



## Full abstract agenda

WEDNESDAY MARCH 6, 2024

8:30 AM Opening and welcome with special guests

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9:00am - River Dialogue: Engaged Communities and Diverse Ways of Knowing (YU Great Room)

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9:00 AM Ganawenindiwig: Working with plant relatives to heal and protect Gichigami shorelines

Karina Heim\*, Lake Superior National Estuarine Research Reserve  
 Rob Croll\*, Great Lakes Indian Fish and Wildlife Commission

Released in 2023, Ganawenindiwig (they take care of each other in Ojibwe) is a resource that empowers users to grow, promote, and use plants adapted to coastal areas of Gichigami (Lake Superior) to heal and protect shorelines which may have experienced erosion from storms and changing water levels. Ganawenindiwig introduces readers to 97 plant beings with photos and iconography sharing known cultural relationships, and text that describes environmental preferences and bank stabilization potential. The resource is infused with a rich narrative that promotes Ojibwe land stewardship and includes tips on planning and caring for shoreline planting projects. Over the course of two years, Ganawenindiwig was developed by a collaborative team including an advisory group of Ojibwe knowledge holders, the Reserve, GLIFWC, the Lake Superior Research Institute, and UW-Madison Division of Extension's Natural Resources Institute. In this presentation, Ganawenindiwig authors will introduce this resource and share a vision for how this work may lead us forward in the ways that we relate to and care for plants.



*Keywords: plant beings, shoreline planting, Ojibwe land stewardship*

## **9:20 AM Centering Communities in Great Lakes Restoration and Ecosystem-based Management Programs**

Katie Williams\*, US Environmental Protection Agency Great Lakes Toxicology and Ecology Division  
Deanna Erickson, Lake Superior National Estuarine Research Reserve  
Meghan Klasic, US Environmental Protection Agency Great Lakes Toxicology and Ecology Division

A notable transformation is occurring across the US, Canada, and the globe, reframing “ecosystem restoration” as more than just technical and management actions that improve the environment, but also as activities that explicitly acknowledge our society and human relationships with nature and each other. More attention is being directed at involving local communities in regional landscape restoration and conservation for planning and long-term stewardship. The goal of these efforts is to enable communities and ecosystems to become more resilient in the face of increasingly challenging stressors, such as legacy contamination, climate change effects, severe weather, and economic instability. Questions remain about how best to organize humans and organizations to achieve this goal in way that that recognizes the complexity of resilience for both ecosystems and people. A gathering of social scientists met in Ann Arbor, Michigan in May 2023 to try to answer these questions. The goals of the workshop were two-fold; to identify the social outcomes that can be achieved through environmental programs, and to identify the recommendations and strategies that will lead us to those outcomes. This presentation summarizes workshop results with special attention to implementation in the Twin Ports. The views expressed in this presentation are those of the authors and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency.

*Keywords: community capacity, ecosystem-based management, Indigenous knowledge systems, environmental restoration*

## **9:40 AM One Block at a Time: equitable adaptation through green infrastructure**

Madison Rodman\*, University of Minnesota Sea Grant Program  
Tiffany Sprague\*, University of Minnesota Duluth Natural Resources Research Institute  
Jessy Carlson, University of Minnesota Sea Grant Program

The One Block at a Time project focuses on enhancing resilience to climate hazards in four marginalized Great Lakes neighborhoods. This presentation will outline our approach to identifying neighborhood vulnerabilities, fostering communication between municipal and community leaders through listening and visioning sessions, and implementing small-scale, multi-beneficial green infrastructure in the Lincoln Park neighborhood of Duluth, Minnesota. Our community-centric engagement processes aimed to broaden access to climate information, involve diverse groups in planning, and enhance environmental literacy on climate hazards and mitigation strategies. We assembled a diverse team comprising community members, non-profit organizations, and AmeriCorps VISTAs to develop and implement stormwater education and outreach and a rain barrel for residents program. By prioritizing community-led visioning and planning, we transitioned from a traditional 'outreach model' towards a 'shared leadership model' in community resilience efforts. The presentation will also address the replicability of our work and share a recently published web-based toolkit on our approach to community-driven engagement and planning. Additionally, we will showcase a snazzy 5-minute video summarizing our project, featuring one of our awesome community leadership team members.

*Keywords: Community engagement, green infrastructure, resilience, stormwater*

**BREAK 10:00am - 10:30am**

## **10:30 AM Barriers to cultural ecosystem services in the St. Louis River Estuary**

Molly Wick\*, University of Minnesota Duluth  
Joel Hoffman, Great Lakes Toxicology and Ecology Division, USEPA;  
Lucinda Johnson, University of Minnesota Duluth Natural Resources Research Institute;  
Deanna Erickson, Lake Superior National Estuarine Research Reserve

Cultural Ecosystem Services (CES) are co-produced through the interaction of people with nature, and provide benefits to people. CES are often the most relevant ecosystem services for human well-being, and are the most relatable and understandable to the public. Environmental and sociohistorical conditions influence the delivery of cultural ecosystem services. However, few studies have holistically accounted for the diverse and interconnected barriers that mediate the delivery of cultural ecosystem service and their associated benefits to a specific community. The Waterway Benefits Study assessed CES in the St. Louis River estuary communities and identified the range of barriers to CES experienced by 500 participants across a range of ages, races, and incomes. Barriers to CES experiences identified were diverse and related to access, amenities, communication, environmental health, human health, governance, social factors, personal resources and privilege, safety, and transportation. Understanding barriers to CES can inform environmental work and public planning in the St. Louis River estuary (and throughout Great Lakes communities) to include measures to mitigate those barriers and thereby increase CES delivery and environmental justice.

*Keywords: cultural ecosystem services, social science, communities*

### **10:50 AM "Lake Stories": A Russian-Ojibwe Collaboration**

Tom Zelman\*, Duluth Sister Cities International  
Tom Morgan, Duluth Sister Cities International

During the winter of 2022-2023, teenagers from the Fond du Lac Ojibwe Band collaborated with their peers in Petrozavodsk, Russia (Duluth's Sister City), to produce "Lake Stories," a 6-minute video about the aesthetic, spiritual, and cultural dimensions of Lake Superior and Lake Onega (the great lake adjoining Petrozavodsk). Working with mentors, the high school students met via Zoom to create a lively tribute to the lakes. Despite geo-political pressures that divide Americans and Russians, the work the students did makes clear their mutual appreciation of the lakes they live near.

The presentation has four parts: 1) the collaboration and how it came to be; 2) a showing of the film; 3) a discussion of the video's sequel "People of the Lake" (currently in production); and 4) time for questions.

Two members of Duluth Sister Cities will be presenting. If possible, several of the Ojibwe students will also speak about their experience.

*Keywords: Lakes, video, collaboration, students, Ojibwe*

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### **11:10 AM (Featured Speaker) Post-Sackett: What Can States Do To Protect Wetlands?**

Brian Vigue, Audubon Great Lakes

"The May 2023 Sackett v. EPA ruling significantly weakened the Clean Water Act (CWA) and federal protections for wetlands. As a result, many States are playing defense when it comes to protecting wetlands. It's even more important now that supporters of wetland protections educate policymakers and the public about the benefits that wetlands provide. Perhaps even more critically, policymakers need to be informed

about the negative consequences that result from wetland destruction, and the policy choices that they'll have to make as a result. By educating policymakers about the policy options that exist to protect wetlands and utilize the ecological services they provide, we can help restore protections for wetlands and more fully integrate them into our landscapes."

*Keywords: wetlands, water, flooding, habitat, conservation*

### **12:00 - 1:15 PM BREAK FOR LUNCH**

**"You've got the Skills!" Student career session in YU Room 204**

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### **1:15pm - Elements of the Estuary: impacts of contamination (YU Great Room)**

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#### **1:15 PM SLR Estuary's Decline and Recovery: An Excerpt from the Sea Change for Lake Superior PBS Documentary**

John Shepard\*, Center for Global Environmental Education, Hamline University

In a time of significant change for the world's largest freshwater lake, the story of the St. Louis River estuary offers valuable lessons. A segment from the documentary, A Sea Change for Lake Superior (a Hamline University, Center for Global Environmental Education and PBS North co-production), chronicles recent efforts to address the devastating historic impacts of industry and development in the estuary. The story offers a model of cooperation between multiple stakeholders and prospects of a waterway on the mend. It highlights the special importance of nearshore environments for the well being of a lake that is now among the fastest warming in the world. Also, the documentary is part of a larger public education initiative, which offers lessons in affecting stewardship action.

*Keywords: documentary, video, stewardship*

#### **1:35 PM Quantifying the response of wild rice mesocosm populations and their growing environment following the removal of sulfate from surface water**

Nathan Johnson\*, University of Minnesota Duluth, Civil Engineering  
Sophie LaFond-Hudson, USGS Upper Midwest Water Science Center  
Nicholas Eshleman, University of Minnesota Duluth, Civil Engineering  
Harsh Jain, University of Minnesota Duluth, Mathematics

Field, mesocosm, and lab studies have established that biogeochemical processes tied to surface water sulfate can limit the growth of wild rice in lakes and rivers. In self-sustaining outdoor mesocosms, the conversion of sulfate to sulfide in sediment interferes with nitrogen uptake and leads to population declines. Here, we report the results from a mesocosm experiment in which sulfate loadings were terminated after wild rice populations declined to near extinction. In mesocosms amended with 150 and 300 mg/L sulfate in surface water, plant populations declined to near extinction in 5 to 8 years and biomass and seed mass recovered to levels similar to control mesocosms 2 to 4 years after sulfate loadings were terminated. These recoveries occurred with no addition of new seeds, apparently from latent seed stocks. The concentration of porewater sulfide dropped precipitously in response to lower surface water sulfate and remained slightly above levels in control mesocosms. Solid phase sulfide remained elevated during the recovery phase,

suggesting a close link between surface water sulfate and porewater sulfide and that total sulfide mass in sediment is less important for wild rice health than the porewater activity of sulfide. A simple time-dependent model that encompasses the exchange of sulfate between porewater and surface water, porewater sulfate reduction and sulfide oxidation, and precipitation-dissolution of sediment sulfide is constrained by observations and used to investigate which processes are most important for defining porewater sulfide during loading and recovery phases. These mesocosm results with a single sediment and seed source provide preliminary evidence that wild rice could potentially be reestablished in waterbodies after sulfate loadings to surface waters are lowered.

