. The quadrat also catches more than 31x as many crayfish per m2 on average. These findings advance our knowledge of how quickly F. rusticus can spread through an invaded ecosystem, specifically that they are capable of moving upstream as well as downstream. The findings also show that a kick seine is an appropriate sampling method when trying to determine the presence/absence of a given organism. However, a quadrat should be used when trying to determine the actual density of a species in a given ecosystem.

23 - A Preliminary Spatial and Temporal Analysis of Gray Squirrel (Sciurus carolinensis) Autumnal Behaviors at Hampton University, a Semi-Urban Campus

Halia Morris, Hampton University

Co-Authors: Ananda Turner, Hampton University; Jake Headen, Hampton University; Mariah Smith, Hampton University; Dante Belcher, Hampton University; Dr. Shawn T. Dash, Hampton University

As a part of an animal behavior course, students were engaged in an authentic research project focused on the behavioral ecology of a selected species. This project focused on the behavioral repertoire of the eastern gray squirrel (Sciurus carolinensis), a common mammal species in urban areas of the Mid-Atlantic, United States, and college campuses. There have been limited behavioral studies of gray squirrels on college campuses, and no study of this kind has been conducted at Hampton University. The overall objective of this study was to determine the daily behavioral budget of gray squirrels and generate an ethogram to investigate the relationship between time of day and sampling location to observed behaviors. This study employed observing gray squirrels at eight locations across campus during the fall (Oct. - Nov.) of 2022. The behavior of the squirrel was recorded on an ethnographic datasheet every 30 seconds for 10 minutes twice a day at all eight locations for about seven weeks. We were able to conclude that squirrels are most active in areas with higher habitat complexity and in the afternoon (1200 - 1500). Of the behaviors observed, foraging comprised the majority of behaviors; containing 38% of morning behaviors and 51% of afternoon behaviors. We infer that this is a reflection of the squirrels preparing for the winter months. We also noted that activity did not decrease as the temperature got colder and similar trends in daily behaviors were consistent over our short sample period. This study needs to be extended over a longer year-long time frame and perhaps with a focus on particular individuals. Overlaid on the research project itself is the educational experience in a non-major course focus on teaching science and quantitative literacy.

24 - Reef Revelations: A Biodiversity Survey of the Artificial Reefs of Lake Allure in Quarryville, Pennsylvania

Elefteria Papavasilis, Millersville University

The reclamation of abandoned flooded mines has long been of interest to SCUBA divers seeking to engage in training and recreation despite their inland locations. In 2021, Barr's Quarry in Quarryville, Pennsylvania was mapped using SONAR, GIS, and GPS to identify any potential hazards and ascertain whether the lake could be used as a dive training facility. The lake was renamed Lake Allure and was opened to the public for SCUBA diving in the Spring of 2022.

In the Spring of 2021, two boats were sunk in Lake Allure, one at 30 feet and one at 70 feet to provide SCUBA divers with attractions. This provided a unique opportunity to study the formation of freshwater reefs in inland lakes. It was hypothesized that depth will influence community composition and succession on the submerged boats. To assess organismal settling over time, a one-meter square grid was placed on each boat and within each grid settling plates were placed to allow the natural growth of organisms. From November 2021 to October 2022, 4 plates were collected from each boat each month and analyzed qualitatively using a dissection microscope and a light microscope at 200x magnification. For each of the 88 tiles that were collected, 3 slides were prepared, and quantitative analysis of all organisms was conducted. A total of 50 different organisms were observed falling into 14 different phyla.

Data were analyzed using R to create NMDS ordination plots, spider plots, and Simpson and Shannon Diversity indices. Differences were observed in diversity, richness and community structure and these differences correlate with depth and collection month which is influenced by light penetration. The lessons learned from this research can help to guide natural resource management plans for Lake Allure as well as be applied to the establishment and conservation of other artificial reefs with high SCUBA diver visitation.

25 - Variation in micro plastic concentrations among freshwater macro invertebrates by functional feeding group

Matt Fuchs, West Chester University

Co-Author: Megan Fork, West Chester University

Microplastics are fragments less than 5mm in size that shed off from larger plastic products. Microplastic pollution is an emerging contaminant in our waters that can sorb toxins and cause physical blockages in consumers digestive tracts. This can lead to the bioaccumulation of microplastics in consumers at the top of the food chain. We collected freshwater macroinvertebrates from a stream in West Chester, PA to discover the rates of microplastic contamination in consumers of relatively low trophic level. Specifically, we compared the number of microplastics in the gut contents among functional feeding groups found in the stream (shredders, collector/gatherers, predators, scrapers, and filter feeders). Microplastics were also categorized by relative size and type (fibers, fragments etc.). We controlled for contamination by subtracting lab blanks and wearing cotton lab coats during sample handling. We used an ANOVA to compare functional feeding groups and stream habitats to help describe how microplastics are distributed in freshwater food webs among organisms with different feeding strategies.

26 - Patterns of Amphibian Community Composition Within Suburban Habitats

Peyton Arbour, Stevenson University

Co-Authors: Isabel Berner, Stevenson University; Mark Norris, Stevenson University

Around the world, amphibians are the most threatened species, mainly due to anthropogenic actions including habitat loss and climate change. They are disproportionally impacted because they rely on both aquatic and terrestrial habitats and their transdermal uptake makes them more sensitive to changes in their environment. Amphibians are not only important to ecosystem function, they are also indicators of habitat quality. In order to determine the habitat quality surrounding Stevenson University (Baltimore County, Maryland), call surveys, coverboard surveys, and vernal pool surveys were used in the spring of 2022 to identify the presence of salamanders and frogs during different stages of their life cycles. During the study, three species of frogs were identified, while there was no presence of salamanders. Lithobates sylaticus (wood frogs) were observed as adults, eggs, and tadpoles, Pseudacris crucifer (spring peepers) from their call, and Rana clamitans (green frogs) as tadpoles. The species of frogs that were present faced extensive predation from several animals, most notably raccoons, great blue herons, ducks, and snapping turtles. In viewing amphibians as indicator species, this suggests that the surveyed habitats are currently in poor health, especially given the absence of salamanders. This is likely due to habitat loss and human development relating to campus expansion which results in loss of canopy cover, decreased soil moisture, loss of leaf litter, and habitat fragmentation.

27 - The Impact of Reforestation Technique on Stem Mortality in a Seven-Year-Old Reforestation Experiment

Kathryn Krueger, West Chester University

Reforestation can restore forest ecosystem services and function to disturbed areas of the mid-Atlantic where they have been lost. While several reforestation techniques exist, their long-term impacts on forest structural development have not been well studied, specifically how different planting strategies affect stem mortality. This question was investigated at Mount Cuba Center, where six plots were established using reforestation treatments varying in planting density (5 vs. 10 foot spacing) and species composition (trees only or trees and shrubs). In each treatment, living and dead stems were identified and measured for diameter at breast height and leaf area index (LAI). Treatments were examined for the degree of stem mortality after seven years of growth by comparing the percent of dead stem density to living stem density in each plot. Species composition, especially for treatments with trees and shrubs, had a greater influence on stem mortality than planting density, though both variables contributed to stem losses. Treatments without shrubs had comparatively lower stem mortality. All treatments experienced some deviation from the originally established species composition, with the greatest differences observed in treatments including shrubs (dead stem density was 25-30% of total stem density). Across treatments, the majority of dead stems were small trees (5.0 - 7.3 cm stem diameter). Average LAI was the greatest in high-density plots, though it was not associated with higher stem mortality. As reforestation techniques including both trees and shrubs yield substantial stem mortality, the high establishment investment (i.e. cost and time) may not yield intended restoration goals.

28 - Growth rates of the non-native liana Celastrus orbiculatus (Oriental Bittersweet) along an urban gradient

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Celastrus orbiculatus, commonly known as Oriental Bittersweet, is a non-native invasive woody vine (liana) that originates from Asia. Since being introduced as an ornamental plant in the 1860s, it has spread throughout the Eastern states of North America. It appears that this species is spreading even further due to the ramification of climate change, such as increasing temperatures and increased levels of CO2, and overall environmental disturbance. The purpose of this study was to determine if individuals from populations in an urban location showed increased growth rates compared to those in suburban and extra-urban sites. We harvested stem cuts from three populations and analyzed the age and annual ring growth. Contrary to expectations, the results showed that the suburban site, with the oldest liana individuals on average, had the strongest growth. The annual growth rate was found to be determined by the age structure of the populations and the overall environmental stability of the sites. In the urban site, a strong disturbance regime was observed, causing marked fluctuations in growth that were absent in more stable sites. We are now exploring whether populations in urban areas are spreading more than those in areas where populations have been established for a long time, by utilizing correlations between stem diameter and age. Overall, this study provides initial insight into how the growth rate of Oriental Bittersweet is influenced by environmental factors and highlights the importance of considering the age structure and stability of populations when studying the spread of invasive species.

29 - Exploring the Diversity of Wolbachia in World-Wide Pheidole Ants

Kenya Lovell, West Chester University of Pennsylvania

Bacteria are an essential component of a healthy organism and environment. The microbiome is thought to play an important role in development, behavior, and evolution of an organism. However, while endosymbionts are common, there is often little known about the role that individual species of bacteria play within the host. One such example is Wolbachia, a common endosymbiont of many ants, but one of which we know little about. The goal of this campaign is to examine how the geographical area of the extremely diverse genus of ant, Pheidole, originated from contributes to the diversity of Wolbachia in this type of host, and observe how the presence of this facultative bacteria affects seed-harvesting behavior. Ant colonies were collected from a range of geographic areas and screened for Wolbachia by sequencing of the wsp gene in several ants from each colony. Then, Multi-Locus Sequence Typing of coxA, fbpA, ftsZ, gatB, and hcpA will be conducted to determine a host's individual sequence type to visualize the range of Wolbachia strains present. Unique sequence types will be added into the Wolbachia MLST database, and then used to observe the relationship between geographic location of the host and diversity of the bacteria. As ants are an excellent model organism for studying host-microbe interactions, the information within this study will play an important role in providing insight into the coevolution of Wolbachia and Pheidole ants, significance of this bacteria in its host, and what environmental factors affect the strength of their symbiotic relationship.

30 - Competition and hybridization between two Faxonius crayfish species in south-central Pennsylvania

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Rusty crayfish (Faxonius rusticus) is an invasive species that has been expanding its range in south-central Pennsylvania for at least two decades, and has been associated with declines in a variety of native invertebrate taxa. It appears to outcompete similar crayfish species by reaching larger densities and body sizes, competing aggressively for shelter and food, and better resisting predation. In addition, it is known to hybridize with several other Faxonius species, including Allegheny crayfish (F. obscurus), a Pennsylvania native and long-established species in the lower Susquehanna drainage. We collected rusty and Allegheny crayfish and possible hybrids from nine allopatric and sympatric sites in the Conodoguinet Creek and Yellow Breeches drainages. For each crayfish, we took 12 morphological measures and recorded the presence or absence of three distinct features: rusty spot, smooth vs. toothed mandible, and black bands on chelae. Based on these features (and following Merovich et al. 2021) we tentatively assigned each individual as rusty, Allegheny, or possible hybrid. Presence or absence of the characteristic rusty spot and smooth vs. toothed mandible were reliable species indicators, and intermediate crayfish had some combination of these features. The black band near the tip of the claw was present in all rusty but also in many Allegheny crayfish, even in allopatric sites, so we do not recommend using this to distinguish species. Principle components analysis (PCA) of the morphological measures distinguished the two species fairly well in allopatric sites, but sympatric populations had many intermediate individuals whether they were tentatively identified as rusty, Allegheny, or hybrid. To examine competition for resources between rusty and Allegheny crayfish in these populations, we are currently preparing crayfish tail muscle tissue for stable isotope analysis. As has been seen in other crayfish, we expect to see significant trophic niche overlap between the two species and likely a shift or decrease in niche width among Allegheny crayfish in sympatry. There are too few putative hybrids in these populations to draw firm conclusions about their trophic niche, but we expect it to overlap broadly with both parent taxa.

