AGENDA

BES 25th Annual Meeting
October 12-13, 2023
https://baltimoreecosystemstudy.org/

Location:
1st Floor, Auditorium
Merrick School of Business
11 West Mount Royal Avenue, Baltimore, MD, 21201

The BES Annual meeting brings together researchers, practitioners, and students from the Baltimore community and beyond who are interested in Baltimore as a social-ecological system and its sustainability, equity, and resilience.

Day 1 Thursday, October 12th

Plenary: Celebrating Our 25th Anniversary!

9:10 - 9:20 Welcome and Opening Remarks, Chris Swan, UMBC

9:20 - 9:50 Steward Pickett, Cary Institute of Ecosystem Studies

9:50 - 10:10 Dan Childers, Arizona State University, CAP-LTER

10:10 - 10:45 Conversation

10:45 - 11:00 Break

11:00 - 12:15 Session 1 (Morgan Grove, moderator)

11:00 **Quantifying the thermal regime of Dead Run: An update**. Claire Welty, Mary McWilliams, Nick Simeone, John J. Lagrosa IV, and Andrew J. Miller

We previously reported on our initial efforts to design and install a measurement system to quantify impacts of stormwater facilities and land cover on the thermal regime of the Dead Run stream network. This type of data is of interest to local policy makers in consideration of setting stream temperature TMDLs. We have deployed 204 HOBO TidbiT MX 2203 temperature data loggers over all 16 km of daylighted segments of Dead Run. Sensor spacing varies between 50 and 100 m, with additional sensors placed ~2 m downstream of every stormwater management facility. Data are recorded every 5 minutes, with data collection beginning in December 2021 and the most recent updates to the system made in March 2023. All downloaded data are stored in a UMBC database and a GIS-based algorithm has been developed to video-animate the data. An example 14-minute storm from 6/27/22 illustrates the richness of the data set. The video animation dramatically illustrates heat pulses entering and traveling down the stream network. Quantitative analysis reveals that stormwater pipes draining headwater buried streams provide an ecosystem service by cooling stream water beneath hot impervious surfaces under non-storm conditions. However, when the headwater storm drain system collects hot runoff from storms (via street inlets), the greatest contrast between baseflow storm temperatures and peak runoff temperatures are observed at these headwater pipe outfalls, thus indicating locations of greatest thermal shock to the system. This temperature variability due to storm runoff collapses moving toward the main stem outlet. Contributions to stream thermal load from stormwater management facilities appears to be no greater than that from the abundant outfalls from pipes draining directly connected impervious area, e.g., from roads and parking lots. Analysis is ongoing to quantify variability of thermal response to differing storm durations and intensities, across all seasons. This work is sponsored by Chesapeake Bay Trust.

11:15 **How do fish meet the challenge of living in urban streams? An analysis of urban fish communities using underwater video surveys in Dead Run.** Stanley Kemp and Mary Kemp

Urbanized watersheds and streams pose many difficulties for aquatic life. These include flash flooding, degradation of habitat, high temperature or saline runoff, toxins, high nutrient input, dams, and other factors. Recent studies have shown general impacts of urbanization on physiology and performance, reproduction, and even genetics of urban fish populations. The filter of urban ecosystem characteristics removes less tolerant and adaptable members of the fish community, leaving behind a resilient and pollution tolerant remainder. While it is important to understand which species are missing and the reasons why they are eliminated or reduced in urban habitats, it is also important to understand how species cope with challenges of the urban environment. We used underwater video techniques (unbaited and baited) to survey fish communities in Dead Run in several locations. Not often applied in freshwater settings, these methods have the advantage of examining in- situ behavior, are not extractive or invasive, and are logistically simple. Our results were compared with existing data to determine the effectiveness of video surveys in establishing fish assemblage characteristics in Dead Run. We present examples of captured video of Dead Run fish and speculate on the mechanisms allowing species to persist in urbanized habitat. Selective use of habitat heterogeneity by fish to overcome challenges in the urban environment remains a largely unstudied possibility. Our results point to further research aimed at improving understanding of how urban fish species adapt to highly altered habitats.

11:30 **How do urban park trees affect soil underneath them?** Ian Yesilonis, Kotze D. J., Ghosh S., Hui N., Jumpponen A., Lee B., Lu C., Lum S., Pouyat R., Szlavecz K., Wardle D., Zheng B.

Humans modify the urban landscape in numerous ways, such as planting trees and relocating soil, to create green spaces such as parks for communal enjoyment. The decomposing leaf litter of these park trees affects soil properties and the organisms inhabiting it. Additionally, climate is a major driver of soil organic matter (SOM) formation, which is crucial for soil functions such as water infiltration and nutrient cycling. Despite the widespread human effort to create parks, the long-term impacts of these modifications on SOM and microbial communities are not thoroughly understood. We conducted a study examining soil under trees in parks across three cities, each in a different climate zone. Our results indicate that while the type of leaf litter had minimal effect on SOM, the climate zone had a noticeable impact. Reference forest soils had higher SOM than those in older parks, but young and old parks showed little difference. Additionally, microbial communities varied between forest and old parks, as well as between young and old parks. Our findings suggest that human-disturbed soils experience long-lasting effects, influenced primarily by climate and less so by tree type.