*Keywords: sulfate, wild rice, ecology, restoration, modeling*

### **1:55 PM Green goo and fish slime: Investigating fish skin mucosal microbiomes in a HAB-impacted area**

Kasey Benesh\*, Oak Ridge Institute for Science and Education fellow at the US Environmental Protection Agency (ORISE at EPA)

Aabir Banerji, US Environmental Protection Agency

Chelsea Hatzenbuehler, US Environmental Protection Agency

Greg Peterson, US Environmental Protection Agency

Cyanobacteria cause freshwater harmful algal blooms (HABs), which impact organisms directly through toxin release or indirectly through alteration of water conditions and habitat. In this study we investigate how HAB disturbance alters the microbial community in the water as well as in fish mucus. The mucus coat on the surface of fish is the first defense against disease. Fish cultivate these mucosal surfaces to allow for colonization of beneficial microorganisms which prevent infection by harmful pathogens and contribute to overall health. We hypothesize that sites with recent histories of HAB disturbance will exhibit differences in the fish mucosal microbiome due to environmental stress related to water quality change. We characterized the mucosal microbiome of Yellow Perch within six sites in the Duluth-Superior Harbor and Allouez Bay. We selected three sites with recent records of HABs and three sites without documented events. We collected five age-1 Yellow Perch around 100mm in size at each site by electrofishing and swabbed them for DNA-based identification of the skin mucosal microbiome. For comparison, we collected water quality metrics and microbial DNA from water samples at each site. We sampled each site twice, once in August and again in September of 2022. We collected samples a week after a bloom had occurred at one of our sampling locations in September. Though we did not observe any signs of the HAB during sampling, we did observe a thick film of algae covering vegetation and differences in water quality metrics (pH, conductivity, and dissolved oxygen). These preliminary findings, combined with subsequent microbial community analysis, will enhance our understanding of the relationship between the surface mucosal microbiome of fish and water quality as well as the long-term impacts of HABs on the ecosystem.

*Keywords: eDNA, fish, mucosal microbiome, HAB*

### **2:10 PM Blooming uncertainty: unprecedented 2023 St. Louis River Estuary cyanobacteria blooms elucidate the necessity of a future-oriented estuary monitoring program**

Peter Birschbach\*

Hannah Ramage, Lake Superior National Estuarine Research Reserve

Dr. Euan D. Reavie, Natural Resources Research Institute

Dr. Chris T. Filstrup, Natural Resources Research Institute

Jerry Henneck, Natural Resources Research Institute

"Cyanobacteria blooms were prominent in the St. Louis River Estuary (SLRE) in 2023. In September and October, unprecedented blooms occurred, dominated by the cyanobacterium *Aphanizomenon flos-aquae*, and earlier in the summer, proliferation of the benthic cyanobacteria genera *Oscillatoria* and *Phormidium* were observed at multiple locations. Despite a long history of water quality improvements beginning in the late 1970's, the recent increase in estuary blooms points to emerging stressors to the functioning and health of the estuary. We are conducting research aimed at illuminating the extent and causes of several novel water quality concerns in the estuary, including algal community shifts, toxic cyanobacteria harmful algal blooms (cHABs), and hypoxia. This research entails high-frequency sampling at eight locations throughout the SLRE, selected for spatial variability and potential bloom susceptibility, to characterize nutrient and phytoplankton community dynamics. Ultimately, this study will be the foundation for a long-term collaborative SLRE monitoring program that will allow us and our project partners to identify and address emerging water quality concerns into the post-delisting future. We will present preliminary findings related to the unprecedented 2023 blooms, including locations, timing, dominant phytoplankton taxa, environmental conditions prior to, during, and after blooms, and evidence of cyanotoxin production. We will also discuss spatial heterogeneity among project sampling locations in water quality and nutrient conditions during the 2023 bloom timeframe. Feedback and questions about the project and phenomena observed thus far are welcome."

Link to project website: <https://sites.google.com/wisc.edu/stlouisrivermonitoring/home>

*Keywords: algal blooms, nutrient dynamics, cyanobacteria, monitoring, management*

### **2:30 PM Natural and anthropogenic factors determined 200 years of sediment metals history in the St. Louis River**

Mal Granmo\*, University of Minnesota Duluth Natural Resources Research Institute

Euan Reavie, University of Minnesota Duluth Natural Resources Research Institute

Elizabeth Alexson, University of Minnesota Duluth Natural Resources Research Institute

Sara Post, University of Minnesota Duluth Natural Resources Research Institute

Joyashish Thakurta, University of Minnesota Duluth Natural Resources Research Institute

Geochemical analyses applied to sedimentary records can reveal the history of metal pollution and effects of remediation. The Saint Louis River Estuary (SLRE) was designated an Area of Concern (AOC) in 1987 after decades of industrial pollution. Historic nutrients and sediment loads have been examined from sediment cores taken throughout the estuary to track recovery, but metal concentrations have so far received little attention. Here we describe the history of metals pollution in the SLRE associated with natural factors and anthropogenic stressors, recovery following remediation, and potential continuing stressors. Estuary sediments were considered to be contaminated with As, Cr, and Cu, but based on pre-Anthropocene sediments data, sediment quality criteria for these metals were exceeded prior to major human impacts. Cluster analysis of the SLRE samples divided the metals into seven functional groups including a subgroup of metals known to be anthropogenically enriched (Cd, Pb, Zn, Mo, Sb, and Sn). Together with mercury (Hg), this group represents metals that are atmospherically sourced and linked to fossil fuels and other industrial sources. Sediment profiles revealed reductions in these metals since they peaked in the ~1970s. Our preliminary data indicate a complex combination of natural and anthropogenic variables to explain the changing metallic compositions in the sedimentary record in the SLRE.

*Keywords: paleolimnology, geochemistry, pollution*

## **2:45 PM Bacteria Hazards: What we know and how communities can help**

Tiffany Sprague\*, University of Minnesota Duluth Natural Resources Research Institute

Christopher Filstrup, NRRI

Chan Lan Chun, NRRI

Jerry Henneck, NRRI

Eva Hendrickson, NRRI

Katie Edblad, NRRI

While stream impairments and degraded ecosystems as a whole are of concern to communities and the public, bacterial impairments are of particular concern due to the human health implications and economic and recreational losses. As more of our local streams and beaches face degradation, become impaired, and/or are closed to recreation and tourism, it is critical for us to understand how our surface waters have changed in recent decades, and how quickly those changes are taking place in recent times. To better address these concerns, we sought to improve understanding of current and future hazards to Duluth-area coastal communities by identifying conditions contributing to unsafe E. coli levels and toxic cyanobacteria (cHABs) in four local watersheds, and at their beaches, with integration of professional monitoring and community science participation. In this presentation, we will provide the data you want to see - like how our hypothesis failed (whomp whomp) and E. coli concentrations at paired stream and beach sites were not significantly related during this study, and how we observed a significant positive correlation between cyanobacteria and precipitation (2-day lag time), suggesting that precipitation events may contribute to cyanobacteria growth - including riveting charts and figures! And yet, we will also touch on the human dimension of this project - like how incorporation of community science volunteers in this project was not simply to expand data collection. While bacteria results by volunteers aligned throughout the season with bacteria monitoring conducted by NRRI scientists, demonstrating simple bacteria monitoring kits can be a low-cost alternative to monitoring by research professionals, we also focused our energy on the process for building a cohort of individuals ingrained into the local community and excited to call themselves "citizen scientists". We were so enthralled by this process, we even put together a wee guide, *Strategies for Engaging Volunteers in Scientific Research*.

*Keywords: bacteria, watershed, community, volunteers, HABs*

## **3:05 - 3:35 PM BREAK**

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**3:35pm - Towards a Resilient River (YU Great Room)**

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## **3:35 PM Lake Superior National Estuarine Research Reserve Habitat Map 2023**

Chris Susnik\*, Lake Superior Estuarine Research Reserve/State Cartographer's Office

Christina Dennis\*, Wisconsin State Cartographer's Office

Emily Lockling\*, Lake Superior Estuarine Research Reserve/State Cartographer's Office

The St. Louis River Estuary has undergone substantial transformation since it was listed as an area of concern in 1987. With many remediation, restoration, and protection projects happening in the estuary, it is vital to understand the effects of this change. A team from the Lake Superior National Estuarine Research Reserve (Reserve) and the Wisconsin State Cartographer's Office spent the summer of 2023 surveying and mapping plant communities within the Reserve to collect training data for remote sensing image classification, which will be used to create a habitat map. The goal of the project is not only to create a

point-in-time understanding of plant communities but create a reference from which to track and analyze change in the estuary. Over 1,000 training site polygons covering over 1,000 acres were mapped using a tablet-based Esri Field Maps collection tool. Join us to hear about the latest progress from the students working on the project this past summer.