31 - World Insect Decline: Impact of Human Constructions on Insect Diversity

Jonathan Morgan, West Chester University (Dr. Ramalho)

In an effort to combat various environmental and developmental challenges, green infrastructure and urban greening, in combination with existing gray infrastructure, will be essential in the effort to develop and maintain a robust, healthy environment across rural and populous regions. Insects and their global diversity hold a crucial ecological role in different environments and ecosystems that directly impact human health, agriculture, and development. Due to overpopulation, pollution, climate change and overall habitat loss, insect diversity has been on the decline in the last few decades. To investigate the effectiveness of green infrastructure and other forms of infrastructure at housing insect diversity, the experiment will look at different forms of rural, urban and natural infrastructures in the West Chester, PA region. Additionally, this project will investigate how seasonal changes impact the diversity of these insects over time. Pitfall trapping was implemented at these locations to collect the insects. The pitfalls traps were set at each location on the same day for a 48-hour period across several months to allow for adequate data collection across different seasons and weather patterns. Understanding how well different forms of infrastructure promote insect diversity amidst the growing issue of overpopulation, pollution and climate change can guide the development and construction of future green infrastructure to encourage and strengthen insect and environmental diversity in the future.

32 - Using stable isotope analysis to explore the exploitation of anthropogenic foods by gray squirrels and eastern chipmunks in urban and rural sites

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As urban and suburban areas continue to grow both in population and land area coverage, natural wildlife habitats experience more anthropogenic effects than ever before. Habitat fragmentation is increasing which typically results in a decrease of species richness and viability, however, species with generalist diets may reap the benefits of anthropogenic effects by consuming human food. We conducted live trapping of small mammals, eastern chipmunk (Tamias striatus) and gray squirrel (Sciurus carolinensis), at differing levels of urbanization to explore this idea using stable isotope analysis. Eastern chipmunks were captured on a college campus in a small city, in urban residential properties, and in rural forests, while gray squirrels were captured on the college campus and a rural deciduous forest. Anthropogenic food availability is highest on campus due to open trash cans and dumpsters, intermediate on residential properties, and lowest in rural forests. Isotopic signatures of gray squirrels from urban locations were significantly higher in Î´15N and Î´13C than their rural counterparts (p<0.0001, p<0.0033, for Î´15N and Î´13C, respectively; t-test). Eastern chipmunks followed a similar pattern such that the isotopic signatures of chipmunks from urban sites were significantly higher in both Î´15N and Î´13C in comparison to their rural equivalents (p<0.0001, p<0.0038; t-test). These data suggest that the animals are exploiting anthropogenic food sources when available. Further analysis of the chipmunk data revealed differences within site types. Signatures of eastern chipmunks from residential properties with bird feeders were significantly higher in Î´13C than those without feeders and rural sites (p<0.0068, Tukey HSD), likely a reflection of corn that is often present in bird seed. The isotopic signatures of eastern chipmunks from a site dominated by nitrogen fixing black locust (Robinia pseudoacacia) trees were significantly lower in Î´15N than any other location (p<0.0001, Tukey HSD). Overall, the exploitation of anthropogenic foods by small mammals is reflected in the isotopic signatures of their fur, but underlying factors such as local vegetation may disrupt these patterns.

33 - Autumn leaf litter removal reduces moth emergence in suburban yards

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Lepidoptera and parasitoid wasps are of interest to urban land managers as pollinators and natural enemies. However, their populations are declining because of urbanization. Leaf litter removal is a ubiquitous landscaping practice in suburban ecosystems, yet we have little understanding of its impacts to these overwintering taxa. To assess this annual disturbance, we conducted litter removal manipulations in both maintained and unmaintained sections of 14-20 suburban yards. We collected Lepidoptera and parasitoid wasps from these treatments weekly using emergence traps throughout the spring and early summer.

Regardless of maintenance area, about 75% more Lepidoptera emerged when litter was retained in both 2021 (Ï‡2 (1, N= 66) = 5.52, p= 0.01) and 2022 (Ï‡2(1, N=34) = 8.5219, p= 0.003). More Lepidoptera emerged from maintained areas than unmaintained areas, two times more in 2021 (Ï‡2 (1, N= 26) = 6.04, p= 0.01) and 1.4 times more in 2022 (Ï‡2 (1, N= 14) = 19.07, p= < 0.001). Litter management within each maintenance area had an insignificant effect on parasitoid wasp emergence in 2021 (Ï‡2 (1, N= 66) = 0.34, p= 0.55). In 2022, there was an interaction effect between litter management and maintenance area (Ï‡2 (1, N=14)= 4.78, p=0.028) where removing litter from a maintained area led to 24% more emerging wasps than removing litter from an unmaintained area (z= -2.785, p=0.027).

Litter removal reduces Lepidoptera, but generally not parasitoid wasp, emergence regardless of yard maintenance intensity. However, more maintained areas have higher total emergences possibly due to the presence of more ornamental vegetation. Mismatches between parasitoids and prey could place further pressure on Lepidoptera populations. These results suggest that removing leaf litter could be a key cause of urban moth decline.

Laila Steele, Towson University

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34 - Effects of Deer Activity on Native Herbaceous Species Abundance

Elevated populations of white-tailed deer (Odocoileus virginianus) can fundamentally alter forest ecosystems. Deer can decrease seedling and herbaceous abundance through grazing and trampling. Although deer population size and vegetation abundance are often negatively correlated; many other factors can further affect forest vegetation growth. Observations from a nearly 10-year deer exclosure experiment in Baltimore County, MD found that vegetation in some deer exclosures were recovering, but vegetation in other exclosures showed no effect of excluding deer. To determine if vegetation recovery was related to local deer activity, we used camera traps to quantify deer activity in the open access plots paired with the 11 deer exclosure plots at the Towson University Field Station. We tested for relationships between the level of deer activity in the access plot over a full year and the change in vegetation abundance in the paired deer exclosure plot over the span of 5-7 years. We hypothesize that areas with more deer activity will have a lower seedling and herbaceous abundance.

35 - Small Mammals Perceive Most Fruits of Invasive Plants as Low-Quality Forage in a Pennsylvanian Forest and Meadow

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Invasive plants often drastically alter food webs. Small-mammal assemblages may be greatly impacted by invasive plants, which often provide cover from predators. In addition, a less-studied potential impact is the possibility that small mammals use invasive plants as a food resource. We quantified small mammal giving-up densities (GUDs) by offering fruits of 5 common invasive shrubs and 1 native shrub in adjacent meadow and forest habitats in Pennsylvania. The study ran for two 48-hour sessions in November in 2 consecutive years with different combinations of shrub fruits available to small mammals within buckets that also contained Panicum miliaceum (Proso Millet), and sand. While some degree of differences in foraging activity could be accredited to annual variation, significant differences in GUDs among fruit species and between habitats were detected. The fruits of the invasive shrubs Berberis thunbergia (Japanese Barberry), Ligustrum vulgare (Eurasian Privet), and Rhodotypos scandens (Jetbead) did not appear to be significantly foraged on by small mammals in either habitat. However, the woody liana Celastrus orbiculatus (Bittersweet) was readily consumed in both the forest and meadow. Fruits of the invasive shrub Eleagnus umbellata (Autumn Olive) was favored but only in meadow habitat, while fruits of the native shrub Lindera benzoin (Spicebush) were moderately foraged in the forest. Through this experiment, we were able to conclude that most woody plants included in this study offers fruits with limited perceived benefit. However, Oriental Bittersweet and Autumn Olive may represent important exceptions that could be influencing small-mammal foraging patterns in northeastern forest and meadow ecosystems.

36 - The Effect of Topography on Soil Characteristics, Diversity and Biomass in Interior Plots of SUNY Old Westbury Forest

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Certain topographical features e.g., percent slope can promote water runoff and an export of nutrients which impact soil properties, vegetation diversity, biomass, and carbon storage. Prior studies about the relationship between topography, edaphic attributes, and vegetation above-ground concern a few species of plants, roots measurements, or vegetation restoration efforts in areas that do not fall under the current temperate forest map. Thus, the effect of topography on characteristics of soil and vegetation is largely unknown in temperate forests such as our study site. Our study investigated the relationship between topographical variation among the three permanent, interior forest plots at SUNY Old Westbury forests and its impact on vegetation's diversity, biomass, carbon storage, and soil characteristics. Specific objectives included the comparison of topographic and physicochemical soil features (percent slope, elevation, aspect, soil texture, density, and pH), in relation to Î± and Î²-diversity of the plots, and productivity measured as biomass and carbon accumulation based on mean diameter at breast height. We also compared the dispersion pattern for each tree species and rank abundance curves in the plots. This study found that the interior plot with the lowest percent slope (5%) had the highest average biomass (18687.72 Kg. ha-1), average carbon storage (8876.67 Kg. C. ha-1), percent water content (40%), percent relative humidity (25%), and the most dominant/codominant trees with the highest mean diameter at breast height (41.87 cm). However, the relationship between the highest Î±-diversity in the plot with the highest percent slope needs to be explored further.

37 - Bird Migration Measured by Audio and Radar are Poorly Correlated

Zachary Hoffman, Gettysburg College

Co-Author: Dr. Andrew Wilson, Gettysburg College

Anthropogenic light at night is a major driver in bird population declines, disrupting vision and causing bird window collisions (BWCs) in nocturnal migrants. Several tools are used by researchers to quantify nocturnal migration to direct mitigation efforts, such as city-wide lights-out programs. These programs are informed by real-time predictions of migration activity produced by weather radars (BirdCast). Previous research has shown that many nocturnal migrants fly at altitudes of several thousand feet, and as such, may be less prone to BWCs. Our aim was to see whether BirdCast data correlate with low elevation migration detected through audio recordings of nocturnal flight calls (NFCs) over 56 nights between September 9th and November 10th 2022, at Gettysburg College, Adams County PA (39.8357° N, 77.2367° W). We also conducted 27 walking surveys of the college campus to see whether BWCs were associated with nights of heavy low altitude migration, as indicated by NFC counts.

Audio recordings were analyzed using BirdVoxDetect to detect and identify bird calls. A total of 31,754 bird calls were detected, a mean of 567 calls per night. During the same period, BirdCast estimated that 29,690,600 migrants passed over Adams County, a mean of 530,189 per night. The correlation between NFCs and BirdCast totals was modest ($r = 0.41$) but changed seasonally, with a strong correlation during September ($r = 0.85$) and a weak negative correlation during October and early November ($r = -0.12$). We hypothesize that the seasonal disparity could be due to changes in the taxonomic makeup of migration throughout the fall. Generalized linear models showed that NFC counts were negatively associated with temperature ($p = 0.014$). Our data suggest that strong low-level migration can occur on nights when overall migration activity is modest. Walking surveys on the Gettysburg College yielded evidence of 15 bird window collisions. We concluded that the college campus has a relatively modest BWC problem and that most of the collisions were not associated with nights of strong low-level migration.

38 - Dominant tree species size distributions are unchanged from urban forest edge to interior

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The majority of temperate forest in the eastern U.S. exists as a patchwork of small, isolated, urban forests, often with a history of deforestation followed by regrowth under surrounding urbanization. Many of these forests are bound by roads or residential development, creating abrupt forest edges. Previous research has suggested that proximity to a forest edge alters environmental conditions and the structure and composition of the plant community. Light availability, temperature, and shrub abundance have all been shown to increase from the forest interior to the forest edge. Because urban forests exist in highly populated areas, humans rely on them to provide physical and mental health benefits. Additionally, we increasingly rely on the carbon (C) storage potential of forests as nature-based solutions for climate change, but if the structure of a forest declines it may not be able to provide these services. Here, I examine if the size distribution of dominant tree species changes from the forest interior to the forest edge in urban forests. Using census (DBH) data from forests in Springfield MA, Philadelphia PA, Newark DE, and Baltimore MD, I constructed size distributions for four dominant tree species at 25 m intervals of distance from the forest edge (0-150 m total). The four species exhibit differently shaped distributions. Acer rubrum distributions are skewed towards smaller individuals, Fagus grandifolia distributions are heavily skewed towards smaller individuals, almost unimodal, and Quercus spp. and L. tulipifera distributions are uniform. For each species, the size distribution was the same at all distance intervals from the edge. The difference in distribution shape between species is indicative of species-specific recruitment and growth patterns. The lack of any structural shift from edge to interior indicates that other site characteristics; history, edge type, or canopy openness, exert a greater influence on the plant community than proximity to the forest edge. Future research should investigate whether tree growth in urban forests reflects the same species-specific patterns, and lack of distance relationship demonstrated in this analysis.