12:00 **How safe are urban vacant lots for greening?** Katalin Szlavecz, Keelin Reilly, Tamas Budavari, Jihoon Kang, Ian Yesilonis

The approximately 14,000 vacant lots in Baltimore City are an important feature of the urban landscape. Given their potential for beneficial reuse, many could provide important health and urban ecological benefits to city residents. Our understanding of the environmental quality of vacant lots at the city scale is very limited, especially as it is related to the potential for contaminant exposure and health risks. The goal of this study was to characterize surface soil properties of 100 vacant lots in two major areas: Northwest and East Baltimore. In general, the soil had high pH, high Ca concentration, mostly due to the mixed-in construction debris. There were strong correlations between the concentrations of specific metals, notably between Pb and both As and Zn, and between Cu and both Mn and Zn. Lead concentrations on most plots were less than 200 ppm indicating that it is safe to grow vegetables and for children to play. However, contamination hot-spots still may exist. To assess within-plot variability, we also conducted a fine scale grid sampling. While most of the lots appeared to be safe for greening efforts, the high variability among them warrants the necessity of local soil screening.

12:15 **Adaptation to the Urban Heat Island in Weedy Plant Species Across US Cities.** Eric Yee and Meghan L. Avolio

Weedy plant species are incredibly successful in urban environments, with adaptations in response to the urban heat island (UHI). However, it is unclear if these plant responses are due to adaptation or phenotypic plasticity. We investigated this in a greenhouse temperature experiment using maternal lines of Lactuca serriola (prickley lettuce) and Taraxacum officinale (common dandelion) from across four US cities: Baltimore, MD; Minneapolis-St. Paul, MO; Phoenix, AZ; and Los Angeles, CA. Seeds were collected along a gradient of UHI strength in summer 2018-2020 and inbred for one generation (F1) to eliminate maternal effects (nLS=359, nTO=389). Land surface temperature (LST) was calculated from Landsat-8 satellite imagery. F1-

plants were subjected to a cool treatment (20C) and heated treatment (28C; UHI temperature) and several morphological, ecophysiological, and phenological traits were measured. Overall, plants in the heated treatment were much smaller and performed significantly more poorly, with clear signs of heat stress (e.g., reddened leaves, small size, etc.). For both species, the heat treatment had significant impacts on aboveground biomass, belowground biomass, and size ($p<0.05$), but there was no significant attribution to LST for L. serriola, while T. officinale was significantly affected by city identity and LST. Interestingly, in the heat treatment, L. serriola from only LA and PX flowered while T. officinale from all four cities bloomed readily, however, city and LST were significant for only T. officinale. Together, the trait and phenological responses suggest that UHI results in adaptations of faster reproductive period and biomass in T. officinale, but not L. serriola.

12:15 - 1:00 Lunch

1:00 - 2:00 Posters

Urbanization Influences Exurban Ecosystem Greenness through Livelihood, Lifestyle, and Connectivity of Rural Households. Zhaxi Dawa, Weiqi Zhou, Steward T.A. Pickett, Daniel L. Childers

Numerous studies have focused on the link between rapid urbanization and vegetation change. These studies, however, have been limited to urban areas proper, and rural areas have not been sufficiently explored. Here, using the Continuum of Urbanity concept, we define urbanization influences on rural areas as urbanity, which involves shifts in the livelihoods, lifestyles, and connectivity of rural households, and we investigate the relationship between this shift and changes in vegetation greenness from 2000-2018. We found that over the past decade, although most Chinese rural households primarily engaged in farming, there has been a significant trend towards non-farming. Farming households have decreased by 22.0%, and non-farming rural households have increased by 101.8%. Rural households are experiencing wealthier livelihoods, diverse lifestyles, and greater connectivity, which are closely associated with the greening of rural vegetation. However, these relationships depend on whether the household is engaged in farming or non-farming activities and whether the household is located in the East or West of China. Moreover, government land acquisition, renting land for non-farm uses, and pensions are potentially related to vegetation greening. By illuminating the potential connections between urban influences and vegetation change in rural regions, our research underscores that rural economic development and ecosystem restoration can progress synergistically.

BES goes high frequency. Mary McWilliams, Claire Welty, Jon Duncan, Peter Groffman, and John Lagrosa

As a complement to the 25-year BES weekly stream chemistry record, in 2023 we embarked on a new project to deploy high-frequency water quality sensors at current BES sampling sites. This high-frequency data will enable investigations of storm event-scale responses of water quality including consistency in water quality patterns across storms and improved quantification of storm contributions to annual loads. This is increasingly important with climate change that is delivering more intense storms. Sites include Pond Branch, Baisman Run, Gwynn Falls at Gwynnbrook, Gwynns Falls at Villa Nova, Dead Run, and Gwynns Falls at Carroll Park, all co-located with USGS stream gaging stations. YSI EXO2 sondes outfitted with temperature, specific conductance, turbidity, dissolved oxygen, and pH sensors collect data at a 5-minute interval. S::can v3 Spectro::lysers measure nitrate-nitrogen and dissolved organic carbon at a 15-minute interval. The end-to-end system utilizes Sierra Wireless RV50X modems and Campbell Scientific secure cellular provisioning to transmit data to UMBC, where data are received by a base station using Loggernet to communicate with the field sites. Data are archived in the CUAHSI Hydroshare repository. This project is part of the new initiative, the "Baltimore Social-Environmental Collaborative", one of a network of DOE-funded Integrated Field Laboratories.