*Keywords: habitat, mapping, remote sensing*

### **3:55 PM Reconstructing the past to inform the future of the St. Louis River estuary**

Joel Hoffman\*, United States Environmental Protection Agency

Tom Hollenhorst, United States Environmental Protection Agency

The St. Louis River estuary is a unique ecosystem within the Laurentian Great Lakes. The estuary is a 50 km<sup>2</sup> drowned river mouth coastal wetland complex characterized by both ecological heterogeneity and a wide diversity of ecosystem services owing to its many back bays, islands, tributaries, and bi-directional flow. This heterogeneity in ecological state and function presents numerous challenges for identifying restoration alternatives, and in numerous instances restoration planners have used reconstructions of a past river state to inform restoration planning. Contemporary (i.e., post 1850) data from the St. Louis River provide different perspectives and temporal resolution on its geomorphology, water quality, and biological communities. Geomorphological reconstructions are possible based on multiple eras of river mapping and provide insight into the rivers many unique forms. Water and sediment quality data reveal a system in recovery after a period of severe degradation, but also provide evidence of recent and ongoing stress from urban impacts and climate change. Benthic invertebrate and fish assemblage data similarly demonstrate a period of past severe degradation that led to widespread change in benthic invertebrates and the failure of fish populations to reproduce, followed by a period of dramatic recovery but also ongoing stress from invasive species. We will discuss how different types of reconstruction may inform restoration efforts in context with contemporary stressors. We conclude that historic reconstructions can aid in the design and gaging the anticipated response of ecological restoration, and their utility is tempered by the need to design restoration that is resilient to contemporary stressors and their impact on ecological states and functions.

*Keywords: geomorphology, water quality, benthic invertebrates, fish, stressor*

### **4:15 PM Visualizing where our estuary is, was, and what it could be**

Kaitlin L. Reinl\*, Lake Superior National Estuarine Research Reserve

Charlie Endris, Moss Landing Marine Laboratories

Suzanne Shull, Padilla Bay National Estuarine Research Reserve

Andrea Woolfolk, Elkhorn Slough National Estuarine Research Reserve

Laura S. Brophy, Estuary Technical Group, Institute for Applied Ecology

Dan R. Brumbaugh, Elkhorn Slough National Estuarine Research Reserve

Jeff Crooks, Tijuana River National Estuarine Research Reserve

Dustin Haines, Lake Superior National Estuarine Research Reserve

Roger Fuller, Padilla Bay National Estuarine Research Reserve

Denise Sanger, ACE Basin National Estuarine Research Reserve

Rachel Stevens, Great Bay National Estuarine Research Reserve

Kerstin Wasson, Elkhorn Slough National Estuarine Research Reserve



In the face of climate change, understanding trajectories of change is critical for coastal management, particularly for identifying future restoration and climate adaptation opportunities. The National Estuarine Research Reserves (NERRs), individually and as a system, therefore have an urgent need to identify the extent and spatial patterns of estuarine habitat loss. To meet this challenge, we studied habitat change across 30 U.S. estuaries to document coastal habitat loss, and identify key opportunities for future restoration and enhancement. At the St. Louis River Estuary, elevation-based mapping revealed 5,043 ha currently within the reach of high water levels and appeared to provide a fairly accurate estimate of current estuary extent. Within a focal area for historical mapping, emergent marsh underwent substantial (52%) loss between 1861 and the present. In order for the estuary to realize its full capacity to provide benefits to plants, animals, and humans, it is critical for the estuary to regain habitats that have seen the most losses. Active restoration, carefully planned to enhance future resilience, can help recover these lost habitats. The new information from this habitat change analysis thus helps us envision a more resilient coast as a legacy for future generations.

#### **4:35 PM Coffee Creek Culvert Removal and Restoration: historic urban stream modifications adapted for changing climate conditions**

Crystal Payment\*, Minnesota Department of Natural Resources

"Coffee Creek is one of the designated trout streams in Duluth that flows into the St Louis River. An undersized, abandoned culvert near the headwaters and on the Enger Park Golf Course grounds has restricted flow and seasonal fish passage for decades.

The Minnesota DNR local Duluth Area Fisheries office proposed a project to remove the culvert and restore natural hydrology to Coffee Creek. This project would augment a previous restoration completed downstream in the golf course, and prepare for future restoration upstream near Observation Drive. Ecological benefits to the culvert removal included increased habitat available to local populations of brook trout, restoration of hydrology, and natural sediment transport. A very unique site condition made a routine culvert removal more complicated; high flows in Coffee Creek, restricted by the undersized culvert and associated embankment, were redirected to a water control structure and bypassed into Miller Creek. Scarce historic records provided little information as to the reasoning, science, and timing behind either structure.

The Fish and Wildlife Division staff collaborated with DNR Clean Water staff, DNR Engineering staff, South St Louis SWCD, and the City of Duluth to design a project that removed the abandoned culvert, restored flow, and prevented nuisance conditions downstream in Coffee Creek from the changed flow conditions. Extensive hydraulic modeling was conducted by certified floodplain modeling/professional engineering staff iteratively with the natural channel design to ensure that appropriate channel and floodplain dimensions were designed to maintain stormwater overflow into Miller Creek at pre-project volumes during flood events and satisfy FEMA requirements.

The project was constructed in August 2023, and survived a 7-in rain event in September unscathed. Local brook trout have been observed after construction in the reach. The removal of the culvert and subsequent stream restoration has created a stream channel that has habitat and natural flow capacity during low-flow and bankfull conditions. It is resilient to the more common high-frequency rain and flow events that are occurring due to climate change. Funding was provided by the Great Lakes Restoration Initiative Focus Area 4 and MN DNR Fish and Wildlife Division."

*Keywords: culvert, removal, piracy, flood, capacity*

**5:00 - 7:00 PM Poster & Art Session in Swenson Hall atrium.**  
*Poster and art abstracts listed at the end of this document.*

Thursday March 7, 2024

8:30 AM Network Sessions (Concurrent)

- **Storytelling: A Method to Imagine Transformative Futures (YU 202)**

*Stories have great ability to communicate, connect, empower, and motivate change. In the face of a changing climate and other unprecedented global social and environmental challenges, author and activist Adrienne Maree Brown says, "Sci fi is simply a way to practice the future together, practicing a future economy together, practicing economic justice together, living into new stories. It is our right and responsibility to create a new world." She calls for us to use storytelling to imagine radical futures as a first step to initiate positive change. This networking workshop will facilitate just that. Participants will use storytelling to envision diverse, transformative futures for the good of the St. Louis River Estuary and her communities. In this workshop, we will lead participants through a speculative fiction storytelling exercise that prompts us to imagine an expansive, healthy, and just future vision for the estuary. Participants will learn how to craft and tell a story through a hands-on experience in a welcoming and accessible environment. The workshop will help participants build creativity, communication skills, compassion, and meaningful connections with colleagues. It will push attendees to think long-term and shake limiting assumptions about the future. Join us outside our collective comfort zone and expect to have fun and to leave invigorated and inspired.*

- **Lake Superior Headwaters Sustainability Partnership: Defining "State of the Estuary Landscape" (Swenson Hall 1058)**

*A focus of the Lake Superior Headwaters Sustainability Partnership is to report on the "State of the Estuary Landscape". Before we can report on this, we want to hear from folks about what "state of the estuary landscape" means to them! In this interactive networking session, we will gather input from the St. Louis River Summit community to help define and explore how best to report out on the health of the estuary. We'll be asking questions like: When thinking about the state of the estuary, what would you most want to know? What reporting format would you find most useful and interesting? How would you like to receive this information?*

- **Centering Communities in Great Lakes Restoration and Ecosystem-based Management Programs (YU 204)**

*What would it mean to center communities in Great Lakes programs related to climate change, coastal management, conservation, remediation and restoration, or any other type of program? What do communities need to engage, participate, and lead in these processes? In this networking session, we will briefly review the results of a gathering of social and applied social scientists that met in Ann Arbor, Michigan in May 2023 to try to answer these questions. A list of six strategies and associated activities detailed in the "Centering Communities in Great Lakes Restoration and Ecosystem-based Management Programs" provides guidance for the way forward. These strategies aim to facilitate combined community and ecosystem resiliency in the face of legacy contamination, climate change effects, severe weather, and economic instability.*

*In this session, we connect these strategies to the Twin Ports, identifying existing and additional needed resources (i.e., knowledge, leadership, skills, vision), examples of community centering, and a wish list for future activities.*

- **Who is Monitoring What in the St. Louis River Estuary in 2024? (YU Great Room)**

*This networking session will provide time to discuss various planned monitoring and sampling in the St. Louis River Estuary. We are interested in hearing about everyone's plans and schedules as we approach the 2024 field season. We'd also like to hear about new projects or initiatives that are starting up this year, as*

*well as new equipment, sensors, boats, and methods (including new methods) that might be employed. Hopefully, this will help identify potential areas of overlap or coordination that could make lives easier and put a bit less pressure on budgets.*

*This session is meant to facilitate sharing this information and spur collaborations. We'll start the session summarizing what we have learned about monitoring efforts from previous years. We'll also compile the session notes from the 2024 session and share these with all the participants afterwards. For those who can't attend we'll also have an online form for collecting this information.*

*Success will be marked by awareness of other projects overlapping by location/time/data set, developing an audience for a data set, or spurring on collaborations around specific sites or research/management questions.*

### **10:15 -10:30 AM Break**

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**10:30am - St. Louis River Area of Concern: progress toward delisting (YU Great Room)**

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### **10:30 AM St Louis River Area of Concern Progress Report and Future Plans**

Barb Huberty, Minnesota Pollution Control Agency

Thanks to the braiding of visions by partners, funders, and other stakeholders, implementation of the Remedial Action Plan for the St. Louis River Area of Concern continues to make progress toward delisting. As of 9/30/23, 53 of 80 management actions are complete (66.3%) and four of nine Beneficial Use Impairments have been removed. This presentation will highlight what work has been done since the last Summit, along with planned 2024 work and milestones. Projected schedules to complete construction projects, remove Beneficial Use Impairments, and delist the St. Louis River Area of Concern will be shared.