39 - Microbial communities in nectar contribute to sexual reproductive success in Asclepias syriaca

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Specialized bacteria and fungi inhabit floral nectar and alter its chemistry. These microbes can have indirect effects on plant fitness through changing pollinator behavior, but more direct effects have yet to be shown. The unique morphology and pollination system of milkweeds in the genus Asclepias create a system where the nectar microbiome can directly affect plant fitness by changing the sugar profiles of floral nectar, thereby altering its efficacy as a pollen germination medium. Previous work suggests that there is an optimum sucrose concentration to support pollen germination; we investigated the effects of glucose and fructose, sugars commonly created through inversion by microbes. To explore microbial contributions to these changes in sugar profiles, we also performed a pollinator-exclusion field experiment where flowers were bagged to prevent pollinator visitation (and, therefore, microbial inoculation) or left open. We analyzed the sugar profiles of these nectars using HPLC and connected microbiome communities to sugar profiles using amplicon sequencing.

Pollinia germinated best in glucose solutions below 20% concentration, and rarely germinated in any concentration of fructose. In tandem, we found that nectar from bagged flowers had 40% more sucrose and 30% less fructose than nectar left open to pollinators. In addition, these bagged flowers'sucrose concentrations were higher than what our lab studies indicate should allow for pollen germination. These results suggest that microbial inoculation of Asclepias nectar may improve pollen germination and therefore for sexual reproduction, providing a first example of a direct link between the nectar microbiome and plant fitness.

40 - Mapping hemlock stand distribution and structure in Otsego County, NY to develop site-specific mitigation of hemlock woolly adelgid

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The invasive hemlock woolly adelgid insect (Adelges tsugae, HWA) threatens eastern hemlock trees (Tsuga canadensis) throughout eastern North America and is an increasing threat in Otsego County, NY. Different management strategies can mitigate the spread and effect of HWA, but landowners need information on the distribution and characteristics of hemlock stands to inform their decision-making process. We used field sampling of stand structure combined with remotely sensed data to a) map eastern hemlock in Otsego County and b) model stand structural characteristics of these stands. This information will be used to develop and disseminate site-specific recommendations on mitigation options to land owners. During the summer of 2022 we used point sampling (n= 5-10 per stand) to measure basal area and density of all tree species from 21 hemlock dominated stands distributed across the county. Stand basal areas were between 24 and 54 m2/ha with relative basal area of hemlock between 37 to 88 %. The majority of the stands were west to north facing and were at elevations ranging from 362 to 557 m. Supervised classification was employed with the Semi-Automatic Classification Plugin in QGIS using Landsat imagery (Landsat 8-9 OLI/TIRS C2 L2, 11/03/22 and 07/03/22) on a training set of 81 plots. This classified the vegetation into categories of Cultivated Field, Hay Field, Deciduous Forest and Conifer Forest. The accuracy of classifying our 21 hemlock stands as conifers was 100 %. With this data set, we were unable to separate hemlocks from stands of other conifer species, especially spruce (Picea sp.); additional remotely sensed data using a different sensor platform is needed. If hemlock stands can be separated from other conifers, we will estimate stand structure based on remotely sensed data. Multiple regression results showed that Landsat bands can be used to estimate hemlock relative basal area with 70% accuracy. Together a map of land cover classification and hemlock stand structural characteristics can inform land owner's decisions on mitigation of hemlock woolly adelgid either by cultural controls, chemical controls and/or biological controls.

41 - Generating continuous disease time series from the historical record

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Ongoing digitization and data-sharing efforts will continue to advance our understanding of historical human disease dynamics, and relevance to current problems. However, many data in the historical record are not immediately amenable to analysis, owing especially to variation in record-keeping. Whereas a wide array of methods have been developed to up- and down-sample unevenly- sampled series of snapshots (e.g., temperatures, stock prices), these tools are inappropriate for cumulative quantities sampled at varying intervals (e.g., rainfall, disease incidence). Generating evenly spaced time series from the historical record is a prerequisite to many analyses ranging from animated visualizations of disease spread to advanced statistical techniques for identifying important time scales of variation (e.g., spectral and wavelet decompositions). Here, we develop a general process for integrating historical disease incidence and population data into continuous disease time series, while addressing data gaps as well as variation and mismatch in the temporal scale and location of reporting intervals.

We use generalized additive models to fit recorded disease incidence counts, with offsets for reporting-period duration and estimated population size. The resulting models predict the expected daily rate of new infections per 100,000 residents, a standard epidemiological measure of incidence rate. Applying this method for a variety of diseases, using a century of infectious-disease surveillance data at the provincial and national level in Canada, we find good fits to observed data, sensitivity to high-frequency changes in regional disease dynamics, and coherence between predictions based on data collected at different spatial scales. Model predictions can be sampled at different time intervals to generate evenly spaced time series amenable to a variety of visualization and analysis approaches. We will be refining these methods and integrating them into a toolkit for interacting with a large, soon-to-be publicly accessible repository of public health data from Canada and the United Kingdom.

42 - Ground arthropod communities in urban and rural riparian forests

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An increasing proportion of human populations are living in cities and increasing urbanization comes at a cost to natural ecosystems. For example, riparian forests are becoming ecologically degraded, and their roles in providing society with ecosystem services are altered. These stream side forests are transitional areas between aquatic and terrestrial ecosystems and facilitate unique species interactions. Anthropogenic change due to urbanization negatively affects the role of riparian forests by changing biogeochemical cycles as well as impacting biodiversity. A large proportion of riparian forest diversity is represented by invertebrate communities which play major roles as pollinators, soil aerators, organic matter processors, and prey for other species. Altered arthropod fluxes in urban areas can affect food webs, nutrient cycling, and stream water chemistry with cascading effects. This study investigates riparian forest ground dwelling arthropod abundance and community composition. Urban and rural riparian sites were selected in the Greater Binghamton area of the Southern Tier, New York. As a medium sized city, these areas often share more interactions with nature compared to large, densely populated cities, and therefore understanding impacts on ecosystem structure and function are of key importance. Field surveys of ground arthropods were conducted using pitfall traps in 2019 and 2020. We counted total abundances and identified ground arthropods to order and family levels.

Our results indicate that on average, urban sites had higher ground arthropod abundances than rural sites when counting the beetles, mites, springtails, spiders, millipedes, ants and crickets. Using generalized linear mixed effects models, we found significant differences between ground arthropod abundances in urban and rural riparian forests in 2020, although this effect was not observed in 2019. We identified 14 families of spiders consisting of 26 species and average species richness was higher in urban sites than rural sites. Further analyses will be conducted to quantify spatial variation in abundance and composition across sites. If riparian forest ground arthropod communities in urban areas are comparable to those within rural riparian forests, then these green spaces in urban areas provide important opportunities for conservation. Maintaining riparian forests as corridors along streams and urban greenspace can allow effective riparian ecosystem management and mitigate some ecological issues related to land use and environmental quality and contribute to human wellbeing and urban sustainability.

43 - Has Historic Redlining Influenced Urban Butterfly Diversity?

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During the 1920s the Home Owners Loan Corporation (HOLC) graded urban neighborhoods from Green (most desirable), through Blue, then Yellow, to Red (least desirable), hence the term redlining. The lasting repercussions of redlining have left previously segregated communities with a multitude of health concerns. Not only are redlined neighborhoods more prone to hotter temperatures, but current residents are more likely to have health complications and less access to green space and nature. We aimed to see whether there were differences in butterfly diversity among the four HOLC neighborhood grades. We obtained butterfly locations for 2010-2019 from iNaturalist and overlaid them on maps of the HOLC grades. We calculated both Simpson's and Shannon's diversity indices for butterfly counts in the four HOLC grades in 52 cities across the United States, based on 14,505 observations of 150 different species of butterfly. We used generalized linear models to test the effects of various environmental factors, including HOLC grade, on butterfly diversity. We found that butterfly diversity was higher in yellowlined than in redlined areas ($p = 0.039$), but there were no significant difference between red, blue and greenlined areas. All areas were dominated by developed land cover types (mean = 96% of area), but greenlined areas had significantly more forest cover (5.3%) than blue (2.0%), green (1.9%), or redlined (2.0%). However, we found no evidence that this resulted in higher butterfly diversity in greenlined areas, and no evidence that butterfly diversity was lower in redlined areas than in nearby yellow, blue or greenlined neighborhoods.

44 - Competition, deer, and the struggle to achieve perfection in prickle density

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To protect themselves from herbivory, some plants exhibit defenses by increasing growth of mechanical structures like prickles. However, these plants may experience a trade-off between higher defense production and growth. Typically, suburban forests with overabundant deer contain abundant nonindigenous, invasive plant species, which can impose significant stresses on plants that experience this trade-off, as they must be well defended from deer, but also need sufficient growth to compete. Here, we focused on Rubus allegheniensis (common blackberry), an indigenous, prickle-defended species for which previous work showed greater prickle density under greater ambient deer pressure, and in plots with access to deer versus fenced plots. Prompted by these findings, we conducted a fuller investigation of prickle defense by using structural equation modeling (SEM) to test a system-wide hypothesis focused on how light, deer pressure, herb layer competitors, and blackberry prickle density and proportion cover directly and indirectly interact. Data on these variables were obtained from 60 plots across four suburban forests in Mercer County, NJ, USA, where fenced and unfenced 16 m2 plots have been part of a white-tailed deer exclosure experiment since 2012. The piecewiseSEM package in R was used to test our hypothesis, and it was refined until a fitted model containing only important paths was reached. The final model explained over 90% of the variation in blackberry cover, with a very strong positive effect from the competitors' relative cover, a strong positive effect from prickle density, a weaker positive effect from light availability, and no effect from deer pressure. Prickle density was somewhat greater with more deer pressure, but a negative effect on prickle density from the competitors' relative cover was twice as strong as the positive effect of deer. A growth response to increased competition appeared to be more paramount than allocation to defense for blackberry in these suburban forests, even though deer density in the region is generally very high. Deer pressure (ranging from zero in fenced plots to a forest-specific ambient measure in unfenced plots) had much less influence on increasing prickle defense than did the herb layer competitors on decreasing blackberry prickles while also increasing blackberry cover. A comparatively more important role of the surrounding plant community in defense versus growth was revealed using the multivariate SEM approach, which allowed us to put our previous univariate results about deer effects on defense into a fuller ecological context.

45 - The effects of overabundant suburban deer on leaf size and percent cover of canopy tree juveniles: why what you eat is more important than you think

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Long-lived canopy tree species like Liriodendron tulipifera are susceptible to herbivory by overabundant white tailed deer within the herb layer of suburban forests. Browsing can cause direct negative effects on juvenile trees' height, percent cover, and competitive ability, potentially reducing their ability to populate the canopy. Overabundant deer may also have indirect effects on plants in the herb layer, as their intensive browsing reduces plant cover and may increase available sunlight, which can influence plant growth and affect traits such as leaf size. We have noted that leaves of L. tulipifera exhibit a tremendous size range in the suburban forests of central New Jersey. After first documenting that deer do indeed browse L. tulipifera, we tested two hypotheses: (1) percent cover is greater in deer exclosure plots than access plots due to a direct effect of deer herbivory; (2) leaf area is greater in exclosure plots due to greater shade, following the shade vs. sun leaf model, and/or because of the bonsai effect of chronic herbivory in the deer-access plots. We used data from a long-term exclosure experiment in Mercer County, NJ, consisting of 16 m2 plots either without deer fencing or fenced since 2013, focusing here on one forest where L. tulipifera is common and was present in nine fenced and five unfenced plots. In the 16 deer access plots in this forest, we measured deer browse rates on all woody species for the 2021/22 winter, and ranked them by feeding preference; L. tulipifera ranked third out of ten common woody species in the understory. In fall 2022, we measured L. tulipifera percent cover, using a releva method, randomly sampled leaves in the fenced and unfenced plots and calculated their areas with ImageJ, and measured the percent of full-sun photosynthetically active radiation (PAR) using an AccuPAR ceptometer (Decagon Devices). All analyses were Welch's t-tests. Leaf area and percent cover were significantly greater in fenced vs, unfenced plots, even though PAR was not, which may show that deer herbivory, not sunlight, is the driver of L. tulipifera leaf size variation. Examining how leaf size can play a role in the growth and survival of L. tulipifera could be applied to similar species that need protection from overabundant deer. Canopy tree species are highly important to the success and health to suburban forest ecosystems, and without protection from herbivory can affect the vital indigenous species of our region.