Visualizing thermal fluctuations of the Dead Run stream network. Nick Simeone, John J. Lagrosa IV, Claire Welty, Mary McWilliams, and Andrew J. Miller

The aim of this research is to create an automated process that generates maps and video animations to display spatial and temporal variability in temperature throughout a stream network from collected sensor data. We are using Dead Run as a test bed, where ~200 temperature sensors have been deployed for 18 months recording data every 5 minutes, periodically downloaded, and data stored in a database. Stream temperature data were pulled from specified time intervals and brought into ArcGIS Pro to display spatial temperature distributions for each time step. Using raster data created through Inverse Distance Weighting, stream temperature sensor data were interpolated along tributaries and displayed using a red to blue color scale. An automated process coded with Python allowed for a large number of maps to be produced, each representing a timestamp between specified time bounds. These maps were then stitched together using video editing software to allow for a fluid transition that makes it easy to visualize the rise and fall of temperature at each location in the drainage network. This video product can help audiences understand the data by providing a striking visual display to highlight the severity of temperature spikes in urban tributaries resulting from summer storms.

Dissolved Organic Matter as a Socioecological Tool. Alexandra Acevedo, Rebecca Hale

Urban stream pollution is a global issue; the most prevalent pollutants are wastewater, stormwater, nutrient runoff, and trash. As urbanization continues, it is important to be able to identify sources of pollution and the impact of mitigation measures. This is especially important since pollution is often disproportionately distributed across populations in the United States; identifying these inequalities is imperative for restoration. Dissolved organic matter (DOM) can be used as a tool, using spectroscopy, to identify potential pollutant sources. Using Baltimore as a focus, we used data on land use, land cover, stormwater and wastewater infrastructure, and socio-demographics to answer: 1) what urban watershed characterizations influence Baltimore's watershed DOM quality? And 2) what do these patterns suggest about the sources of poor urban water quality more generally? We sampled surface water at 54 sites within the city of Baltimore and analyzed them for concentrations of nutrients, organic carbon, and DOM quality. We then used linear regression to assess relationships among water quality variables and watershed characteristics. We found that correlations between watershed fluorescence indices, best management practice (BMP) density, and household income were all statistically significant. The fluorescence index, an indicator of microbially-source DOM and therefore expected to be associated with wastewater inputs, was negatively correlated with median household income ($R^2 \leq =0.26$, $p= <.0001$), and negatively correlated with BMP density ($R^2 \leq =0.34$, $p= .0002$). BMP density was positively correlated with household income ($R^2 \leq = 0.54$, $p= <.0001$). These results indicate that restoration efforts disproportionately distributed within Baltimore watersheds, and that BMP density may mitigate wastewater inputs to streams, either due to a change in wastewater inputs, or a change in terrestrial or humic DOM inputs. These disproportionalities cause poorer communities to have more impaired waterways.

Quantifying the N Footprint of Baltimore City. Ayal Alkhateeb

Reactive nitrogen (Nr) compounds encompass all nitrogen (N) species, except N2, and originate from various sources such as the Haber-Bosch process for food production, fossil fuel combustion, biological nitrogen fixation, and lightning. While essential for agricultural and industrial processes, effective Nr management is key to mitigating its detrimental environmental impacts, thus achieving a balance between demand and sustainability. Calculating Nr emissions from an entity's resource consumption is the first step toward addressing this issue, and the Nitrogen Footprint Tool (NFT) offers an innovative approach to do so. Through the calculation of an NFT, a concept that had only previously been applied at the personal and institutional levels, individuals can observe and assess the ecological consequences of their consumption patterns. By applying the NFT framework to Baltimore, Maryland, USA, the scope is broadened to embody a community nitrogen footprint. This thesis, conducted in the same sample region as Dukes et al. (2020), aims to revisit their findings from 2016 by integrating data from 2022. In 2022, Baltimore observed a total nitrogen footprint of ‚àº13,800 MT per year, equivalent to 29 kg N per capita. The combined impact of energy consumption sectors, including electricity, natural gas, and transportation, accounted for 57% of the city's footprint, the majority of which can be attributed to the transportation sector (55%). Through mapping, it became evident that economic and developmental factors were the primary drivers of geographic disparities. Various management scenarios, including the reduction of meat and transportation consumption, were examined to gain insight into possible reductions in the city's nitrogen footprint. This model can be applied to other communities within Maryland and the United States to evaluate nitrogen sustainability further.