*Keywords: Area of Concern, St. Louis River, Progress toward delisting*

### **10:50 AM 10 years of AOC work; what have we accomplished since the 2013 Roadmap to Delisting Remedial Action Plan**

Matt Steiger\*, Wisconsin Department of Natural Resources  
Rick Gitar, Fond du Lac Band  
Barb Huberty, Minnesota Pollution Control Agency  
Melissa Sjolund, Minnesota Department of Natural Resources

The "Roadmap to Delisting" was completed in 2013 and outlined a plan to move the St. Louis River Area of Concern toward delisting in a more systematic fashion. How have we done in 10 years? This presentation will explore some of the AOC accomplishments and report out on AOC progress by the numbers.

*Keywords: SLRAOC, collaboration, celebration, progress, review*

### **11:05 AM Munger Landing Sediment Remediation**

Brad Leick\*, Minnesota Pollution Control Agency

Mark Elliott, Minnesota Pollution Control Agency

The Munger Landing Sediment Remediation Area is located within the St. Louis River Area of Concern and contains a fishing pier and a popular boat launch that serves as a public water access point for recreational boaters and paddlers. The boat launch was constructed adjacent to a former municipal sewer outfall that contaminated sediments at the landing. Multiple sediment and upland investigations spanning a period of ten years identified and delineated the primary contaminants of concern.

The remedial footprint covered approximately 35 acres with an estimated contaminated sediment volume of approximately 100,000 cubic yards. The remedial action at Munger Landing included a full dredge with off-site disposal and placement of a residual cover over the entire remedial footprint. Additional habitat restoration work was completed in approximately seven acres of near-shore areas by applying a nominal six-inch thick layer of biomedium to restore aquatic vegetation and provide a substrate for muskie spawning. In-water work was completed in November 2023 and final site restoration will occur in the spring of 2024.

*Keywords: remediation, dredging, Munger Landing, restoration*

### **11:25 AM Remediation and Restoration Success at Superior's Pickle Pond**

Joe Graham\*, Wisconsin Department of Natural Resources  
Darienne McNamara, City of Superior  
Caryn Kiel-Simpson, EA Engineering  
Devon Draper, ENTACT

A review of this summer's restoration project on the Superior waterfront. The presentation will update the attendees about the progress, successes, challenges and remaining work at Pickle Pond.

*Keywords: Pickle Pond, Superior, remediation, restoration, habitat*

### **11:45 AM Acknowledging Inequities of St. Louis River Neighborhoods: Restore, Listen, Connect**

Kris Eilers\*, St. Louis River Alliance

"In the St. Louis River Estuary Area of Concern (SLRAOC), river-adjacent residents have been historically cut off from the river due to industry and legacy pollution. As a result, they have suffered disproportionate health consequences, barriers to resources that support well-being, and greater economic disparities. The St. Louis River Alliance, (Alliance) a non-profit, is the Citizens Action Committee for the SLRAOC and have been working since 1989 to help lend a voice to the Area of Concern (AOC) Process. Because of the inequity in river neighborhoods and the shortcomings of leaders in both the Alliance, and state and city governments to recognize that they were not reaching the very people they needed to hear from, the gap was made larger, and relationships to each other and to the river suffered.

In recent years the Alliance has been working with residents and partners to help close the gap and attempt to learn how best to build relationships through listening and connection.

The Alliance is working on several projects through funding from the Great Lakes Restoration Initiative and the Legislative-Citizen Commission on Minnesota Resources. Key objectives are learning what residents'

preferred activities on the river are, what barriers they are experiencing, and ultimately connecting citizens to recently restored areas of the St. Louis River and providing resources to overcome barriers.

This presentation will explore the experiences of these projects and the failures and successes of learning to work towards environmental justice."

### **12:00 PM Lunch in the Yellowjacket Union Great Room**

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### **1:00 PM (KEYNOTE PRESENTATION - YU Great Room)**

#### **Visions: Stories for an Enduring Future**

Telling stories helps us reflect on the past, share thrills and laughter, and transmit important knowledge to future generations. The St. Louis River has seen some wild tales- historic, ecological, adventurous, and personal. In this very special keynote session, storytellers invited from the community share short personal stories connected to the river on the theme of Visions. Hosted by Mary Fox and Blake Thomas of the live radio broadcast Take it With You and Zeitgeist Arts in the format of a non-competitive story slam (think a local version of The Moth podcast), this event connects research, restoration and education efforts to the oh-so-human lives on the shores of one of the greatest rivers in the Great Lakes.

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### **2:30pm - Life After Delisting (YU Great Room)**

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### **2:30 PM Interstate Island Habitat Restoration: Summary of avian use 4 years post-restoration**

Annie Bracey\*, Natural Resources Research Institute  
Steve Kolbe, National Resources Research Institute  
Stephen Nelson, National Resources Research Institute  
Alexis Grinde, Natural Resources Research Institute  
Fred Strand. no affiliation

"The St. Louis River Estuary is a high priority area for bird conservation and designated an internationally Important Bird Area, meaning it provides essential habitat for breeding and migratory birds during some phase of their life cycle. Although the Duluth-Superior harbor contains one of the longest freshwater sand spits in the world, it is used intensively by humans for recreational purposes, resulting in non-suitable breeding habitat for coastal nesting species and high levels of disturbance for migratory shorebirds. Interstate Island, a dredge-spoil island in the Duluth-Superior harbor, is recognized as a high-priority breeding site for Common Tern and critical habitat for Piping Plover in the Great Lakes region. However, since its creation, wind, water, and ice erosion significantly reduced the elevation of bird nesting habitat, causing seasonal flooding of nesting areas. A large-scale restoration project initiated in the autumn of 2020 stabilized the habitat and increased the footprint of the island. The primary objective of the habitat restoration was to maintain and increase the population of Common Terns breeding at the Interstate Island colony. To assess the effectiveness of the restoration, annual monitoring was conducted to document the breeding status of Common Terns relative to pre-restoration averages. We also documented shorebird use of the island during migration to determine if this species group was utilizing the restored habitat. Based on post-restoration surveys, population targets are not currently being met for Common Tern. However, overall quality of the nesting habitat was greatly improved and if habitat quality is the primary factor limiting the size of the breeding population, we anticipate the restoration actions will result in an increase in breeding numbers although a lag in response time is likely. We documented 22 shorebird species and 38 other avian

species using the island. Our results indicate that shorebirds and many other species readily used the newly restored habitat at Interstate Island. Continued monitoring and management will be necessary to determine long-term effects of the restoration. This extensive project not only enhanced habitat quality for breeding Common Terns but also provided high-quality habitat for many migratory birds."

*Keywords: birds, restoration, migration, conservation*

### **2:50 PM Identifying and forecasting drowning hazards in the St. Louis River Estuary**

Christopher Filstrup\*, Natural Resources Research Institute, University of Minnesota Duluth

Joshua Anderson, University of Wisconsin-Madison

Natalie Chin, Wisconsin Sea Grant

Melody David-McKnight, Recreational Sports Outdoor Program, University of Minnesota Duluth

Jerry Henneck, Natural Resources Research Institute, University of Minnesota Duluth

Sarah Peterson, University of Wisconsin-Madison

Kelsey Pihoda, Minnesota Sea Grant

Tiffany Sprague, Natural Resources Research Institute, University of Minnesota Duluth

Chin Wu, University of Wisconsin-Madison

As the St. Louis River Estuary (SLRE) Area of Concern (AOC) progresses towards delisting and new amenities are added along its shorelines, more people will return to the river to enjoy its many recreational opportunities. Unfortunately, increased visitation also brings an increased risk of drownings. While dangerous currents (i.e., rip currents) pose a well-known safety hazard at Lake Superior beaches, far less is known about drowning hazards within the SLRE despite a long history of drownings. Highly dynamic inflows from the St. Louis River and smaller tributaries combined with seiche effects from Lake Superior create complex circulation patterns in the SLRE. Limited knowledge of the diverse types of drowning hazards within the SLRE and the conditions under which they form make it difficult to forecast drowning risks and effectively communicate drowning hazards to the public. In this project, we will (1) synthesize records of historical drownings within the SLRE, including locations and conditions under which they occurred, to identify high drowning risk locations and scenarios; and (2) develop a forecasting model of surface currents and temperatures to increase the lead time for communicating drowning hazards. The forecasting model will be freely available online. Additionally, we are working with stakeholder communities, such as the paddling community, to increase paddling safety when visiting the SLRE by adding appropriate signage of drowning hazards at various access points.