46 - The influence of soil properties on abundance and diversity of subarctic soil microarthropod communities

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Soil mesofauna play pertinent roles in soil processes. Microarthropods strongly influence the rate of decomposition performed by microbial communities. The relationship between microarthropods and their environment are understudied in low arctic ecosystems compared to other regions. A more detailed grasp of these soil assemblages are necessary for understanding the current functioning of these ecosystems. We characterized the soil mesofauna community across different low arctic habitats and hypothesized that key soil physiochemical properties would affect the distribution, abundance, and diversity. Samples were taken at five different lakes in Northern Finland, in both alpine meadows and sub-alpine birch forests, with increasing distance from the lake's edge. Soil mesofauna were extracted and sorted into orders and soil physiochemical properties (pH, electrical conductivity, loss on ignition, nitrogen content (%N), soil water content) were also tested. We performed ANCOVA's to explore differences in the mesofauna community among the lake habitats, and Pearson's correlation and CCA to identify their relationship to soil properties. We found that diversity and evenness decreased as distance from the lake increased, but abundance and richness remained consistent. Soil physiochemical properties only affected abundance, but not diversity or evenness, and may better explain community composition changes. Our results provide further insight regarding the soil fauna assemblies in Northern Finland but further, more extensive research should be done to have a more comprehensive foundation. This will allow for better monitoring of community changes and responses in the face of climate change in the low-arctic.

47 - Colony hygiene behaviors and undertaking mechanisms in the arboreal turtle ant (Cephalotes varians)

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Social insects live in densely-populated nests, and therefore must be concerned with how to best maintain colony health in the face of disease risks. The turtle ant Cephalotes varians exhibits hygiene behaviors that reflect the species' behavioral adaptations to life in an arboreal habitat. Undertaking behavior has been described in a variety of ant species, and refers to the usage of mandibles to lift debris, wounded ants, or deceased ants to relocate them; in arboreal ants, often this relocation involves heaving ants off the tree branches in which they live. This project aimed to investigate the undertaking mechanisms of C. varians, with a focus on understanding how the ants manage waste and maintain cleanliness within their nests. To achieve this, a four-box arena connected by paper bridges of varying heights was constructed. The colony nest was placed in one of the boxes, and experimental trials were conducted, in which a deceased member of the colony was placed on top of the nest roof. Recordings were taken over the course of multiple hours, and the footage was observed for the colony's behavioral response. Ants were monitored over time to determine how the insects would react to the placement of a disease hazard within close proximity to their nest. It was theorized that ants would utilize the paper bridges - representative of the tree branches and vines found in nature - as reliable peaks off of which to dispose of these hygiene threats.

The resulting observations revealed that C. varians utilize their undertaking behaviors to ensure that hygiene threats are located as far as possible from the nest. The ants showed a strong preference for distance over any other variable tested, including height. Presentation of deceased colony members often triggered a panicked response in nearby worker ants, which lasted for a brief time interval, after which ants no longer displayed significant reactions. Despite this, the deceased ants continued to gain distance from the central nest, regardless of not actively being presented to the colony. Overall, this project shed light on the complex behavioral interactions that allow these ants to maintain a healthy and efficient nest environment.

48 - Relative Habitat Utilization of white-tailed deer (Odocoileus virginianus)

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Habitat utilization by white-tailed deer has been analyzed across large- and fine-scales. Large landscape-scale studies generally conduct research over areas greater than a typical deer home range, often with the purpose of estimating deer population sizes. Most fine-scale studies are typically smaller than the species home range and focus on movement patterns and habitat use by specific populations. Overabundance of white-tailed deer and the resulting over utilization of many habitats results in low forest regeneration and decreased vegetation cover and density. An understanding of white-tailed deer habitat use at a local scale can help habitat managers, public, and private landowners, and other stakeholders determine actions to manage white-tailed deer populations and improve local forest communities. In this study we focus on a fine-scale approach to determine the habitat characteristics related to high visitation from white-tailed deer. White-tailed deer visits were quantified in a 280-acre area by using twenty-five game cameras randomly distributed across three distinct forest vegetation communities for one year. At each camera location vegetation surveys were used to determine composition, vertical density, and canopy openness and these data were used to identify vegetation characteristics associated with both high and low white-tailed deer activity. We predict that white-tailed deer are selecting areas that contain dense vertical vegetation cover over areas with available food sources.

49 - Comparison of bold/shy behavioral responses of the blacknose dace, Rhinichthys atratulus, between urban and rural populations

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Urbanization is rapidly altering stream characteristics and consequently disrupting associated ecology and biodiversity of urban streams. Increased impervious surface cover (ISC), through expansion of cover by asphalt, concrete, roofs, etc., results in warmer temperatures, greater variability of flow, and has been associated with decreased fish diversity of urban watersheds. Blacknose dace (Rhinichthys atratulus) are among the few urbanization-tolerant species that persist in both substantially degraded streams of Baltimore, MD and in nearby, rural streams with diverse fauna.

Although previous studies have examined how urbanization and increased ISC may influence physiological plasticity of the blacknose dace, little is known about how it may influence their social dynamics and behavioral interactions. In focusing on behavior of this tolerant species, the long-term objective is to determine if urbanization can be directly linked to divergence in behavioral phenotypes or consequences in urban and rural fish populations and therefore divergence in their natural selection processes.

The specific focus of this study was to identify possible differences in behavioral responses among individual blacknose dace from urban and rural populations. The proactive-reactive behavioral axis, also known as the shy/bold continuum, is a measure of an individual's propensity to engage in risk taking, aggression, or exploratory behavior with higher propensity being associated with boldness and lower propensity associated with shyness. It was hypothesized that those belonging to urbanized habitats will exhibit bolder behavior and greater inspection of novel environments and stimuli due to habituation to human activity or lack of predators in urban environments.

To establish population-level differences in behavior and identify bold individuals, we evaluated individual exploration times of novel environments both with and without the threat of predation. To control for differences in physicality, sprinting ability was tested to see if bold individuals were merely better swimmers than shy individuals. Data will be used to infer whether different gradients of urbanization influence behavior of blacknose dace, and if that behavior can be linked to variations in fitness.

Gaining insight on variations in behavioral response of blacknose dace from urban and rural populations will help to further our understanding in how such rapid urbanization can lead to anthropogenically-driven diversification or even influence evolution.

50 - Exotic Seed Dispersal in Restored Urban Streams

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Urban systems can introduce exotic plant species to watersheds and increase their spread. Urbanization can also affect stream systems by increasing the amount of impervious surface and stormwater runoff in watersheds, leading to flash floods. These flash floods can erode streams and disconnect the streams from their floodplains. This increasingly common phenomenon known as urban stream syndrome, has affected many riparian zones in Baltimore County. Stream restoration using floodplain reconnection has potential to decrease floodplain elevations, to increase overbank flooding and overall seed dispersal on floodplains; this local remedy may not affect the proportion of exotic seeds being dispersed. To determine the effects of urbanization and stream restoration on exotic seed dispersal we collected seeds from restored and unrestored streams that spanned a gradient of watershed urbanization. Seeds were collected on turf mats affixed to the floodplain in summer and fall 2021. The trapped sediment and associated seeds were then placed in pots and censused and identified over the course of a year. We hypothesize that while restoration may increase overall seed dispersal, the proportion of exotic seeds dispersed will be positively correlated with urbanization, and will not differ between restored and unrestored streams.

51 - Deer movement patterns or road's topography: what kills deer on roads in a suburban area?

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Spatial and temporal patterns of road crossings and roadkills were studied in an area in and around Bryn Athyn (suburban Philadelphia). A total of 74 deer were tracked using high density duty cycle (5 min between fixes). We collected spatial data on roadkills in the study area and generated a map of the roadkill density which we compared to the spatial distribution of road crossings. We found significant geospatial hotspots for roadkills that could not be attributed to increased road crossings based on telemetry data. The position of these hotspots coincided with areas of poor line-of-site visibility caused by topography inherited by the road-planning in late 1800s, suggesting that the special topographical conditions on the roads are the cause of deer-vehicle collisions. It appears that 2.6% of the road network in our study area accounts for 58.5% of total roadkills. The fact that the deer cross roads everywhere, whereas they get killed in few locations suggests that the topography of the roads is a greater factor predicting the roadkills position.

52 - Juvenile Tree Dynamics During Canopy Loss Due to Emerald Ash Borer; Ashes vs Maple

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Forest community structure will change subsequent to widespread loss canopy loss from emerald ash borer (EAB), and this change will begin among juvenile trees in the herb layer. Our research question was how herb layer juveniles of two common canopy tree species, green ash and red maple, have been affected during the period of ash canopy loss in central New Jersey. Annually since 2012, we have measured juvenile tree abundance and percent cover (using a releva method) in 16 meter squared plots within six forests, each containing 32 to 40 plots. Here, we used those data to describe how ashes and maples have changed in the herb layer over ten years. We considered these dynamics in the context of the calculated importance values (IV) of green ash and red maple in these forests. Green ash ranked among the top six most important species in the canopy, measured in 2016 just prior to the start of ash death, in five of the six forests we studied. In those forests, its abundance in the herb layer decreased over time, but its abundance varied in the forest where it had low IV. Ash mean percent cover exhibited no distinct patterns over time. Red maple IV ranked among the top six canopy species in four of the six forests; in three of these, red maples increased in both abundance and cover in the herb layer. In forests where canopy red maples were not important, there was no noticeable pattern of increase or decrease in mean percent cover or abundance. These observed patterns suggest that EAB may be causing a shift in the herb layer community, which could eventually result in a structural shift in the forest. With rapid death of canopy ashes, there is little to no seed rain to initiate new juvenile cohorts of ashes. At the same time, patchy increased light from the canopy gaps caused by ash mortality may be promoting growth (cover) of ash juveniles already present in the herb layer, and growth of the abundant red maple seedlings produced from healthy red maples in the canopy. This period of ash decline and red maple increase in the herb layer, caused by a nonindigenous, invasive insect acting on canopy trees of one species, will have unknown, long-term consequences for the future of each forest.

53 - Life In Plastic, It's Not Fantastic: The Impact of Plastic Pollution on Olive Ridley (Lepidochelys olivacea) Sea Turtles

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Ingestion of pelagic plastic debris threatens the viability of marine biota. Olive ridley (Lepidochelys olivacea) sea turtles were collected as bycatch throughout the Hawaiian and American Samoa-based longline fisheries between February 2015 and April 2021. Through necropsy, the gastrointestinal tracts were assessed and plastics were dissected from each section. Plastics were further organized into groups based on color, thickness, and type, and compared across capture location, season, year, turtle length, sex, and body condition. Three statistical approaches for quantifying amounts of ingested plastic included: number of plastic pieces, mass, and ratio of plastic mass to body mass (i.e. body burden). Of the olive ridley turtles sampled in this study (n = 28), 98.9% had ingested plastic. Plastic fragments (>2.5cm) were the most common debris type, making up 88.3% of the ingested debris, followed by fishing line/rope (6.9%), sheets (4.1%), foam (0.5%), and nurdles (0.2%). We found that the turtles consumed debris that were mostly white (65%), followed by blue (9.7%), green (7.8%), grey (5.5%), clear (4.2%), and black (3.8%). We identified the polymer composition of all ingested plastic pieces through Fourier transform infrared spectroscopy. Polyethylene polymers made up the majority of all debris ingested (61.8%). Polyethylene polymers made up a larger proportion of ingested mass in the northern hemisphere than in the southern hemisphere ($p = 0.001$). These analyses will add to the literature on the threat of pelagic plastic ingestion and provide insight into the potential impacts of prolonged contaminant exposure in sea turtles.