Selection in the City: How Artificial Selection Affects the Genetic Diversity of Urban Trees.
Beatriz Shobe, Meghan Avolio

Many cities are setting goals to expand tree canopy as trees are known to mitigate the urban heat island effect, as well as to aid in storm water management and sequester carbon. As a result, Baltimore has committed to investing resources to increase overall urban canopy to 40% with initial efforts focused in sparsely vegetated areas. Planting a diverse array of species is often recommended, however, studies have shown that those recommendations are often not put into practice. Trees that can tolerate certain conditions, such as compact soils, drought, and contaminated soils are favored as they have a higher likelihood of survival. Additionally, many of the planted trees are cultivars that are obtained from large nurseries and may have very limited genetic diversity. We hypothesize that the tree communities in the Baltimore region are largely comprised of cultivars and are therefore lacking in genetic diversity. Homogeneity of both genetic makeup and species makeup can expose trees to other threats and create a community that lacks resilience, especially in the face of climate change or invasive pests. To evaluate this, we will examine 2 of the most commonly planted species, A. rubrum, which is native, and A. platanoides, which is invasive. Comparing these two species will provide insight into how selective pressures drive adaptation both in the presence of a local wild-type population with potential for interbreeding, as is the case for A. rubrum, as well as in the absence of such a population, as in the case for A. platanoides. Several location types across the city were sampled, including highly managed streets and parks, managed and unmanaged residential areas, and unmanaged urban and rural forests. During the summer of 2021, 250 individuals of each species were located, measured, and tagged. Tissue samples were collected, and DNA was extracted for genetic analysis using microsatellites. Twelve unique microsatellite markers were identified for both species and subsequent analysis with GeneMarker allowed us to determine the degree of genetic relatedness among our samples. To date, we have found evidence of reduced genetic diversity of managed street, park and residential trees through the planting of cultivars. As urban trees are increasingly under stress from climate change, invasive species, and diseases, understanding the genetic diversity of urban trees and forests will help us to maintain more resilient and robust urban vegetation.

Adaptation of Common Dandelion and Prickly Lettuce to Different Urban Climates
Max Carroll, Meghan Avolio, Eric Yee

Many cities are setting goals to expand tree canopy as trees are known to mitigate the urban heat island effect, as well as to aid in storm water management and sequester carbon. As a result, Baltimore has committed to investing resources to increase overall urban canopy to 40% with initial efforts focused in sparsely vegetated areas. Planting a diverse array of species is often recommended, however, studies have shown that those recommendations are often not put into practice. Trees that can tolerate certain conditions, such as compact soils, drought, and contaminated soils are favored as they have a higher likelihood of survival. Additionally, many of the planted trees are cultivars that are obtained from large nurseries and may have very limited genetic diversity. We hypothesize that the tree communities in the Baltimore region are largely comprised of cultivars and are therefore lacking in genetic diversity. Homogeneity of both genetic makeup and species makeup can expose trees to other threats and create a community that lacks resilience, especially in the face of climate change or invasive pests. To evaluate this, we will examine 2 of the most commonly planted species, A. rubrum, which is native, and A. platanoides, which is invasive. Comparing these two species will provide insight into how selective pressures drive adaptation both in the presence of a local wild-type population with potential for interbreeding, as is the case for A. rubrum, as well as in the absence of such a population, as in the case for A. platanoides. Several location types across the city were sampled, including highly managed streets and parks, managed and unmanaged residential areas, and unmanaged urban and rural forests. During the summer of 2021, 250 individuals of each species were located, measured, and tagged. Tissue samples were collected, and DNA was extracted for genetic analysis using microsatellites. Twelve unique microsatellite markers were identified for both species and subsequent analysis with GeneMarker allowed us to determine the degree of genetic relatedness among our samples. To date, we have found evidence of reduced genetic diversity of managed street, park and residential trees through the planting of cultivars. As urban trees are increasingly under stress from climate change, invasive species, and diseases, understanding the genetic diversity of urban trees and forests will help us to maintain more resilient and robust urban vegetation.

Silicate weathering and mineral chemistry in the Eastern Piedmont of Maryland Critical Zone.
Kyle Farrington, Mary McWilliams, Daniel J. Bain, Claire Welty, Joel Moore

Chemical weathering of silicate minerals releases nutrients into soils, turns bedrock into soil, shapes landscapes, and regulates atmospheric CO_2 concentrations on geological timescales. Mineral weathering processes in soil redistributes elements with depth, commonly resulting in depletion of many elements near the surface. Understanding mineral weathering processes in a watershed is essential to quantifying elemental fluxes and to assessing influences of urbanization on soils. We collected soil (and saprolite) cores to determine subsurface geochemistry, mineralogy, and characteristics in silica-rich and silica-poor rocks in the Maryland Piedmont. C and N concentrations were enriched at the surface of all profiles and decreased with depth. SiO_2 concentrations were lower and Al_2O_3 and Fe_2O_3 were higher in weathered material overlying the silica-poor bedrock in comparison with material overlying the silica-rich bedrock. Higher Al_2O_3 and Fe_2O_3 over the silica-poor bedrock likely reflects higher concentrations of secondary minerals such as clays and iron oxides. The silica-poor cores had quite low Na_2O and K_2O and higher CaO and MgO, as might be expected based on bedrock geochemistry; one core was nearly depleted of all cations down to 7-8 m depth. The silica-rich core had higher Na_2O and K_2O than the silica-poor cores and particularly high CaO and MgO in the mid-depths (1-2 m), suggesting that bedrock chemistry variability might drive soil chemistry more than weathering processes. Future work will quantify the short-term (decadal-scale) influence of urbanization on soil chemistry using sequential extraction.