*Keywords: currents, drowning, forecasting, hazard communication, model*

### **3:05 PM Break (30 min)**

### **3:35 PM A Transition from Planning to Implementation in Phase 1 of the Allouez Bay Marshbird Habitat Restoration Project**

Tom Prestby\*, Audubon Great Lakes

Dave Grandmaison, Wisconsin DNR

"After the alarming report that over 3 billion birds have been lost over the past 50 years, Audubon strategically prioritized to curve this trend. Audubon Great Lakes (AGL) has prioritized a dozen regions in the Great Lakes as highest importance for the restoration of coastal wetlands, due in large part to the loss of up to 60% of some breeding marshbird species in the last 30 years. The St. Louis River Estuary (SLRE) is one of these locations, and this multi-phased effort by more than a dozen partners aims to preserve and enhance high-quality native vegetation, control invasive vegetation, enhance resiliency, and increase hemi-marsh habitat in Allouez Bay, and Important Bird Area (IBA) within the SLRE. Project planning is synchronized with the ongoing wild rice restoration project and the Lake Superior Headwaters Sustainability Partnership vision plan. The project scoping process involved baseline avian surveys by Natural Resources Research Institute (NRRI), field visits to sites with similar restoration methodologies, a two-day climate adaptation menu workshop with National Institute of Applied Climate Science (NIACS), and collection of field data such as mapping of shallow bathymetry, ordinary high-water mark (OHWM), and dense invasive cattail stands by Barr Engineering.

AGL, Wisconsin Department of Natural Resources (WDNR). And GEI Consultants developed a restoration design which incorporates baseline bird data and known habitat preferences for focal marsh bird species and AGL research indicating that muskrat huts create habitat directly and indirectly for marsh birds and other wildlife. Invasive cattail will be cut below the waterline in selected areas, and monotypic invasive cattail stands will be diversified by adding networks of inlets, pools, and channels of open water while spoils are used to mimic muskrat huts to create a matrix of variable habitat. This presentation will provide details of the restoration design that will be implemented starting in 2024, how the partner group arrived at this design, and an estimated timeline going forward."

*Keywords: marshbirds, restoration, birds, native vegetation*

### **3:55 PM Charting Progress; Biocontrol Impact Over 5 Years**

Dara Fillmore\*, Wisconsin Department of Natural Resources

Five years ago at this Summit, Dara Fillmore shared that she was starting a biological control journey focused on Purple Loosestrife around the St Louis River and Lake Superior basin, and she asked for insights and help. Five years later, with your help, she has results to share, as well as thoughts for future work on the River.

*Keywords: Purple Loosestrife, biocontrol, beetles, resilience*

### **4:15 PM Rolling Out the St. Louis River Estuary Avian Visualization Tool**

Jennifer Fuller\*, Audubon Great Lakes

Tom Prestby, Audubon Great Lakes

"Audubon Great Lakes (AGL) created a data visualization tool to provide a summary of baseline avian monitoring data for Allouez Bay and additional locations in the Wisconsin St. Louis River Estuary (SLRE). Data inputs include two years of targeted breeding marshbird and spring and fall migration survey data collected by the Natural Resources Research Institute (NRRI) and more than a decade of Great Lakes Coastal Wetland Monitoring Program (GLCWMP) Allouez Bay bird survey data, complemented by eBird data (2012-2022) collected by community scientists throughout the Wisconsin portion of the SLRE. Geospatial data layers can be overlaid with bird data on an interactive map, allowing simple comparisons



and evaluations. Focal species (which include black tern, American bittern, least bittern, Virginia rail, sora, pied-billed grebe, yellow-headed blackbird, swamp sparrow, sedge wren, and marsh wren) have an SLRE-specific profile which displays a map of detection and eBird 2021 modeled relative abundance, habitat description and pictures, species results from other AGL projects, conservation status and climate sensitivity, and links to additional information. Maps pinpoint areas within the SLRE that support the highest diversity and numbers of focal species and aid in identifying future conservation priorities to benefit breeding and migratory species. In the future, post-restoration data will be added to compare with the baseline data that is currently displayed.

The data visualization tool is a publicly accessible tool for partners to explore bird data and aid conservation planning and habitat restoration projects. AGL will present the basics on using the tool and provide a demo, including how to find and explore the Wisconsin SLRE bird data. Feedback from attendees will be welcomed to strengthen the tool in the future."

*Keywords: marshbirds, visualization tool, birds*

#### **4:35 PM Challenges and Opportunities for Manoomin Restoration & Stewardship in the St. Louis River Estuary**

David Grandmaison\*, Wisconsin Department of Natural Resources  
Darren Vogt, 1854 Treaty Authority  
Thomas Howes, Fond du Lac Reservation Resource Management Division

Manoomin (wild rice; *Zizania palustris*) restoration in the St. Louis River Estuary (SLRE) has been underway since 2014 when Great Lakes Restoration Initiative funding supported the development of the 2014 St. Louis River Estuary Wild Rice Restoration Implementation Plan. Much has been learned about the effectiveness of restoration techniques since that time and progress is being made. Conditions during the last three growing seasons (2021 – 2023) have facilitated increased Manoomin density and distribution at core restoration sites where the SLRE Manoomin Restoration Model (MRM) is being fully implemented. We provide an update on this collaborative Manoomin restoration work, present details about the MRM, and address the challenges and opportunities considered most likely to influence on-going Manoomin restoration efforts in the St. Louis River Estuary.

*Keywords: St. Louis River Estuary, wild rice, Manoomin, restoration, stewardship*

#### **4:55 PM Closing Remarks**

## POSTERS & ART SESSION (Wednesday March 6 from 5-7PM in Swenson Hall atrium)

### ART and ARTISTS

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**Avian Night Skies Mysteries**, Marybeth Garrigan, Petra Johnita Lommen, and Stephen Wilbers

*Keywords: Dark Skies, Starry Nights, Avian Night Series paintings & poetry*

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**5th Grade Visions for an Enduring Future**, Bryant Elementary, Stacy Burfields's 5th grade class

*Keywords: Enduring Future*

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**Love Gichigami Ziibi (Love the St. Louis River)**, Lisa Fitzpatrick

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**Red River**, Kelly Beaster

*Keywords: sandstone, water, river, habitat, mapping*

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**Foundation Bay**, Kelly Beaster

*Keywords: sandstone, water, river, habitat, mapping*

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**Grave Marker for St. Louis River Denizen**, Ellen Sandbeck

*Keywords: waterfowl, pollution, grave, marker*

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**Surrounding**, Anastasia Bamford

—

**Into the Woods & Waterways of the St. Louis River Estuary**, Michael Anderson

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**2022 Storm Drain Art Project - City of Superior Environmental Services Division in partnership with Rachel Eisenmann ([racheleisenmann.com](http://racheleisenmann.com)), Chelsey Miller ([chelseymillerart.com](http://chelseymillerart.com)), Anndrea Ploeger ([anndreasart.com](http://anndreasart.com)), and Dawn, Molly, and Mazie Turchi**

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**Mouth of the Lester River, Spring**, Adam Frankiewicz

*Keywords: Lester, River, Watercolor, Spring, nature*

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**Peregrine Falcon Landing**, Adam Frankiewicz

*Keywords: Peregrine, Falcon, Watercolor, Nature*

—

**Bronze Hercules Beetle**, Adam Frankiewicz

*Keywords: Bronze, Beetle*

—

**Digital illustration of Daphnia pulex**, Adam Frankiewicz

*Keywords: Daphnia, illustration, Digital*

—

**Digital illustration of the fingernail clam Sphaerium striatinum**, Adam Frankiewicz

*Keywords: illustration, fingernail clam, Sphaerium,*

—

**Life Cycle of a Caddisfly (Limnephilidae: Pycnopsyche)**, Adam Frankiewicz

*Keywords: Caddisfly, nature, life cycle, illustration*

—

**Healing Our Great Lakes Habitat**, Vidya Balasubramanyam

*Keywords: Habitat restoration, collective art, art making in community*

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**In the St. Louis River Estuary, Where Do You Go and How Do You Feel?**, Tom Hollenhorst, Karin Kraemer, and Molly Wick

*Keywords: St. Louis River Estuary, Emotions, Stories*

## POSTER PRESENTATIONS

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### 1. Exploring the St. Louis River Estuary Avian Visualization Tool

Jennifer Fuller, Audubon Great Lakes

Tom Prestby, Audubon Great Lakes

Audubon Great Lakes (AGL) created a data visualization tool on the ArcGIS Experience Builder platform to provide a summary of baseline avian monitoring data for Allouez Bay and additional locations in the Wisconsin St. Louis River Estuary (SLRE). Data inputs include breeding marsh bird and migration survey data collected by the Natural Resources Research Institute (NRRI) and Great Lakes Coastal Wetland Monitoring Program (GLCWMP) Allouez Bay bird survey data, complemented by eBird data (2012-2022) collected by community scientists throughout the Wisconsin portion of the SLRE. Geospatial data layers can be overlaid with bird data on an interactive map, allowing simple comparisons and evaluations. Focal species (which include black tern, American bittern, least bittern, Virginia rail, sora, pied-billed grebe, yellow-headed blackbird, swamp sparrow, sedge wren, and marsh wren) have an SLRE-specific profile which displays a map of detections, eBird 2021 modeled relative abundance, and several life history details and information from other AGL studies. Maps pinpoint areas within the SLRE that support the highest diversity and numbers of focal species and aid in identifying future conservation priorities to benefit breeding and migratory species. In the future, post-restoration data will be added to compare with the baseline data that is currently displayed. The data visualization tool is a publicly accessible tool for partners to review bird data and aid conservation planning and habitat restoration projects. AGL will provide a guided opportunity to interact with the ArcGIS Experience Builder directly on a laptop, including how to find and explore Wisconsin SLRE bird data. Feedback from poster session attendees will be welcomed to strengthen the tool in the future.