54 - Impact of wind speed and direction on relocations of the White-tailed deer

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A total of 74 white-tailed deer (Odocoileus virginianus) were monitored using high density radio-tracking (5 min between fixes) in a suburban land area north of Philadelphia that includes the Pennypack Ecological Restoration Trust (PERT) preserve. The GPS location (fixes) of deer were merged with weather parameters from nearby weather stations. We also derived slope, aspect, elevation and habitat type of the deer GPS fixes. We used a circular correlation/regression procedure to analyze the impact of wind speed and direction on the position of the deer. When winds are calm or when at high speed (>20mph), deer show little preference for position based on slope, aspect, or elevation. In moderate wind speeds, they select patches with aspects directly opposite to the direction of the wind. Effects of the wind direction on habitat use and types of vegetation are discussed.

55 - The Impact of Floodplain Reconnection on Hydrochory in Baltimore County

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Stream restoration via floodplain reconnection is a land management practice frequently used throughout Maryland to decrease the amount of nutrients and sediment entering the Chesapeake Bay. Floodplain reconnection lowers the floodplain to increase overbank flooding, letting the water flow onto the floodplain, slowing the water velocity. We predicted that if restoration successfully increased floodplain connection, it would also result in increased dispersal of seeds onto the floodplain (hydrochory). To evaluate how floodplain reconnection stream restoration projects in Baltimore County, Maryland impact hydrochory, we collected sediment deposited on turf mats placed on the banks of fourteen streams (7 restored and 7 unrestored) throughout Baltimore County in summer and fall 2021 The sediment and associated seeds captured on the turf mats was distributed into pots in the Towson University greenhouse and germinated seedlings were censused through February 2023. Hydrochory was assessed as the total number of seeds that germinated. Preliminary results show higher levels of hydrochory at restored sites, largely due to decreased mat elevations, suggesting that floodplain reconnection stream restoration projects are successful at increasing overbank flooding.

56 - Treatments for managing the invasive grass Microstegium vimineum differ in effectiveness, effort required, and regeneration of native plants after one year

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Restoration of native biodiversity often requires management of invasive species. Methods for controlling invasive plants in ecological restoration vary in cost and effectiveness, and for many treatments little is known about long-term effects on native plant communities. There is a need for evaluation of invasive species management techniques that integrates labor and cost, effectiveness at reducing invasive plants, and long-term benefits to biodiversity. The annual grass Microstegium vimineum invades forests of the eastern United States with negative impacts on native species richness, cover, and regeneration. Few studies have examined long-term effects of methods used to control this species on both reducing invasive plant cover and on native plant communities, and none have examined inputs of management effort over time.

In the first year of a long-term experiment, we compared the efficacy of chemical, mechanical, and manual methods commonly used to control M. vimineum and examined effects on M. vimineum cover, plant community composition, and effort required. Cutting, selective hand pulling, and pre- and post- emergent herbicides were applied using a randomized block design in three forest patches located in natural areas surrounding Longwood Gardens in Kennett Square, Pennsylvania.

In one year, mean M. vimineum cover was reduced in plots treated with pre-emergent and post-emergent herbicides (all results significant at $p < 0.05$). Mean richness of both native and introduced species increased after one year of treatment in plots that were selectively hand-pulled, while introduced richness decreased in pre-emergent treated and increased in cut plots. Herbicide methods required the least time to implement while hand-pulling required the most. First-year results indicate that different management strategies are successful by different metrics. As this long-term study progresses, we will evaluate how effects of these treatments change over time.

57 - Invasive Species Impact Native Tree Regeneration at Powdermill Nature Reserve

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Invasive plant species found on the forest floor can negatively impact the abundance and diversity of native trees regenerating in the understory. Ecosystems with a history of previous environmental disturbance tend to be more invaded with invasive species, and in turn have less abundance and diversity of young native trees. At Powdermill Nature Reserve, the environmental field station of Carnegie Museum of Natural History located in southwestern Pennsylvania, twenty 10-meter radius vegetation surveys were conducted in the summer of 2022 within and around a former strip mine. Eight of the twenty plots were inside the mine footprint, meaning that they were previously cleared and strip mined. Twelve of the plots were not cleared for strip mining and represent a control or benchmark of the ecosystem in the absence of mining. Using a non-dimensional, multivariate ordination system, we found the control plots overall to have wider variance and more diversity than the mined plots. This suggests that strip mining has made the ecosystem more vulnerable to invasive species, resulting in poorer regeneration of native tree species.

58 - Benthic Macroinvertebrate Community Variability and Association Differs Across Stream Microscale Habitats

Jenna Baljunas, Chatham University

Stream-dwelling benthic macroinvertebrates often have habitat affinities in correspondence to their evolutionary traits. Such relationships, though, are best understood in the temperate zone rather than the biodiverse tropics. In Nicaragua, there is a lack of knowledge about aquatic ecosystems, despite being a high-priority area for conservation and research. This study provides an analysis of microscale habitat preferences of Nicaraguan aquatic species. We sampled benthic macroinvertebrates from 11 locations within eight relatively pristine streams within the Rama-Kriol Territory of southeast Nicaragua. At each sample location, habitat assessment was performed, with measurements following US EPA Ecosystem Monitoring and Assessment Program (EMAP) protocols. Non-metric multidimensional scaling was performed on genera to explore how habitat partitions communities. Results suggest that pools have the greatest community variability while rapids have the narrowest. Habitat partitioning at higher taxonomic resolution was also evident. For example, we detected an association between Coleoptera and pools as well as Trichoptera with riffles. Because our study location in Nicaragua is almost completely ecologically undescribed, our results could serve as important baseline information for streams in Mesoamerica including for biomonitoring applications.

59 - Slow Apparent Recovery of an Eastern Coastal Plain Forest After Intense Deer Browsing

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Odocoileus virginianus (white-tailed deer) density has exponentially increased in many areas of eastern North America over the last century due to active management for hunting, habitat loss, global warming, and the elimination of natural predators. Consequently, deer over-browsing has become an important problem, leading to changes in plant community composition and regeneration dynamics. While there is a growing body of literature showing positive vegetation responses after the cessation of deer browse, the magnitude of the responses varies. Forests may be particularly slow to respond from the release of deer pressure after chronic long-term browsing due to infrequent disturbance events that open the canopy as well as legacy effects of deer such as an impoverished bud bank, low seedling recruitment, and spread of non-palatable species. Moreover, the contribution of abiotic factors, if not accounted for, may obscure the interpretation of the vegetation responses to deer. The goal of our research is to examine the effects of vegetation recovery after chronic deer browse in a second-growth Eastern Coastal Plain forest and to account for the contribution of abiotic conditions in the vegetation response. In 2014, we constructed sixteen 10 x 10 m deer exclosure plots with paired control plots across 8 locations in the College Woods in Williamsburg, VA. Within each plot, all plants within two 1.3 m2 subplots were identified, counted, and classified into size classes. In 2022, we measured light beneath the canopy using hemispherical photography, soil moisture 24 hours after a rainstorm, and soil nutrient composition (N, P, and C). Generalized linear mixed models using R tested the associations of treatment with the change in richness and abundance with location as a random effect. We found that excluding deer led to an increase in plant species richness (P 0.07). We subsequently conducted a principal components analysis of the abiotic conditions in plots to extract axis scores that will be used in subsequent models. The first two axes explained 76% of the total variation (PC1 = 49%, PC2 = 27%) with PC1 largely driven by nitrogen (-0.52) while PC2 was mostly explained by light (-0.45) and moisture (0.63). The relatively high explanatory potential of the PCA axes suggests the important need to investigate the contribution of abiotic factors to help understand what appears to be a slow response in plant abundance to the cessation of deer browse.

60 - Mortality of Overstory and Midstory Trees in Two Hardwood Forests in Northern New Jersey

Veronica Klenk, Ramapo College of New Jersey

Co-Author: Karyssa Cendaña, Ramapo College of New Jersey; Nathan LaDuke, Ramapo College of New Jersey; Eric Wiener, Ramapo College of New Jersey

A variety of stressors have been causing increased mortality among several tree species in forests of the northeastern United States in recent decades. The purpose of this study was to survey tree mortality in two mixed hardwood forest stands in the New Jersey Highlands over a four year period. Species, trunk diameter, stratum, and GPS coordinates were recorded for all trees that died from 2019 to 2022 within 34-hectare survey plots. Data from this survey of 1,621 dead trees across both sites were compared with data from surveys of living trees at the same sites in 2018 and 2019.

Results revealed that whether mortality of particular species was greater or lower than expected based on the relative densities of living trees varied between strata and sites. More overstory and midstory trees of white ash (Fraxinus americana) and overstory trees of chestnut oak (Quercus montana) died than expected due to invasive insect outbreaks at both sites, while fewer overstory trees of red maple (Acer rubrum), sugar maple (Acer saccharum) and black birch (Betula lenta) died than expected at both sites. Conversely, more red maples died than expected in the midstory stratum due to a fungal outbreak that occurred exclusively on red maple saplings at each site. Interestingly, it is unknown why midstory black birch trees died at higher rates than expected at one site and lower rates than expected at the other site. Fewer American beech (Fagus grandifolia) trees died than expected in both strata at both sites, suggesting that the beech bark disease and the beech leaf disease observed at the sites had not yet led to significant die-off.

Clearly, forest tree species composition is in a highly dynamic state as some species are suffering high mortality rates. Unfortunately, the species that are currently experiencing low mortality rates are much more vulnerable to expected changes in climate than the species that are in decline.

Madison Grant, Hampton University

Co-Authors: Shawn T. Dash, Hampton University; Zuri Murph, Hampton University

61 - An Update to Hampton University SEEDS' Campus Biota Survey

The Hampton University Campus Biota Survey is an ongoing iNaturalist project supported by the Strategies for Ecology Education, Diversity, and Sustainability Club chapter. This survey began on September 1, 2016, and has amassed 11,682 observations (2,437 research grade ranking) as of March 2023. A total of 1,008 species have been observed, with the majority being typical of built environments such as eastern gray squirrels, white clover, northern mockingbirds, mallards, and southern live oak. There have been a total of 403 observers, mainly SEEDS members and enrolled students from different majors as well as persons from the community. This survey has served as an intersection between multiple departments as well as courses. The efforts of the club are coupled with several courses to engage students in authentic research experiences. Hampton University is one of three Historically Black Colleges and Universities with a campus-wide survey using iNaturalist; HU has also compiled and invited other HBCUs under an umbrella project to unite efforts. This has allowed for the documentation of regional biodiversity on a semi-urban campus and for students to participate in hands-on discovery while learning to appreciate nature. The identifications from this survey can be used in future research projects for students and beyond the University.

62 - Behavioral Consequences of the Urban Ant Feeding Syndrome

Emily Kanach, Rutgers University Camden

Co-Author: Amy Savage, Rutgers University Camden

As humans continue to shape the physical environment we live in due to rapid urbanization, the species who share our cities are forced to adapt to changing abiotic conditions. The highly isolated and stressful sites of the urban mosaic where urban ants exist are often devoid of traditional components of their diet, particularly insect prey. While their preferred food sources are scarce, high-carbohydrate human food waste is abundant. Previously, our lab demonstrated that ants exhibit a distinct feeding syndrome, with increased lipid preferences after consuming carbohydrate rich urban food waste. Moreover, we have preliminary data suggesting that ants in the most urbanized habitats in cities are more voracious predators than those in lower stress urban habitats. To gain a better understanding of this relationship, we assessed the predatory behaviors of Tetramorium immigrans colonies in city parks and street medians before and after supplementing their diets with insect prey (house crickets). We predicted a rescue effect, in which ant voracity would decline after their diets became more balanced. Initial aggression trials showed that T. immigrans ants discovered proxy prey at equal rates in street medians and city parks. However T. immigrans workers attacked and removed significantly more proxy prey from bait stations at significantly faster rates compared to those in parks. After 3 months of cricket supplements, T. immigrans workers in parks attacked fewer proxy prey and predatory behaviors occurred more slowly. T. immigrans workers from street medians took longer to discover proxy prey after supplements, but attacked and removed proxy prey faster after cricket supplements than before they were supplemented. We will discuss potential alternative hypotheses that may explain these results and suggest future research that could help us better understand how the combination of increased availability of carbohydrate-rich anthropogenic food waste and prey scarcity affects urban ant predatory behaviors.