Baltimore Street Trees: Distribution and Diversity. Trinidad Fleming, Meghan Avolio, Nancy Sonti, Dexter Locke

Tree distribution and diversity reflect both social and ecological processes in an urban area. Previous studies found urban tree diversity and distribution is associated with socioeconomic factors like race, income, and education level. These findings illustrate potential inequity in tree planting practices towards typically marginalized groups in urban areas. This project examines the relationship between socioeconomic factors, average temperature, and street tree diversity and distribution in Baltimore, MD neighborhoods. Demographic factors were measured at the neighborhood level using data from the Baltimore Neighborhood Indicators Alliance. We used five independent variables: percent white, percent black, median household income, percent of population over 25 with a bachelor’s degree or higher, and average temperature for each neighborhood. Our predicted dependent variables are: street tree species richness, evenness, diameter at breast height (DBH), percent native species, and proportion of potential street tree sites filled. The current results suggest a positive relationship between the richness of street trees with a DBH less than 5 cm and education, income, and percent white in a neighborhood. Species evenness, percent nativity, and average DBH demonstrate strong negative relationships with average temperature. The percent of potential street tree sites filled demonstrates a positive relationship with percent white and average temperature in a neighborhood. Additional analyses will investigate what these relationships mean for street tree equity in Baltimore Neighborhoods and how they might inform street tree planting efforts.

2:00 - 3:00 Session 2 (Rebecca Hale, moderator)

2:00 **Assessing Climate Adaptation for Socio-ecological Systems at the State and County Scale.** Katie May Laumann, Annie Carew, Conor Keitzer, Lili Badri, Ann Foo

Over 4 million people live and work along Maryland's coast, and coastal communities are already experiencing climate change threats. Although the State of Maryland has been investing in climate adaptation over the last decade, a mechanism to assess the level of adaptation and to track progress toward resilience was lacking until fairly recently. We worked with over 100 stakeholders to develop such an assessment; we asked community members to identify the most pressing climate threats and adaptation needs in their communities, identify goals for adaptation, and assess adaptation at the state level using a scientific process. The resulting Climate Adaptation Report Card has been used in community and state-level planning efforts, but more specific, county- or community-level assessments are needed to guide adaptation planning and efforts at the local level. We will discuss the Maryland State-wide Assessment and an ongoing county-level assessment, and explore how such an assessment might inform adaptation and resilience building efforts in Baltimore in the near future.

2:15 **Shaping Baltimore's Urban Forests: Past Insights for Present-Day Ecology.** Nancy Sonti, Matthew Baker, John Lagrosa, Michael Allman, J. Morgan Grove

Context: Land use history of urban forests impacts present-day soil structure, vegetation, and ecosystem function, yet is rarely documented in a way accessible to planners and land managers.

Objectives: To (1) summarize historical land cover of present-day forest patches in Baltimore, MD, USA across land ownership categories and (2) determine whether social-ecological characteristics vary by historical land cover trajectory.

Methods: Using land cover classification derived from 1927 and 1953 aerial imagery, we summarized present-day forest cover by three land cover sequence classes: (1) Persistent forest that has remained forested since 1927, (2) Successional forest previously cleared for non-forest vegetation (including agriculture) that has since reforested, or (3) Converted forest that has regrown on previously developed areas. We then assessed present-day ownership and average canopy height of forest patches by land cover sequence class.

Results: More than half of Baltimore City's forest has persisted since at least 1927, 72% since 1953. About 30% has succeeded from non-forest vegetation during the past century, while 15% has reverted from previous development. A large proportion of forest converted from previous development is currently privately owned, whereas persistent and successional forest are more likely municipally-owned. Successional forest occurred on larger average parcels with the fewest number of distinct property owners per patch. Average tree canopy height was significantly greater in patches of persistent forest (mean = 20.6 m) compared to canopy height in successional and converted forest patches (mean of both = 16.8 m).

Conclusions: Historical context is often absent from urban landscape ecology but provides information that can inform management approaches and conservation priorities with limited resources for sustaining urban natural resources. Using historical landscape analysis, urban forest patches could be further prioritized for protection by their age class and associated ecosystem characteristics.

2:30 **5 Million Trees: Tracking Trees and Climate Progress.** Frances Marie S. Panday, Rachel Lamb, JT Bowers, and Justin Arseneault

The Maryland Department of the Environment (MDE) is the lead coordinating agency of the 5 Million Trees Initiative, which commits Maryland (MD) to planting and maintaining 5 million native trees (5MT) by 2031 with at least 500,000 in urban, underserved areas.