*Keywords: marshbirds, restoration, St. Louis River Estuary, habitat, visualization*

### 2. Characterization of PFAS residues in the tree swallow food web to support bioenergetics-based dosimetry modeling for contaminated site risk assessments

Alexandra Pesano, Oak Ridge Institute for Science and Education / US Environmental Protection Agency

Jonathan Haselman, US Environmental Protection Agency

Matthew Etterson, US Environmental Protection Agency

Emily Pavlovic, Oak Ridge Institute for Science and Education / US Environmental Protection Agency

Abigail Odegard, Oak Ridge Associated Universities / US Environmental Protection Agency

Michael Thiel, US Environmental Protection Agency

Bioaccumulation and biomagnification of per- and polyfluoroalkyl substances (PFAS) are known to occur in avian food webs, but the fate and transport dynamics of PFAS at different trophic and taxonomic levels are poorly understood. Insectivorous birds, such as the tree swallow (*Tachycineta bicolor*), are reported to have high PFAS exposure because of their diverse feeding guild originating from contaminated sediment, surface water, and soils. However, little is known about PFAS partitioning behaviors to terrestrial and aquatic invertebrate groups serving as tree swallow prey items. Two main objectives were established as a result of this knowledge gap: 1) characterize PFAS residues in invertebrates across taxonomic Orders suspected to be tree swallow prey items, as well as in the nestlings being fed the potentially contaminated prey items; 2) implement bioenergetics-based dosimetry modeling to generate hypotheses related to prey composition based on empirical relationships between insect-nestling residue levels. Residue data in both invertebrates and tree swallow nestlings were collected from an ongoing field study consisting of six nesting sites with various levels of environmental PFAS contamination near Duluth, MN. Sites were established at the Duluth

Air National Guard Base, as well as the associated watershed that empties into the St. Louis River. Seven invertebrate Orders of both terrestrial and aquatic origin were analyzed from each site. Both observed PFAS nestling and invertebrate residues followed a hypothesized concentration gradient in which concentrations were highest at sites closer to the point-source of contamination. Variation in invertebrate PFAS residues was best explained by the site and taxonomic Order from which the samples were collected, regardless of terrestrial/aquatic origin, life stage, and taxonomic Family. PFAS concentrations of nestlings and prey, as well as nestling growth and metabolic rates, were then used to parameterize the bioenergetic-based dosimetry model. Parameterization of the model based on caloric contributions and PFAS residues in invertebrate Orders yielded hypotheses of dietary composition and assimilation rates required to meet empirical partitioning behavior. Ultimately, the utility of the bioenergetics-based model will be compared to existing food web bioaccumulation models, support downstream predictions of in vivo effects, and provide PFAS-relevant predictive tools for contaminated site assessments.

*Keywords: PFAS, food webs, bioenergetics, modeling, avian toxicology*

### **3. Food-web exposure and consequent effects of PFAS on insectivorous birds in the St. Louis River watershed**

Abby Odegard, Oak Ridge Associated Universities  
Matt Etterson, US Environmental Protection Agency  
Jon Haselman, US Environmental Protection Agency  
Emily Pavlovic, Oak Ridge Institute of Science and Education  
Allie Pesano, Oak Ridge Institute of Science and Education  
Mike Thiel, US Environmental Protection Agency

Per- and polyfluoroalkyl substances (PFAS) are a group of highly persistent chemicals that are known to bioaccumulate. Lab and field studies suggest that exposure to PFAS may be harmful to avian reproduction and that insectivorous birds feeding in aquatic habitats may have an increased risk. However, the distribution and movement of PFAS in avian food webs and the subsequent effects on avian reproduction are poorly understood. To address these knowledge gaps, there is an effort being made to characterize PFAS concentrations in environmental and biological samples at sites in Duluth, MN. Established populations of three species of breeding songbirds (tree swallows, house wrens, and black-capped chickadees) are observed at five sites with a gradient of environmental PFAS concentrations. During the 2022 and 2023 field seasons, nest boxes were monitored twice weekly for occupancy, productivity, and success to assess potential fitness consequences and effects. Avian tissue samples from eggs and nestlings were collected to assess PFAS exposure and potential effect endpoints. Water, sediment, and soil samples were collected at each site every two weeks to establish baseline concentrations of PFAS and legacy contaminants at each site. To characterize the potential food-web pathways of accumulation and transport, aquatic and terrestrial invertebrate samples were collected using active and passive sampling techniques. In addition to PFAS analysis, these samples were measured alongside representative plants for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  to determine trophic feeding status of nestlings and the contribution of aquatic or terrestrial food sources. To characterize invertebrate prey diets, fecal sacs were collected from nestlings for eDNA metabarcoding and preliminary data suggests that nestlings are fed a diverse variety of invertebrate prey. Field data will ultimately be integrated into a model system to predict avian fitness based on environmental concentrations of PFAS.

*Keywords: Avian toxicology, food-web, nest success, PFAS*

### **4. Pokegama Bay rustic boat launch improvements increase visitor use and improve visitor experience**

Hannah Ramage, Lake Superior National Estuarine Research Reserve  
Deanna Erickson, Lake Superior National Estuarine Research Reserve  
Linda Cadotte, City of Superior  
Luciana Ranelli, Lake Superior National Estuarine Research Reserve

The Pokegama Bay rustic boat launch in the Superior Municipal Forest got an upgrade in September 2021. The City of Superior, collaboratively with the Lake Superior Reserve and the Wisconsin Coastal Management Program, received competitive funding from the National Estuarine Research Reserve System to add a garbage and recycling bin, bathroom, parking lot, dock, native plantings, and a paddle craft launch to the site. To document visitor-use before and after the improvements, a trail camera was deployed in July of 2021 and July of 2022. The number of visitor groups, vehicles, boats, and paddle craft were counted from photographs taken every 5 minutes and compared between the two years. Findings reveal that the number of visitor groups to the launch increased significantly, with an average of 3.8 more visitor groups per day in 2022 than in 2021. Although not statistically significant, more visitors in 2022 launched paddle craft and fished than in 2021. Not only has the quantity of visitors increased, but the quality of the visitor experiences has also risen. The Lake Superior Reserve uses the launch as a primary education programming site to get teachers and students on the water. Education programming is easier for the kids, teachers, and Reserve staff with access to a bathroom and a dock! Previously the launch was a slick, muddy clay slope. Now, the gently graded gravel launch allows for a friendly and accessible way to launch canoes.

*Keywords: recreation, revitalization, canoeing, fishing, education*

## **5. USFWS Midwest Coastal Program**

Lacey Hill Kastern, United States Fish & Wildlife Service  
Reena Bowman, USFWS  
Ted Koehler, USFWS  
Jessica Collier, USFWS

"Our poster will provide an overview of the USFWS Coastal program, our Midwest Coastal Program Strategic Plan, and some of the success stories in this region. The Coastal Program is a voluntary, partnership-based program of the U.S. Fish and Wildlife Service (Service or USFWS) that provides technical and financial assistance for habitat conservation in coastal watersheds. The Coastal Program improves and protects habitat on both public and private lands, which is important in coastal areas where there is a mosaic of landowner types. The Coastal Program began nationally in 1985, with the Midwest Region receiving Coastal Program funding and formal recognition in 2000. The Midwest Coastal Program's mission is partnering with others to protect and restore priority Great Lakes coastal ecosystems for the mutual benefit of fish, wildlife, and people. This Strategic Work Plan (Plan) marks the national Coastal Program's fourth generation of strategic plans and covers fiscal years 2022-2027. New in this generation is a common set of priorities that have been developed to advance the strategic nature of the Coastal Program. These priorities include 1) Species Conservation, 2) Habitat Connectivity and 3) Resilient Ecosystems. The St. Louis River Estuary is in the Coastal Programs Western Lake Superior Focus area that is approximately 4,317 square miles in size and extends from the Lake Superior watershed on its northwestern border in Minnesota to the Wisconsin portion of the Montreal River watershed on its eastern border. The Western Lake Superior Focus Area Five-Year Targets include: • Wetland Restoration/Enhancement/Protection: 100 acres • Upland Restoration/Enhancement/Protection: 300 acres • Stream Channel Restoration/ Enhancement: 0.5 mile • Aquatic Organism Passage Structures: 2 structures The focus species in this focus area include: Northern Long-eared Bat (*Myotis septentrionalis*), Blue-winged Teal (*Anas discors*), Brook Trout (*Salvelinus*

fontinalis), Canada Warbler (*Cardellina canadensis*), Common Tern (*Sterna hirundo*), Mudpuppy (*Necturus maculosus*), Piping Plover (*Charadrius melodus*)."

*Keywords: Habitats, Species, Restoration, Strategic Plan*

## **6. Manomin Camp 2023: Welcoming Manomin Back to Gichi Gami Ziibi**

Marne Kaeske, 1854 Treaty Authority

Manomin Camp was an educational event, hosted at Chambers Grove Park and Perch Lake Landing in West Duluth, the week of September 11-15th, 2023. The major objective was to provide an opportunity for participatory learning as part of a multi-partner project "Harvesting Manomin as Climate Adaptation" (funded through NOAA). Due to a century of industrialization, *Zizania palustris* (manomin, wild rice) was reduced to a few remnant stands that were in danger of extirpation. In 2023, it is witnessed that manomin is successfully reproducing in the Gichi Gami Zibi (St Louis River Estuary) once again. Contributing project partners in hosting a successful Manomin Camp included environmental educators from the Lake Superior National Estuarine Research Reserve ("the Reserve"), resource managers with the Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, The Nature Conservancy, The Minnesota Land Trust, volunteers/stewards of resource conservation organizations in the area (Issac Walton League, Friends of the Reserve, St. Louis River Alliance), the University of Minnesota, and Sea Grant. Over 500 students and professionals participated in Manomin Camp throughout the week.