63 - Quantifying the variation of tannin concentration in Eastern US nut-producing trees and understanding squirrel foraging behavior in the absence of seed mass variation

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Seed dispersal by squirrels and other animals is an important process affecting forest dynamics and structure. Tannin concentration and other seed traits interact with squirrel behavior to modulate seed dispersal in nut-producing trees of the Eastern United States (Sundarum et al. 2015). Our aim was to determine the extent to which variation in seed traits within a species affects squirrel behavior by quantifying the variation of tannin concentration in several Quercus species and determining how squirrel foraging behavior changes when mass is constant in a seed presentation field study. We performed a radial diffusion assay on nutmeat from three oak species (Quercus rubra, Quercus alba, and Quercus michauxii) to determine tannin concentration variance, standard deviations of 17.29, 5.77, and 13.54 respectively. To assess squirrel foraging behavior patterns in absence of mass variation, we presented four rounds each of 24 tagged Quercus rubra and Juglans nigra seeds rotating between two sites in the same area. We then returned 48 hours later to search and determine seed fate. 52 out of 96 Quercus rubra seeds were cached, while only 29 out of 96 Juglans nigra seeds were cached. Quercus rubra seeds were cached an average 39.53 meters from the origin, and Juglans nigra seeds were cached an average of 34.94 seeds from the origin. Understanding how tannin concentration affects squirrel foraging behavior is important for understanding squirrel dispersal dynamics.

64 - Quantification and Classification of Microplastics and Isolation of Microplastic Residing Bacteria in the Blue Marsh Watershed

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Co-Authors: Olivia Sullivan, Pennsylvania State University Berks; Emma Diliberti, Pennsylvania State University Berks; Jill Felker, Pennsylvania State University Berks; Tami Mysliwiec, Pennsylvania State University Berks

Due to the hazardous effects of stressors, such as agricultural fertilizers, climate change, and stormwater flooding, the preservation of waterways is necessary in order to sustain clean water resources. A prevalent anthropogenic stressor affecting water sources is plastic pollution. Plastic pollution has led to the rise of microplastics in streams, lakes, rivers, and oceans all around the world. These microplastics consist of various shapes, sizes, and materials. Microplastics come from a multitude of items, such as clothing, cosmetics, and plastic bottles. Not only do microplastics cause habitat destruction, endanger aquatic life, and change nutrient cycles within aquatic ecosystems, they can also negatively impact human health. Microplastics can harm one's gastrointestinal tract, serve as an endocrine disruptor, and cause oxidative stress. The Blue Marsh Watershed is a tributary to the Schuylkill River, which eventually enters the Delaware River Watershed. The Delaware River Watershed serves as drinking water supply for more than 2 million people in the City of Philadelphia. This study classified and quantified the presence of microplastics in the watershed as well as isolated bacteria inhabiting microplastic samples. The water samples were collected at a downstream shore location of Blue Marsh Lake using a modified version of the NOAA microplastic collection protocol. Samples for microplastic classification and quantification were dried at room temperature and examined using a dissecting microscope. Samples for bacteria classification were stored at 4 A°C and placed within respective agar plates, Tryptic Soy, Nutrient Agar, Pseudomonas Agar, and Reasoner's 2A Agar. The total number of microplastics in the water samples was 845. Fibers (51%), nurdles (46%), and fragments (3%) respectively. These results suggest that the presence of microplastics may contribute to poor water quality in the Blue Marsh Lake. Future testing will involve classifying the bacteria isolated from the microplastics grown in the respective media.

65 - BCEENET: Supporting faculty to bring natural history collections research into ecology and evolution courses

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Co-Authors: Janice Krumm, Widener University; Cecily Bronson, BCEENET

Course-based Undergraduate Research Experiences (CUREs) increase student engagement, retention, and long-term success. Incorporation of digitized natural history collections (dNHCs), a free and abundant source of data, can provide endless opportunities to bring ecology and evolution research into your classroom. The Biological Collections in Ecology and Evolution Network (BCEENET) community has created 4 flexible CUREs using dNHC data, including course syllabi, student handouts, and teaching notes. Using dNHCs, the BCEENET CUREs span diverse topics including species distributions, invasion biology, and sexual dimorphism, and can be customized to incorporate a local species of interest. Students who participate in BCEENET CUREs can gain skills in data management, mapping (QGIS), georeferencing, and image analysis (ImageJ). These CUREs only require access to computers and the internet, and have been implemented in person, online, and in hybrid formats, with course lengths ranging from 4 to 16 weeks. More than 2000 students have participated in BCEENET CUREs at over 30 institutions, in both synchronous and asynchronous courses. BCEENET supports implementation of dNHC CUREs through free 4-day summer training, stipends for new implementers, and ongoing community support, and offers the opportunity to participate in assessment activities.

66 - Life in urban vs rural habitats does not affect feather structure in a generalist bird, the American Crow (Corvus brachyrhynchos)

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Expanding urbanization has increased our need to understand how wild birds cope with the resulting changes in ecological conditions. For many species, there is a major urban change in the quality and quantity of food resources, including an increase in anthropogenic food and decrease in invertebrate abundance. An urban diet can strongly affect bird biology, including body condition and stress physiology. However, few studies have explored whether life in urban environments affects feather structure, which supports locomotion, signaling, and heat regulation. Protein-based feathers must be shed and replaced as they wear, an energetically demanding process that is affected by diet. In this study, we compared structural properties of flight feathers in urban and rural American crows. American crows molt during the summer months when rural crows are consuming mostly animal material. Urban crows eat a more anthropogenic diet, possibly influenced by its easy accessibility as suggested by research that found lower suburban (vs rural) nestling growth and serum protein. For this study, we collected molted tail and primary feathers from two urban areas in central New York and their rural surrounds and measured two structural properties at six positions on each feather. The density of feather barbs, which branch off the central feather shaft, and the density of barbules, which branch off the barbs, were measured at the base, middle, and distal tip of the feather and on both the leading and trailing edges. There were no differences between urban and rural feathers for either metric for either feather type, suggesting that either urban diets do not compromise feather quality in American crows or that molting birds are dietarily selective. However, tail feathers had consistently lower barbule densities than primaries, suggesting that barbules help to generate lift and thrust during flight. Barb densities were consistently higher on the leading edge of the primaries, consistent with aerodynamic models that show higher air pressure on the leading edge of the wing. These results for a strong distance flier will inform future comparisons, first highlighting the need to control the areas of feathers sampled even within species and second to consider functional specializations and flight style before making interspecific comparisons of feather structure with respect to habitat.

67 - Does lingering ash really exist?

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Co-Authors: Andrew Edwards, Washington and Jefferson College; Jonathan Grabowski, Washington and Jefferson College; Ty Laughlin, Washington and Jefferson College; Jason Kilgore, Washington and Jefferson College

The introduced emerald ash borer (EAB, Agrilus planipennis) has caused the mortality of millions of ash (Fraxinus spp.) trees in North America over the last two decades, with almost complete mortality of all trees infested by EAB. However, some evidence suggests potential resistance, with survival, by some trees to EAB.

As part of a larger project to monitor EAB-induced mortality of ash and community effects and to explore in situ conservation of ash on the Allegheny National Forest (ANF) in northern Pennsylvania, where EAB was first detected in 2013, we began searching for lingering ash (LA) in Summer 2022. LA are defined as untreated ash trees at least 10 cm diameter (dbh) with living canopy (AC 1-4) in an area with > 95% ash mortality. We used two approaches to locate ash: 1) pre-identified putative LA reported to the ANF; and 2) meander surveys with 30-40 m between people taking 5-6 min per acre and in areas known for complete ash mortality for at least two years (i.e., south end of ANF). For each LA, we measured dbh, assessed canopy condition, noted insect/disease symptoms, recorded coordinates, took photos, installed a metal numbered tag, and searched the area for other LA.

We located a total of 22 lingering ash (LA) across the two approaches, with 19 by pre-identification by others or in that vicinity and 3 through meander surveys in 10 stands (total 243 acres, or 98.3 ha). Mean dbh is 31.1 cm (95% CI 24.8 - 39.2 cm), and mean ash canopy condition is 3.0 (95% CI 2.8 - 3.3). All data were reported to the ANF through a 123Survey and to the Great Lakes Basin Forest Health Collaborative (Holden Arboretum) with a shared spreadsheet. These trees will continue to be monitored in the future for potential use in a conventional breeding program and to better understand resistance to EAB. Furthermore, we will refine search approaches in collaboration with the Forest Service and then search for additional LA in 2023 - 2024. This work could lead to the conservation of an important and widespread genus of trees in the North American forested landscape.

68 - Tools for Urban Ecology and Evolution

Meredith Hart, University of Rutgers-Camden

In the rapidity of global urbanization, it is imperative to foster collaboration between researchers working in ecology and evolution within urban systems. Once these collaborations have been established, it is also important to create opportunities for science communication to involve communities. Due to the myriad challenges facing international collaboration, such as language barriers and reward systems in different countries, researchers are often unaware of existing research and researchers, which contributes to a knowledge gap in the field. This knowledge gap is especially prevalent in the global south, as much collaboration in the field of urban ecology is based in the global north. One proposed tool for this collaboration, is the creation of a visual database including researchers, projects, and science communicators, using a publicly accessible and continually updating map that displays the location and names of different people and projects. This map will include researchers and their focus on one layer, ongoing and past urban research projects with links to their findings on another layer, and then science communicators such as illustrators, writers, and videographers on a final layer. This map will be based on google platforms, with five different initial translations available, and the layers will have options for sorting according to interest and focus. Specialized icons will be used to represent different fields and focuses. Because this map will be made publicly accessible, it will be available for the use of local individuals who wish to connect with urban researchers, or find out about urban ecological research happening in their areas. This map includes data on science communicators so that in global collaboration, artists and communicators who work near chosen projects can be selected for communication of the findings, and science communication is not outsourced. The goal of this map is to visualize and promote ongoing research in urban ecology, and make finding collaborative partners easier.

69 - Predictions about changes in forest structure and tree species composition in two New Jersey forests following the impending die-off of American beech (Fagus grandifolia)

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Co-Authors: Rachel Stone, Ramapo College of New Jersey; Eric Wiener, Ramapo College of New Jersey

American beech tree (Fagus grandifolia) populations are declining dramatically throughout much of its range due to beech bark disease and beech leaf disease. The objectives of this study were to determine the spatial distribution of American beech trees and predict how forest structure and species composition will change as beech trees die in two forest plots (11.4 and 18.7 hectares) in the New Jersey Highlands. Vertical stratum was recorded for all beech trees > 1 m height, and GPS coordinates and trunk diameter (DBH) were recorded for all beech trees > 10 cm DBH. Allometric equations were used to estimate the canopy area of beech trees in the upper midstory, subcanopy and canopy strata. Predictions of likely replacement species for beech trees > 20 cm DBH were weighted by the DBH of neighboring saplings.

The spatial distribution of the 10,340 beech trees found across both plots was highly aggregated, with at least 75 % of the trees of each vertical stratum found in just 11.8 % - 23.3 % of the beech patches. Consequently, the estimated 7.6 % - 11.5 % of overall canopy area and 6.0 % - 8.8 % of overall subcanopy area that will become open as beech trees die will be patchily distributed. Furthermore, the replacement calculations reveal that 60.4 % - 77.4 % of the beech trees > 20 cm DBH will not be replaced by younger trees in the coming decades, creating ideal conditions for invasive plants to proliferate. Finally, red maple (Acer rubrum), sugar maple (Acer saccharum) and black birch (Betula lenta) are most likely to eventually replace the larger beech trees, which is concerning given that these species do not provide as much food for wildlife. Moreover, A. saccharum and B. lenta are expected to eventually decline due to climate change, suggesting additional shifts in tree species composition over time.

70 - Comparison of soil CO2 efflux between an extensive green roof and a prairie site.

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A green roof provides different benefits in an urban environment, like habitat, stormwater management, reduced energy usage, and aesthetic values. Green roofs can also help in minimizing the emission of CO2 through decreased energy usage. Besides these benefits, there is increased interest in understanding whether the green roof can help in carbon storage. In order to understand the ability of the green roof to act as a sink for carbon, quantification of COÂ¬2 efflux from the green roof is essential as it relates to the amount of CO2 Â¬released from the green roof. This will help in understanding the net carbon storage capacity of the green roof. But there are not many research articles that studied the CO2 efflux from a green roof; comparing a green roof with a natural ecosystem (in this research, a prairie site) will provide information about how it differs in different aspects like soil temperature, moisture content, and soil CO2 efflux. As soil CO2 efflux is influenced by the soil moisture and soil temperature, moisture and temperature data were also collected while measuring the CO2 efflux between the green roof and the prairie site.