MDE tracks progress towards 5 million by collecting spatially-explicit tree planting data from state agencies, non-profit organizations, local communities, and other independent planters. Tree planting progress is mapped across the State to document and verify eligible plantings. MDE also partners with the University of Maryland (UMD) to calculate the carbon sequestration benefits of these trees to include their contributions within the State's greenhouse gas inventory. To do this, UMD leverages high-resolution remote sensing data and a process-based ecosystem model to track net carbon changes (e.g., carbon fluxes). Tree planting data is also verified and tracked with optical imagery and machine learning algorithms to support improved tree maintenance and management over time.

The 5MT Initiative directly supports MD's climate resiliency and net zero carbon mitigation goals. Long-term data evaluating different tree planting type survivorships (e.g., urban) could also improve program efficacy.

2:45 **Heavy Metals and Microbiomes: Empowering Under-resourced Institutions through Genomics, Data Science, and Cloud Computing.** Michael Schatz

Research experiences play an integral role in STEM education by enhancing students' learning, engagement, and propensity to pursue related careers. However, securing hands-on opportunities remains a challenge for many institutions, especially those lacking robust research infrastructure and funding. Underresourced colleges frequently also serve student from diverse backgrounds underrepresented in STEM fields. Thus, barriers to research participation at these schools serve to widen preexisting inequities. To address this, the Genomic Data Science Community Network (GDSCN) - a collaborative of faculty at community colleges, historically Black colleges and universities, Hispanic-serving institutions, and tribal colleges and universities - launched a pilot project using genomics and data science to study soil microbe responses to heavy metal contamination. Our goal is to expand genomic data science and bioinformatics education through authentic research.

For our pilot study, we sampled soils for metagenomic sequencing at 48 locations in Baltimore City and Montgomery County, Maryland. We coupled genomic sequencing with soil elemental analysis and heavy metal quantification. By focusing on soil microbes, the project circumvents the ethical complexities of human genomic research, making it ideal for training undergraduate students. Moreover, it highlights the ecological and human health consequences of heavy metals, which accumulate in urban areas due to human activities and disproportionately affect disadvantaged communities. The project leverages the NIH's AnVIL cloud computing platform, which helps circumvent barriers stemming from insufficient local computational infrastructure.This highly scalable project will provide genomics training to students and faculty, nurture cross-institutional research collaborations, and further our understanding of how heavy metals and soil microbial communities impact human health.

3:00 - 3:30 **Lightning Talks:** Rapid fire up and coming ideas or new and emerging science needs and projects

3:30 **Conclude**

5:00 **Reception hosted by Pastor Mark Montgomery and Terris King II**
Union Baptist Church, 1219 Druid Hill Avenue, Baltimore

Day 2 Friday, October 13th

9:10 - 9:15 Welcome, Morgan Grove, USDA Forest Service

9:15 - 10:30 Session 3 (Nancy Sonti, Moderator)

9:15 **Baltimore Green Space Science for Policy, Planning, and Management.** Katie Lautar

9:30 **Evidence for altered seasonal patterns of solute export from urbanized watersheds.** Jon Duncan, Peter Groffman, Claire Welty, Larry Band

Urbanization has shown to increase solute fluxes in many watersheds, largely through increased sources and higher streamflows, particularly during storm events. However, less is known about urbanization alters the seasonal patterns of streamflow export. Data from long-term water quality stations from the Baltimore Ecosystem Study Long-Term Ecological Research (BES LTER) watersheds were used to quantify solute fluxes over a 20-year period. We modeled daily nitrate, phosphate, total nitrogen, and total phosphorus fluxes using the USGS Weighted Regressions on Time, Discharge, and Seasonality (WRTDS) model. Results show strong seasonal cycles for some solutes including nitrate in the forested reference watershed that are reversed in all other watersheds, including at Baisman Run the larger mostly forested watershed that contains Pond Branch but has low density residential development in the headwaters. We show there is no strong seasonal pattern at Dead Run, the most heavily developed watershed. More work is needed to see if these findings hold for other solutes and for other regions.

9:45 **Teaching Earth Science of Baltimore for all Baltimore High School Students.** Alan Berkowitz and Angela Hood

EarthX is a research/practice partnership between Baltimore City School District science leaders and teachers, and collaborators at Cary Institute, George Washington, University of Montana, American University and UC Berkeley. Our goals are to: 1) support the integration of Earth science into high school Biology, Chemistry, and Physics courses in Baltimore City Public Schools, and 2) advance the District’s transition to three-dimensional (3D), ambitious and equitable science teaching aligned with the Next Generation Science Standards (NGSS). All high school Biology, Chemistry, and Physics teachers in traditional City Schools (approx.. 140 teachers) will use EarthX assessments and participate in EarthX professional learning (PL). In this way, the project will reach the entire student population attending traditional City Schools. EarthX will develop, test, and refine embedded and unit assessments for all three courses that will provide near-real-time feedback to teachers and students, and be used in the project’s PL activities and supports. EarthX assessments will be 3D, featuring core concepts from both Earth science and the course discipline combined with a science or engineering practice and a crosscutting concept. Assessments will support teaching and learning of phenomena in the local-to-global environment in ways that are both engaging and accessible to Baltimore students and teachers.