*Keywords: manomin, restoration, education, harvest*

## **7. Options for Cleaning up Contaminated Sediments in the Superior Slips, St. Louis River Area of Concern**

Joseph Graham, Wisconsin Department of Natural Resources

Brian Mastin,

Alison Bitel

Josh Loomis

Reece Frederick (AECOM)

The St. Louis River was designated as an area of concern (AOC) because historic habitat destruction and discharges of toxic pollution impaired beneficial uses of the water. Promulgation and implementation of major environmental regulations starting in the mid-twentieth century have improved conditions, although these laws don't address ongoing impacts from legacy contamination. The remedial action plan for this AOC endeavors to address these legacy impacts. Under the Great Lakes Restoration Initiative, the restoration and remediation of many sites in the St. Louis River AOC have accelerated, and the goal of delisting the AOC is within reach. The remediation, aka "cleanup," of contaminated sediments in the Superior Slips (Slips) are among the remaining actions needed to address beneficial use impairments and ultimately delist the AOC. For over 135 years, the Slips have been a nucleus for shipments of fossil fuels, grain, and various industrial activities. Unfortunately, these uses have resulted in legacy sediment contamination from petroleum, coal, byproducts from coal processing, metals, and organotin. These pollutants increase water quality control and disposal costs for dredging projects and are toxic to organisms living in or on the bottom sediments. The Slips also have hotspots of industrial mercury, i.e., mercury levels above anthropogenic background, that contribute to bioaccumulation of mercury in fish, necessitating local fish consumption advisories. In addition to their influence on waterway use impairments, the chemicals in the Slips warrant cleanup to protect human health and the environment. Wisconsin DNR and AECOM developed conceptual site models, remedial action objectives, and cleanup targets for the Slips. This information was used to identify and

evaluate potential cleanup options. A range of options was considered: “no action,” monitored natural recovery, capping, and dredging with landfill disposal. Options for each slip were ranked based on their technical and economic feasibility and their ability to provide the best long-term protection for human health and the environment. Because public dollars may be used for the cleanups, significant consideration was given to approaches that provide long-term sustainability. The recommended options include mechanical dredging with limited capping and offsets to protect structures. The DNR will host an informational meeting online in Spring 2024 to allow the public to ask questions and give input on the recommended cleanup approaches.

*Keywords: Contaminated sediment, sediment remediation, public input, Area of Concern, beneficial use impairments*

## **8. Explore the Lake Superior Reserve Habitat Map**

Chris Susnik, Lake Superior National Estuarine Research Reserve & Wisconsin State Cartographer's Office  
Emily Lockling, Lake Superior National Estuarine Research Reserve & Wisconsin State Cartographer's Office

The St. Louis River Estuary has undergone substantial transformation since it was listed as an area of concern in 1987. With many remediation, restoration, and protection projects happening in the estuary, it is vital to understand the effects of this change. A team from the Lake Superior National Estuarine Research Reserve (Reserve) and the Wisconsin State Cartographer's Office spent the summer of 2023 surveying and mapping plant communities within the Reserve to collect training data for remote sensing image classification, which will be used to create a habitat map. The goal of the project is not only to create a point-in-time understanding of plant communities but create a reference from which to track and analyze change in the estuary. Over 1,000 training site polygons covering over 1,000 acres were mapped using a tablet-based Esri Field Maps collection tool. Explore interactive data visualization tool Experience Builder developed by students on the project team.

*Keywords: Habitat, Mapping, Remote Sensing, GIS, Data visualization*

## **9. Morphological Zooplankton Analysis of 2021 Early Detection and Monitoring Samples from the Smithsonian Environmental Research Center's (SERC) Great Lakes Invasives Sentinel Sites Network Program (GLISSNet)**

Lana Fanberg, Lake Superior Research Institute, University of Wisconsin-Superior

Zooplankton are small planktonic animals that are an important part of the aquatic food web, linking higher and lower trophic levels. Zooplankton can be identified using microscopy. Morphologic analysis of zooplankton complements eDNA analysis for early detection and monitoring of nonindigenous species. The Smithsonian Environmental Research Center collected morphologic and eDNA zooplankton samples in the Duluth-Superior Harbor in 2021 as part of the Great Lakes Invasives Sentinel Sites Network Program. This poster details the methods used for the morphological analysis of the zooplankton samples, summarizes the density and composition of the zooplankton, and highlights some notable finds from these samples.

*Keywords: Zooplankton, Microscopy, Morphology, Early Detection and Monitoring, Density and Composition*

## **10. Assessing the Perceptions of Environmental Restoration through Aesthetics Monitoring Allouez Bay Marsh Bird Habitat Restoration**



Jules Witts, U.S. EPA  
Sebastian Paczuski, USEPA  
Kathleen Williams, USEPA

The Great Lakes Water Quality Agreement (GLWQA) identifies degradation of aesthetics as one of the beneficial uses of the ecosystem that should be restored. Degraded aesthetics, such as odors and debris, can leave a negative impact on the local community through decreased recreation opportunities and a diminished aesthetic value. According to the GLWQA, aesthetics can be degraded when “an objectionable deposit or unnatural color or odor” is present. In Areas of Concern, the objectionable deposits are most often oil slicks, odors, or trash and are attributes easily recognizable to both resource managers and citizens. Using the observation and classification of aesthetics as a boundary concept between resource managers and citizens may enhance the ecological and social benefits of environmental restoration through a more defined and shared understanding of how people perceive their environment. Using aesthetics as a method for documenting how people perceive the environment is critical as citizens may characterize impairments differently than resource managers do. As a result, state agencies and local government decisions may be influenced by the application of aesthetics monitoring. This presentation is a status report and will share how United States Environmental Protection Agency (USEPA) is documenting aesthetics and environmental change at Pickle Pond in Superior, WI and other sites around the Great Lakes. We will share preliminary data to describe the process and implementation of aesthetics monitoring. We expect this study to become a longitudinal study of place, as well as a potential model for a crowdsourcing platform.

*Keywords: climate change, Great Lakes, wetlands, prioritization framework*

## **11. Green Stormwater Infrastructure Code Audits: Updating Local Regulatory Structures for a Changing Climate**

Jessy Carlson, University of Minnesota Sea Grant  
Juli Beth Hinds, Birchline Planning LLC  
Madison Rodman, University of Minnesota Sea Grant  
Tiffany Sprague, Natural Resources Research Institute

"The impacts of climate change, such as increasingly intense storms and more frequent floods, mean regulatory frameworks designed to manage stormwater runoff in previous decades may no longer be effective; codes and ordinances may inadvertently prohibit or inhibit the use of nature-based approaches to managing stormwater runoff. To adapt to current and projected climate change scenarios, local governments need updated regulatory frameworks that effectively manage stormwater runoff in a changed climate. Adapting local regulations to promote systematic use of green stormwater infrastructure (GSI) and other nature-based solutions is a key strategy that can contribute to the development of resilient, climate-adapted communities.

We worked with ten urban and rural municipalities across the Duluth area to conduct code audits and assist with designing and accomplishing community-specific GSI objectives, and we are currently expanding this project to include Lake and Cook Counties. These participating communities display a diverse array of geographical and demographic characteristics. However, after working with these communities' technical staff and elected representatives to assess their regulatory structures and internal policies for areas that could be updated to prepare for increased heavy precipitation events, we have noted some important themes regarding needs, challenges, and opportunities that cut across the region. This poster will share

what we are hearing from these communities and whether these themes point to emerging climate adaptation needs in Northeast Minnesota."

*Keywords: Adaptation, Regulations, Local Government, Stormwater*

## **12. Biofilm Formation is Impacted by Additives and Weathering of Polymers**

Clare List, University of Minnesota Duluth

Dr. Melissa Maurer-Jones, University of Minnesota Duluth

In recent years, bioplastics, plastics derived from biological materials, have been presented as an environmentally friendly alternative to traditional petroleum based plastics. Yet, it is unclear how these plastics behave and degrade in the environment. The goal of this study is to determine how UV irradiation impacts biofilm growth on bioplastics, taking into consideration the role that polymer additives may play in biofilm growth. Thin polylactic acid (PLA) films cast with TiO<sub>2</sub> nanoparticles, a white pigment often used in plastic production, were irradiated with UVB light (~300 nm) for varying amounts of time to simulate sunlight exposure. TiO<sub>2</sub> nanoparticles, which acts as a photocatalyst, amplified the photodegradation of PLA. This was observed in our samples as evidenced by increases in lactic acid leached into solution by the irradiated polymer samples. Biofilms of *Shewanella oneidensis* were grown on the polymer samples and quantified using crystal violet staining. Greater biofilm growth was observed on the polymers that had been irradiated for longer periods of time, and this trend was particularly evident in the TiO<sub>2</sub> samples. This suggests that abiotic degradation of PLA results in a polymer that promotes bacterial attachment and biofilm formation. Additionally, samples with significant growth were very brittle, indicating the biofilm's ability to induce further biological degradation. Ultimately, this work demonstrates that behavior of bioplastics in the environment are going to be impacted by formulation and weathering.