The green roof and prairie sites were located where most environmental parameters, like humidity, temperature, and precipitation, were the same. In the case of the green roof, although both sites had the same amount of precipitation, the water content in the green roof substrate was significantly lower in comparison to the prairie site ($F=146.82$, $df = 1, 8$, $p < 0.001$). Regarding the soil temperature, the mean midday soil temperature on the green roof was 20 +/- 0.5 C, which was significantly higher than the prairie site at 17.31 +/- 0.4 ($p < 0.001$). Similarly, above-ground and below-ground (root biomass) were significantly higher on the prairie site than on the green roof. Regarding the soil CO2 efflux, the green roof had significantly lower CO2Â¬ efflux in comparison to the prairie site ($F = 686.747$, $df = 1, 7.98$, $p < 0.001$). Soil flux at the prairie site ranged from 4.03 +/- 0.18 Î¼mol CO2 m-2 s-1 in June to a low of 0.27 +/- 0.04 Î¼mol CO2 m-2 s-1 in December. In contrast, the highest measured CO2 efflux on the green roof was 1.46 +/- 0.12 Î¼mol CO2 m-2 s-1 on one day in July, and the lowest was 0.05 +/- 0.01 in December.

71 - Insular distributions of Opuntia humifusa: informed by seas and stomachs

JH Ness, Skidmore College

I combined field studies, experiments, and biogeographic models to explore drivers of the insular distribution of the eastern prickly pear (Opuntia humifusa). This species is expected to be tolerant of osmotic stress but susceptible to frost (as a cactus), amenable to storm surge induced fragmentation and vegetative propagation (owing to modularity), and produces large fruits appropriate for consumption by mammals. For the field portion of this work, I described Opuntia fruit removal using repeated censuses (Sept and Nov, 2019) at four coastal sites on Shelter Island, NY co-located with an array of wildlife cameras. During that 2.5 month interval, fruit removal ranged from 0.67 - 0.98 among sites (mean Â± SD = 0.84 Â± 0.15) and was positively correlated with among-site differences in daily camera records of deer (r = 0.97). I measured tolerance of drifting propagules for exposure to salt water by comparing survival rates of individual Opuntia cladodes (n = 55) floating in salt water for intervals ranging from 1 minute to 19 days (as well as controls). Mortality increases with salt water exposure; estimated survival rates were >98% when immersed in water for <10 days but <20% after 18 days afloat. The biogeographic portion of this work used descriptions of 82 islands along the mid-Atlantic Coast with either published floras or personal observations that permitted positive designations of Opuntia presence versus no mention / discovery of the plant. These islands ranged from 32-43A N latitude, 0.008 - 3630 km2, and were a minimum overwater distance from the mainland of 0.05 - 15 km. Published descriptions of mammal communities allowed me to designate 30 of the islands as occupied versus unoccupied by deer. I used AIC model comparison to contrast the utility of the seven possible univariate, bivariate and tri-variate geographic models involving island area, isolation, and latitude, as well as these same seven model frames with deer presence/absence as a fourth independent variable. All 14 models were logistic regressions describing likelihood of occupation by Opuntia. Among these 14 models, the best two were [Area + Latitude + Deer] and [Latitude + Deer] (R2 = 0.69 and 0.61, Wj = 0.497 and 0.303, respectively), and all seven best included deer as an independent variable. Hydrochory and endozoochory both appear valuable. Whether decreased incidence at higher latitudes reflects a range limited by frost or the Gulf Stream heading into the open ocean at the Gulf of Maine is unclear.

72 - How does tree community diversity affect plant palatability for a generalist lepidopteran herbivore?

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Co-Authors: Lauren Schmitt, University of Maryland, College Park; John Parker, Smithsonian Environmental Research Center; Karin Burghardt, University of Maryland, College Park

Plant-insect interactions are a foundational component of terrestrial ecosystems, and understanding the drivers of variation in these interactions is of key interest to the field of ecology. One possible causative factor of variation in plant quality, or palatability, for herbivores may be the interaction between plant community diversity and plant trait expression. In this experiment, we use 72-hour feeding assays with the generalist lepidopteran herbivore Spodoptera frugiperda to assess whether tree community diversity predicts leaf tissue palatability in a large-scale native tree diversity experiment. We measured larval growth rate as a proxy for palatability of 13 tree species planted in three different diversity treatments (n = 12 per treatment, 475 total) to test the effect of plot-level tree diversity and tree species identity on larval weight change. Our preliminary results indicate that tree species, not plot-level tree diversity, predicts palatability for S. frugiperda, which suggests that tree species-specific traits play a role in determining S. frugiperda performance. Moving forward, we will use green leaf trait data collected from the same tree individuals at the experimental site to assess (1) which traits are driving variation in performance and (2) whether the relationship between tree species traits and palatability can be explained by plot-level tree diversity effects on these traits. This research aims to expand our understanding of whether and how forest community ecological processes might be impacted by tree community diversity. It may also have implications for reforestation and conservation projects.

73 - Automated Tracking of Lemna Minor

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Co-Authors: Theodore Muth, Brooklyn College; Christian Hoyek, Brooklyn College

TrackMate and Ilastik, two tracking algorithms that have been used extensively as a tool to track eukaryotic cells, bacteria, and small organisms such as C. elegans as they grow, move, and divide. However, its use in tracking larger organisms has scarcely been investigated, and, as such, this research project aims to test the utility of using TrackMate and Ilastik to track larger organisms. Specifically, we wanted to track Lemna minor, a common duckweed species that has been shown to have the potential for bioremediation in polluted waters due to its microbiome. A time-lapse camera was used to record L. minor and the videos were analyzed via the two tracking algorithms to track movement, divisions, and growth of the duckweeds. Duckweeds were grown in differently colored boxes and wells and placed against differently colored backgrounds in order to find which combination yielded maximal contrast between the duckweed and its environment. It was found that objects that were lighter than the background by a large margin yielded the highest quality detection of objects in TrackMate and Ilastik, and this has been achieved by growing duckweed in a black box or well placed against a black background. Furthermore, using its machine learning algorithm, we trained Ilastik on a variety of different time lapses in order to produce a better segmentation and object classification algorithm than TrackMate. The utility of using TrackMate and Ilastik to track large populations of duckweed is still being investigated; however by using the detection algorithm along with filtering of the image on imageJ and Ilastik we have successfully tracked smaller populations of duckweeds. This technique, when perfected, has a variety of applications that can be used in future experiments which includes: investigations on how the microbiome density of duckweed influences the rate of growth, how microbiomes of an inoculated duckweed spread throughout a population of sterile duckweeds, as well as investigations of the health of specific duckweeds within a population over time.

74 - Cyanobacterial Blooms and Zooplankton Diversity in Southern New Jersey Reservoirs

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Harmful cyanobacterial blooms (cHABs) are becoming increasingly common in lentic freshwater ecosystems and present potential challenges to grazing zooplankton species due to the production of cyanotoxins and/or mechanical interference with filter feeding processes. In this study, we collected weekly estimates throughout the summer of 2022 of cyanobacterial abundance and environmental variables in three artificial reservoirs (Daretown, East, and Memorial Lakes). All three lakes are interconnected in the Salem River watershed in southern New Jersey and are known to have experienced periodic cHABs since state monitoring began in 2017, although only Daretown Lake experienced a significant bloom in 2022. Zooplankton were counted and identified to genus (cladocerans and rotifers) or order (copepods) level, and the density and taxonomic diversity of the zooplankton were analyzed with respect to the weekly cyanobacterial and environmental variables in all three lakes. In addition, zooplankton density and diversity were also compared to higher frequency cyanobacterial and environmental data available from a NJ Department of Environmental Protection buoy deployed in Daretown Lake. Changes in zooplankton abundance and diversity associated with cHABs have the potential to significantly affect trophic dynamics in lentic systems.

75 - Shining a light on pond biodiversity: Differences in microbe abundance in sunny and shady ponds in an agricultural landscape

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Co-Authors: Gabe Horner, McDaniel College; Lupe Mondragon, McDaniel College

Microorganisms are in continuous competition for nutrients and light, as light is a critical factor of ecosystem dynamics. Benthic samples are important to consider because these samples can predict how shallow lake ecosystems react to light. This project examines the relationship between light availability and species abundance and tests the hypothesis that light availability plays a role in species abundance in ponds. The ponds were located at the McDaniel College Environmental Center in Westminster, Maryland which is in an agricultural landscape. One of the ponds has an abundant source of plants and receives little sunlight while the other has less vegetation and receives a generous amount of sunlight. Eleven samples were collected from each pond from different areas with varying amounts of light availability. Samples were taken from sub-locations that were shady, sunny, or with intermediate light conditions. The sunny sublocations were the controls, the shady samples were collected directly under tree cover and the intermediate samples were collected from areas near tree cover but that received some light. From these sub-locations benthic and water column samples were taken. Once the samples were collected, they were examined six times each under a microscope in reservoir or depression slides. We found that species abundance was slightly greater in the pond receiving less sunlight than in the pond receiving sunlight throughout the day. Additionally, microbe abundance was slightly greater in the benthic water samples than in the water column samples. We conclude that species abundance varies somewhat with light availability. However, the data do not support our hypothesis that if there is less light availability in a pond, then there will be less species abundance in a pond.

76 - Diversity and composition of rhizosphere microbial communities of Solidago rugosa in Northeastern Pennsylvania grassland soils

Caroline Fortunato, Widener University

Grasslands are important centers of biodiversity but have been in decline in Pennsylvania. Studies have shown that understanding soil microbial communities may help rehabilitate these regions. Microbes are abundant and important to grassland soil environments as they cycle and transform key nutrients, making them available to higher organisms. Studies of microbes have shown that they influence plant dispersal, diversity, and community composition in many environments. The overall objective of this study is to understand how soil microbial community diversity and composition is related to grassland plants. This study specifically looked at the rhizosphere region of Wrinkled Leaf Goldenrod (Solidago rugosa) at Ricketts Glen State Park and Nescopeck State Park in Northeastern PA in 2021 and 2022. Soil samples were taken from the rhizosphere region of 36 plants as well as from the surrounding area (proximal soil) in June and August of 2021 and 2022. DNA was extracted and PCR was used to amplify the 16S ribosomal RNA gene, a universal marker gene for bacteria and archaea. A total of 5,128,924 sequences were obtained from 70 samples which resulted in 29,758 OTUs (Operational Taxonomic Units) after the removal of singletons. Sequencing data suggests that pH is the driving factor behind microbial community diversity (ANOSIM, p=0.006) and the overall data shows that there is not a significant difference between rhizosphere and proximal soil microbial communities (ANOSIM, p=0.043) or between Ricketts Glen and Nescopeck sampling locations (ANOSIM, p=0.022). This can be attributed to the influence of the different soil pH found at each sampling site overwhelming the difference between sites and soil type. Within specific individual sites, microbial communities did separate by soil type, with the rhizosphere and proximal soil having significantly different microbial communities (Ricketts Site 1 2021: ANOSIM, p=0.002 Ricketts Site 2 2021: ANOSIM, p=0.006 Nescopeck Site 3: ANOSIM, p=0.006). This indicates that the community composition of the rhizosphere and proximal soil do differentiate, but on a larger scale these differences are overwhelmed by differences due to soil pH. Results from this study can be used in conservation and rehabilitation of diminished grassland regions.

77 - How do biotic interactions in the soil contribute to coastal forest ecosystem resilience?

Mia DiCianna, Smithsonian Environmental Research Center / Chatham University

As Earth's changing climate is significantly affecting global weather patterns, coastal forests are some the first ecosystems that will face ecological consequences. Understanding the biogeochemical transition of a coastal forest to a wetland due to climate change is essential in predicting how resilient a forest is to such changes. After inundating plots of a coastal forest in the Chesapeake Bay with freshwater and brackish water to study forest resilience, greenhouse gas measurements of the forest soil showed various stress signals of the forest's biotic components reacting to the inundation. Stress responses from the soil rhizosphere following the brackish inundation were observed most notably. By isolating and studying the biotic components of the soil, I observed how changes in greenhouse gas production/consumption varied based on soil biota. The data, though, suggest an overall resilience to storm surges and rising sea levels as greenhouse gas cycling in the soil bounced back to expected levels post-inundation. However, the planned continuation of the study over a period of at least 10 years with increased inundation frequency and intensity will be helpful in determining long term coastal forest resilience to climate change.