Several EarthX assessments build on BES and related science of the City. We will share examples of our first assessments and preliminary results, and highlight exciting new opportunities for urban ecosystem curriculum development that could bring even more BES science to all City high school students.

10:00 **Hydro-bio-geo-socio-chemical interactions and the sustainability of residential landscapes.** Peter Groffman, Amanda K. Suchy, Dexter H. Locke, Robert J. Johnston, David A. Newburn, Arthur J. Gold, Lawrence E. Band, Jonathan Duncan, J. Morgan Grove, Jenny Kao-Kniffin, Hallee Meltzer, Tom Ndebele, Jarlath O'Neil-Dunne, Colin Polsky, Grant L. Thompson, Haoluan Wang, Ewa Zawojska

Residential landscapes are essential to the sustainability of large areas of the United States. However, spatial and temporal variation across multiple domains complicates developing policies to balance these systems' environmental, economic, and equity dimensions. We conducted multidisciplinary studies in the Baltimore, MD, USA metropolitan area to identify locations (hotspots) or times (hot moments) with a disproportionate influence on nitrogen export, a widespread environmental concern. Results showed high variation in the inherent vulnerability/sensitivity of individual parcels to cause environmental damage and in the knowledge and practices of individual managers. To the extent that hotspots are the result of management choices by homeowners, there are straightforward approaches to improve outcomes, e.g., fertilizer restrictions and incentives to reduce fertilizer use. If, however, hotspots arise from the configuration and inherent characteristics of parcels and neighborhoods, efforts to improve outcomes may involve more intensive and complex interventions, such as conversion to alternative ecosystem types.

10:15 **Baltimore City Water Resources Science for Decision Making.** Kim Grove

10:30 - 10:45 Break

10:45 - 12:00 Session 4 (Terris King II, Moderator)

10:45 **How does tree genetic background and management context affect associated insect communities in Baltimore city?** Eva Perry, Beatriz Shobe, Nancy F Sonti, Meghan Avolio, Karin T Burghardt

Trees are essential to well-functioning urban systems, providing services that benefit humans and wildlife. However, the potential effects of tree genetic background and management context on the efficacy of these services remain a largely unexplored topic. Insects associated with trees in cities can perform key roles in the urban food web as both a food source and as predators, but they can also be damaging in high numbers during pest outbreaks. Understanding how tree genetics and the environment might affect associated insects is necessary to inform best practices for urban tree management and pest mitigation. To investigate the genetic and environmental effects on associated insect community composition in and around the Baltimore metropolitan area, we first determined the genetic relatedness of 250 individual trees of 2 tree species: Acer rubrum, and its non-native congener Acer platanoides. For both tree species we then selected 64 focal trees by delineating 6 genetic clusters, and within each cluster choosing trees growing in street, managed park, urban forest, or rural forest locations. We used vacuum and visual sampling methods to collect mobile and sessile arthropods respectively from the lower canopy of each focal tree in June and August of 2023. We preserved vacuum samples and sessile Sternorrhyncha in 85% EtOH solution for future identification. We reared larval Lepidoptera collected via visual sampling methods for the purpose of identification. Here, I will present preliminary results of the insect communities found on trees between both genetic clusters and management type to determine which factor plays a larger role in shaping insect community composition in cities. A second year of sampling is planned for June and August of 2024.

11:00 **Ongoing and New efforts from the USDA Forest Service Field Station: STEW-MAP; UTC Change with Front / Back; and Urban Silviculture Training Program with Stillmeadow and TurnAround Tuesday.** Morgan Grove, Nancy Sonti, and Ian Yesilonis

In this presentation, we will share with the BES Community some on-going and new research and training programs that will be of interest. 1) Since 1999, the Field Station has collected data on the stewardship organizations and networks in Baltimore. We will share current trends and announce the new iteration for 2024. 2) In partnership with urban areas from Kentucky to New Hampshire, we are engaged in a 30-year study of white and chestnut oak regeneration and to asses whether the climatic progeny of oak seed source affects survival and growth. Finally, we have developed a curriculum and launched an urban silviculture training program in partnership with Stillmeadow Peace Park and TurnAround Tuesday during the summer of 2023. This program is in partnership with numerous organizations in Baltimore. The program will continue through Forest Service funding of the Stillmeadow Peace Park.