78 - Disturbed and Diverse - Management Practices Impact Urban Soil Microbial Communities in Green-Wood Cemetery

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Aim: A better understanding of urban soil microbial communities will allow for effective management practices that can support essential ecosystem services, such as nutrient cycling, handling of stormwater runoff, and promoting plant and tree health in urban spaces. The managers at Green-Wood Cemetery (Brooklyn, NY) have three levels of landscape management, intensive turf management, minimally managed meadows, and unmanaged woodlands. We hypothesize that there will be an inverse relationship between the level of management intensity and soil microbial diversity.

Methods: We tested this hypothesis by collecting total soil DNA for 16S amplicon sequencing and samples for community-level metabolic profiling using BioLog Ecoplates. We analyzed a total of 36 soil samples. The 16S amplicon DNA was sequenced on an Illumina MiSeq at Wright Labs, LLC. The DNA sequence data were analyzed using QIIME2 and Nephele. Using the Ecoplates we determined the utilization of 31 different carbon sources.

Results: Our preliminary data from the Ecoplates, and a subset of 16S amplicon samples, show that there are distinct microbial communities at the two soil depths tested and from the three management regimes. Consistent with results from other studies, we see greater soil biodiversity in the shallow samples. However, we see lower levels of microbial diversity in the unmanaged sites relative to the intensive and moderately managed sites.

Conclusions: Our work demonstrates that landscape management practices can impact soil microbial communities. We found that urban soils have microbial diversity that is equivalent to soils that experience lower levels of impact from human activity.

79 - Local microtopography affects bryophyte water loss more than differences in canopy structure

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Boreal forests are undergoing rapid environmental changes that impact ecosystem water fluxes. Bryophytes (mosses and their relatives) can cover forest floors in these systems and are a key component of water cycling. However, little is known about how coarse- and fine-scale variation in structure interact to affect these fluxes. Previous research has demonstrated that roughness due to structural heterogeneity of the bryophyte canopy (0.01 m scale) affects the conductance of water to the atmosphere. In the field, the effect of such roughness may depend on the local position along the microtopographic surface (variation at 0.1-1 m scale). Identifying the interaction between canopy structure and the microtopographic location of the vegetation will facilitate the development of quantitative models of water fluxes in boreal forests. To better understand how the canopy structure and microtopography interact, we fabricated Dicranum scoparium shoots into smooth and rough canopy structures (n=3). Water loss was measured in a wind tunnel under five different wind speeds and at four topographic positions on a surface modeled as a sine wave (height 8 cm, period 1.1 m, dimensions based on the field structural dimensions). The four sampling locations were in the valley and on the windward side, leeward side, and crest of the hill created by the sine wave. Results show that canopy variation of the bryophyte plays a minor role in conductance compared with differences in the microtopography of the local area. There is a significant difference (p<0.001) between the average conductance to water loss among the four assigned topographic positions. The overall mean conductance was 4.2 cm/s and was 65%, 21% and 53% higher in the windward position than in the valley, crest and leeward positions, respectively. However, conductance did not differ between rough and smooth canopies. Consequently, when the canopies form along a surface with microtopographic variation, local positioning affects water fluxes more than surface variation due to canopy structural heterogeneity. As a result, water flux models of boreal forests should work to incorporate the effects of microtopographic variation in the forest floor.

80 - Copper and Zinc Speciation in Urban Streams

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Urban freshwater systems are and will continue to be a critical resource for ecological and human needs, creating a demand for increased knowledge of their physical and biogeochemical processes. Metal speciation relates to a metal's various forms or elemental compositions, which has significant implications for a metal's bioavailability and mobility. This research aims to better understand the speciation of zinc and copper in urban streams, both essential nutrients to life that can have toxic effects at too high of concentrations. Stream public data was collected from the EPA and USGA for elemental concentrations and interval recordings of conductivity, pH, temperature, and dissolved oxygen, respectively. The EPA and USGS public data was imported into the online chemical equilibrium model, Visual MINTEQ, to calculate Zn(2+) and Cu(2+) concentrations throughout July 2020. In the Black River, averaging the relative standard deviation of each day in July showed that Zn(+2) concentrations had a 16.27% variability while Cu(2+) had a 37.28% variability. For the Mahoning River, Zn(2+) had a 0.57% variability and Cu(2+) showed an 8.59% variability throughout July. Furthermore, this research intends to process speciation data from additional streams to determine whether urbanization influences metal speciation and its potential implications for bioavailability.

81 - Biodiversity and vertical structure of microhabitats of forest trees

Ian Sachs, Stevenson University

Research from around the world has shown that much of the biodiversity in forests lives off of the ground in the canopies of trees but surprisingly little is known about the eastern deciduous forests like those of our region. This project, a new collaboration with several forest ecologists at small colleges, is seeking to explore the vertical structure and overstory biomass, biodiversity, and habitat use in trees of common species in our region. So far, we have examined one large forest tree on campus, focusing on identifying methods and then describing the vertical structure and distribution of biodiversity and Tree-Related Microhabitats (TReMs) in and on our study tree. We identified 26 arthropod species in the tree but with species and assemblages varying with canopy position. TReMs were dominated by lichens which were found throughout the entirety of the tree but no clear pattern otherwise. These results suggest that our temperate deciduous tree canopies likely are important habitats for forest biodiversity but we have more work to do to improve methods and expand the research.

82 - Does ectoparasite load in BND depend upon stream urbanization or personality?

Kara Branstad, Towson University

The genus Neascus is a trematode that requires three separate hosts to proliferate, one of these being the blacknose dace. There is limited information on whether ectoparasite load in fish depends on personality. Eighty blacknose dace were sampled from four sites; two urban, one suburban, and one rural based on impervious surface cover (ISC). These were sampled from the Maryland region and tested in a bold/shy personality trial. Each individual was separated in tanks with a cover minimizing external influences on the individual's behavior. Neascus occurred in urban, suburban, and rural streams and affected both sexes. Bold fish have a tendency to explore their surroundings more readily than that of fish with a shy personality in a novel environment.

Because of this difference in behavior, personality may be an indicator of ectoparasite load. In addition, urban streams, due to their high nutrient content, may have a higher concentration of parasites. The relationship between the sex of the fish, bold/shy personality, and external parasite load in black nose dace in an urban/rural setting will be presented.

83 - The effects of floodplain restoration on biodiversity

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There has been a significant loss of wetlands throughout the centuries, with many of them in the Piedmont region being buried under thick layers of legacy sediment. The removal of legacy sediment is a new technique used to restore wetlands, mainly with the intent to improve water quality. However, a restored wetland may also have numerous benefits on the biodiversity within the area. Our intended goal was to evaluate the effects of floodplain restoration on biodiversity. To accomplish this, three restored floodplains in Lancaster County were surveyed for vegetation and amphibians. Vegetation was sampled using a randomly selected transect with a 1-meter quadrat and amphibians were sampled haphazardly using dip-nets with 300-600 dips depending on the site. Specimens were collected and identified using identification keys. The amphibian and plant species we found at these three sites are indicative of the success of these restored floodplains.

84 – The use of large online data sets to teach quantitative literacy introductory biology students at an HBCU: Wind impacts on adbundance of birds-of-prey in Hawk Mountain Sanctuary, Kempton, Pennsylvania

Jahia Collier, Hampton University

This project was part of a larger set of authentic inquiry-based activities designed during COVID to build student skill sets in the process of science and quantitative literacy. In the studies, groups of students selected Hawkwatch sites and invested in trends in Bird-of-Prey migration, and developed a unique research question for their group. This represents one group's efforts. Bird-of-Prey are counted and recorded every fall season at Hawk Mountain Sanctuary in Kempton, Pennsylvania. We investigated the fundamental trends in Bird-of-Prey seasonality and biodiversity for Hawk Mountain Sanctuary for Fall 2020. Several studies have noted the weather's influence on the birds' migratory patterns. We hypothesized that stronger wind speeds and lower temperatures would have a positive effect to increase migrating birds. Over 107 days, from mid-August to late November, nearly 12,700 Bird-of-Prey were counted with 19 species observed. Alongside daily count, wind speed and temperature were gathered hourly. It was found that wind speeds, an average of 12-19 kilometers per hour, correlated with an increase in abundance. Our data shows the count of individual species of Bird-of-Prey throughout the fall season and can be used to predict the best migration days. Further research would need to be conducted to analyze temperature-aiding hawk migration, due to the variance of hot and cold fronts. The relationship between temperature to abundance is likely an artifact of shifts in overall seasons and not a direct influence of total migration. Analyzing such patterns across time allows for comparisons and potential impacts on conservation. Other related research should utilize the same methodologies but compare the effects of sampling bias resulting from COVID with 2020 and 2021 data sets which were done by recent students enrolled in the course.

85 - Life Cycle Costing of Aquaponics and Hydroponics System; a case study on an experimental production system in the District of Columbia

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Abstract: Over the last 30 years, the scientific community has developed several methodologies to measure sustainability for food production. Aquaponics is a burgeoning technology that blends recirculating aquaculture operations and hydroponics to produce fish and vegetables. To better understand the project's long-term sustainability, we used the Lifecycle Thinking (LCT) technique to examine the complete life cycle of aquaponics-hydroponics operation. Life Cycle Costing (LCC), an ISO 15686-5:2017 approach for calculating the total cost of an investment project or system across its lifetime, is being applied in the project. Our primary purpose for conducting LCC is to assess the potential for aquaponics and hydroponics from cost perspective as responsible and sustainable food security solutions for the Washington, DC, region. The framework for life cycle assessment (LCA) has been developed and is being utilized for LCC. In this case study, we are conducting LCC for hydroponics, aquaponics and soil-based food production systems. Our LCC will show the present value calculations for the three alternatives. Moreover, the result summary will be an overview of capital cost; annual operating and maintenance cost; repair and replacement cost and, salvage value. Thus, the methodologies to perform LCC is being developed and will be presented at the conference. Activities resulting in direct costs or advantages to the decision-making process from the investment (aquaponics and hydroponics) will be examined and reflected in monetary units (e.g., dollars, etc.).

86 - Life Cycle Sustainability Assessment (LCSA) of Aquaponic and Hydroponic farming systems

Assefa Tadesse, University of Delaware

The production and distribution of food in the US have a considerable negative impact on the environment, accounting for 33.6% of freshwater withdrawal and 8% of greenhouse gas emissions. However, hydroponics and aquaponics provide more sustainable alternatives by recycling water, requiring less agricultural land, and emitting less carbon dioxide compared to traditional farming methods. The potential environmental, economic, and social impacts of adopting hydroponic and aquaponic systems in the Washington, D.C. region are being evaluated through a life cycle sustainability assessment (LCSA) at the Urban Food Hubs managed by the University of the District of Columbia (UDC). The project aims to evaluate the benefits of hydroponics and aquaponics in urban settings from a sustainable perspective. The LCSA framework being developed will equip municipal authorities with the necessary tools to make informed policy decisions and enhance manufacturing processes. The study involves experimenting with black magic kale, lettuce, basil, and some microgreens such as radish. This is the first project to conduct a comprehensive assessment of hydroponic and aquaponic systems in urban agriculture using a life cycle sustainability approach. The environmental performance of the three different agriculture systems is being quantified using SimaPro software. Life cycle assessment (LCA) will be utilized to estimate total life cycle costs, including Acidification, Eutrophication potential (EP), and global warming potential (GWP).). Preliminary results from the SIMAPRO software show that 0.00035 Kg CFC-11 eq of ozone depletion and 2.993E3 Kg-CO_2 eq global warming from greenhouse materials used in hydroponics are caused by the glass panel used as roofing during the construction phase. While the use of nutrients in the hydroponics caused 4.36E-8 Kg CFC-11 eq ozone depletion and 0.648 Kg-CO_2 eq global warming. The study aims to compare soilless food production techniques with traditional soil-based agriculture and identify gaps in data that must be filled to undertake LCA, LCC, and sLCA. Overall, this research will provide valuable insights into the benefits and drawbacks of hydroponics and aquaponics in urban agriculture, with a particular focus on sustainability.