11:15 **Simulation of spatially distributed sources, transport, and transformation of nitrogen from fertilization and septic system in Baisman Run.** Ruoyu Zhang, Lawrence E Band, Peter M Groffman, Amanda K Suchy, Jonathan M Duncan, Arthur J Gold

Excess nitrate (NO3-) export from urban watersheds is a major source of water quality degradation and threatens the health of downstream and coastal waterbodies. Ecosystem restoration and best management practices (BMPs) can be introduced to reduce in-stream NO3- loads by promoting vegetation uptake and denitrification on uplands. However, accurately evaluating the effectiveness of these practices and setting regulations for nitrogen inputs requires an understanding of how human sources of nitrogen interact with ecohydrological systems. We evaluate how the spatial and temporal distribution of nitrogen sources, and the transport and transformation processes along hydrologic flowpaths control nitrogen cycling, export, and the development of hot spots of nitrogen flux in suburban ecosystems. We chose a well-monitored suburban watershed, Baisman Run in Baltimore, Maryland, to evaluate patterns of in-stream NO3- concentrations and upland nitrogen-related processes in response to three common activities: irrigation, fertilization, and on-site sanitary wastewater disposal (septic systems). We augmented a distributed ecohydrological model, RHESSys, with estimates of these additional loads to improve prediction and understanding of the factors generating both upland nitrogen cycling and stream NO3- concentrations. The augmented model predicted discharge-weighted NO3- concentrations of 1.37 mg NO3-, -N/L, compared to observed 1.44 mg NO3-, -N/L, while the model predicted concentrations of 0.28 mg N/L without the additional loads from human activities. Estimated denitrification rates in grass lawns, a dominant land cover in suburban landscapes, were in the range of measured values. Interestingly, the highest denitrification rates were downslope of lawn and septic locations in a constructed wetland, and at a sediment accumulation zone at the base of a gully receiving street drainage. These locations illustrate the development of hot spots for nitrogen cycling and export in both planned and "accidental" retention features. Appropriate siting of best BMPs and the identification of spontaneously developed nutrient hot spots should be pursued to retain nutrients and improve water quality.

11:30 **Legacy effects of long-term autumn leaf litter removal slows decomposition rates and reduces soil carbon in suburban yards.** Max Ferlauto, Lauren Schmitt, and Karin Burghardt

Each year in the United States, residential properties dispose of 35 million tons of yard waste, made up of grass clippings and leaf litter. While we understand that the removal of grass clippings reduces soil carbon, leaf litter removal has not been well studied. However, the long-term practice of leaf litter removal may alter decomposition processes and deplete soils of carbon. To test this, we removed or retained leaf litter for 2 years (short-term treatment) within historically raked and un-raked areas (long-term treatment) in 20 suburban Maryland yards. In each treatment plot we measured total soil carbon and used a standardized substrate (TeaBag Index) to assess decomposition rates. We found that long-term historical litter removal reduced decomposition rates by 17% and total soil carbon by 24%. Our short-term management treatment did not significantly affect soil carbon or decomposition rates. Here, we find evidence that legacy effects from long term litter removal create enduring reductions to decomposition rates and soil carbon that are difficult to restore by short-term management changes. This information can be used to guide best management practices to conserve important soil ecosystem functions like carbon sequestration and soil fertility.

11:45 **Differences in mosquito and plant communities along socioeconomic gradients.**
Sarah Rothman, Dr. Paul Leisnham, and Dr. Shannon LaDeau

Nonnative mosquitoes Aedes albopictus and Culex pipiens are two of the most abundant urban mosquito species in the eastern United States and can vector numerous arboviruses. Previous research shows that adult mosquitoes are larger, more abundant, and have higher infection rates in lower-income Baltimore, MD and Washington, DC neighborhoods, creating a disproportionate and unjust risk of disease for residents. The abundance, distribution, and vectorial capacity of A. albopictus and C. pipiens are mostly determined by developmental ecology in water-filled container habitats, which usually includes strong resource competition for allochthonous organic detritus and associated microbes. We surveyed urban plant communities that supply detrital inputs on socioeconomically diverse residential properties in Baltimore, MD and Washington, DC and found distinct plant communities that were more frequently dominated by nonnative plants in lower-income neighborhoods. Past studies suggest that non-native plant detritus supports mosquito population growth better than native plant detritus, and that more non-native biomass can alleviate pressure of larval competition. Using these results, we sought to determine whether differences in field-relevant detrital resource bases help explain previously observed patterns of mosquito composition and abundance in those neighborhoods. We conducted density-dependent trials, testing the effects of characteristically low-income (nonnative trees Ailanthus altissima and Paulownia tomentosa), characteristically high-income (native trees Acer rubrum, Ulmus americana), and regional (native Juglans nigra and nonnative Morus alba) detritus on mosquito intra- and interspecific competition, documenting survival, development time, and body size. We found that characteristically low-income detritus was most effective in releasing mosquitoes from competition pressure, though the regional detritus base supported the highest survival, shortest development time, and longest wings. Meanwhile, mosquitoes raised on the characteristically high-income detritus had the lowest survival, longest development time, and shortest wings, helping explain the lower mosquito infestation rates observed in high-income neighborhoods. These results suggest managing vegetation as a tool to control mosquito populations in neighborhoods where nonnative trees dominate. Understanding the associations between mosquitoes and plants across socioeconomic gradients can help us better predict mosquito infestations and address inequitable disease risks.

Concluding Remarks **Steward Pickett**

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