*Keywords: biofilm, bioplastic, PLA,*

## **13. St. Louis River and Nemadji River Watershed Monitoring Results**

Murphy Steininger, Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency (MPCA) works with local partners to monitor and assess water quality in each of the state's watersheds every 10 years. The St. Louis River Watershed was monitored for the second time in 2019, and the Nemadji River watershed was monitored for the second time in 2022. Lakes and Rivers are sampled for biology (fish and macroinvertebrates) and water chemistry parameters to gauge the health of aquatic ecosystems. Determining the health of these waterbodies helps prioritize restoration and protection efforts throughout these watersheds. This poster will go over some of the key findings from MPCA's monitoring and focus in on a few highlights from these watersheds.

*Keywords: Water quality, Monitoring, MPCA, St. Louis River, Nemadji River*

## **14. Manoomin-Psiŋ, an Indicator for Healthy Lives, Minds, and Ecosystems!**

Giovanni Delgado-Ortiz, University of Minnesota

Sofia Ledeneva, University of Minnesota

Jessica Tran, University of Minnesota

Hannah Jo King, University of Minnesota

Mae Davenport, University of Minnesota

Kathleen Smith, Great Lakes Indian Fish & Wildlife Commission  
Joe Graveen, Lac du Flambeau Tribal Natural Resources Department"

Manoomin (Ojibwe) or Psij (Dakota) (wild rice, *Zizania palustris*) is a keystone cultural and ecological species found in the western Great Lakes region. To the Anishinaabeg (indigenous people), Manoomin/Psij is a relative, a gift, a source of food and medicine. However colonization, climate change, and land use changes have all threatened its existence, leading to concern about future generations' connection with this relative. A collaborative between tribal natural resource agencies, university, and non-profit partners to protect and honor Manoomin/Psij has allowed us to conduct 17 semi-structured interviews with wild rice harvesters and knowledge holders, helping us better understand what we can learn from Manoomin and its integral connection with Nibi (water). Five of these interviews were located in the Fond du Lac Reservation within the St. Louis River interconnected waterways and will be analyzed separately due to their proximity to the Watershed. Knowledge holders in the St. Louis River area expressed a need for comprehensive educational materials around Manoomin to engage diverse stakeholders and effectively promote sustainable harvesting practices. These educational materials include a dedicated Wild Rice Day, graphic novels for all audiences, multilingual books, and story maps. Additionally, harvesters put emphasis on the importance of connecting and engaging youth in Manoomin harvesting and knowledge sharing. Many harvesters also described how current government agencies are falling short on effective management practices designed to protect Manoomin, hindering open data sharing and data collection methods. In whole, interviews in the St. Louis River area illuminated participants' desire for inter-cultural awareness around different ways of knowing, and how coming together for Manoomin can promote culturally-meaningful management practices and healing in communities. Our Wild Rice Symposium in the fall 2023 and the subsequent findings from our post-survey further illustrates this assessment, highlighting how opportunities for sharing restoration practices, monitoring efforts, and cultural values can nurture reciprocity and trust around Manoomin.

*Keywords: Wild rice, sustainable, Social Science*

## **15. Dive into the Lake Superior Reserve with a new site profile**

Deanna Erickson, Lake Superior National Estuarine Research Reserve

National Estuarine Research Reserves amplify local and national research and understanding of estuaries, but each site in the system of 30 Reserves is unique. Understanding place-based history, ecology, environmental setting and social-ecological context is essential for responsive engagement with Reserve research and education efforts. The Lake Superior Reserve has recently completed a site profile synthesizing knowledge about its social, physical, ecological and biological characteristics to guide research, monitoring and learning. Through a grant from the NERRS Science Collaborative, the Lake Superior NERR worked with the He'eia NERR in Hawai'i to reimagine site profiles and create a responsive digital format for organizing data and research spatially. Explore the new site profile at [www.lakesuperiornerrprofile.org](http://www.lakesuperiornerrprofile.org).

*Keywords: historical ecology, community engagement, ecology*

## **16. Assessing the sensitivity and resiliency of Lake Superior coastal wetlands to climate change Evolving Research Priorities, Reporting Methods, and Partnerships within the St. Louis River Estuary**

Mike Smale, Wisconsin Sea Grant  
Sophie LaFond-Hudson, Wisconsin Sea Grant  
Madeline Magee, Wisconsin Department of Natural Resources

Cherie Hagen, Wisconsin Department of Natural Resources

Great Lakes coastal wetlands are diverse and dynamic ecosystems that have developed to function under disturbances at the interface of terrestrial and aquatic systems. Climate change is projected to alter these disturbances outside their historical ranges, subjecting wetlands to warmer temperatures, more extreme precipitation events, larger fluctuations in lake levels, and increased wind and wave action. These anticipated changes pose as an uncertain risk to coastal wetland habitats and are therefore challenging for natural resource managers who have limited resources for wetland management, preservation, and adaptation efforts. Using Lake Superior as a pilot, we are developing a framework to quantify the relative sensitivity of Great Lakes coastal wetland habitats to the anticipated effects of climate change. Data from the Coastal Wetlands Monitoring Program (CWMP) and state databases (e.g. Wisconsin National Heritage Inventory, Wisconsin Wetland Inventory) are used in conjunction with the Wisconsin Initiative on Climate Change Impacts (WICCI) and expert opinion of regional and state-wide wetland professionals to assign sensitivity scores to each wetland. Initial wetland vegetation sensitivity rankings for 38 coastal wetlands in the Lake Superior basin of Wisconsin will be shared, 17 of which are within St. Louis River Estuary. By combining sensitivity and adaptive capacity scores, estimates of wetland resiliency may assist in the prioritization of management efforts and distribution of limited funds in the Lake Superior basin, which can then be replicated on other Great Lakes systems.

*Keywords: climate change, Great Lakes, wetlands, prioritization framework*

### **17. A new look at species composition and distribution of invasive Dreissena mussels in the lower St. Louis River and Lake Superior**

Chelsea Hatzenbuehler, United States Environmental Protection Agency

Joel Hoffman, USEPA

Courtney Larson, USEPA

Greg Peterson, USEPA

Aubree Szczepanski, ORISE

Anett Trebitz, USEPA

Invasive zebra mussels (*Dreissena polymorpha*) were first found in the St. Louis River (SLR) in 1989 and have now been established for several decades. A few specimens of the congener *Dreissena bugensis* (quagga mussel) have also been documented in the Harbor but were thought to make up only a tiny percentage of the *Dreissena* given their general preference for deeper, colder habitats. We were surprised, then, when in 2019, quagga DNA was detected at similar abundance to zebra DNA in the SLR outwash plume along the south shore of Lake Superior. The unexpected finding led us to revisit *Dreissena* species distribution and abundance via a pilot assessment in the lower SLR and in Lake Superior proper. In late summer 2022 we sampled both entries and from Allouez Bay to Hwy 23 bridge for planktonic veliger (larval stage, via zooplankton tows), environmental DNA (eDNA, via surface grab samples), and settled adults collected as bottom trawl bycatch (1854 Treaty Authority fish survey) and by targeting suitable habitat including bridge pilings, tree stumps, docks, and buoys. We also obtained ethanol preservative from 187 Lake Superior zooplankton tow samples collected as part of the 2022 Cooperative Science and Monitoring Initiative (CSMI) survey. Adult mussels were weighed as a proxy for abundance, and surface water eDNA and ethanol preservative from zooplankton tow samples was filtered to condense eDNA, then amplified and analyzed via quantitative PCR (qPCR) to obtain DNA copy numbers for each species. Both zebra and quagga DNA was detected throughout the SLR and in the Lake Superior samples. Adult abundance estimates derived from the weights ranged from 1 to 3657 mussels (mean = 215 mussels/station), with the highest abundances observed in Superior Harbor, Pokegama Bay, Riverside, and Spirit Lake areas of the SLR. Our findings

suggest both a greater spatial overlap between the two species and a greater incursion of veligers into Lake Superior proper, prompting us to continue to investigate the state of Dreissena mussels in the St. Louis River and beyond.

*Keywords: Aquatic invasive species, St. Louis River, Dreissena, DNA methods*

## **18. NOAA's New High-Resolution Coastal Land Cover**

Brandon Krumwiede, NOAA Office for Coastal Management  
Nate Herold, NOAA Office for Coastal Management  
Lara O'Brien, NOAA Office for Coastal Management

NOAA has been working to establish a higher resolution 1-meter land cover product that will bring the national C-CAP framework to the local level. These higher resolution land cover data will help support more site-specific applications related to land use planning, nature based solutions, flood modeling, wetland monitoring, carbon sequestration, urban forestry, and more, which will help improve climate change adaptation and resilience for coastal communities and ecosystems.

*Keywords: Landcover, coastal wetlands, remote sensing, infrastructure, canopy*

## **19. "Introducing GLISSNet: A new detection program for introduced invertebrates in the Great Lakes"**

Aubree Szczepanski, US EPA  
"Clinton Arriola, Smithsonian Environmental Research Center  
Sarah Bailey, Fisheries and Oceans Canada  
Sarah Brown, United States Environmental Protection Agency  
Jenny Carney Zollars, Smithsonian Environmental Research Center  
Andrew Chang, Smithsonian Environmental Research Center  
John Darling, United States Environmental Protection Agency  
Ruth DiMaria, Smithsonian Environmental Research Center  
Carlo Echiverri, Smithsonian Environmental Research Center  
Janet Echiverri, Smithsonian Environmental Research Center  
Lana Fanberg, Lake Superior Research Institute of University of Wisconsin - Superior  
Kristina Fleetwood, Smithsonian Environmental Research Center  
Jonathan Geller, Moss Landing Marine Laboratories  
Emmet Haggard, Moss Landing Marine Laboratories  
Jenna Hanlon, United States Environmental Protection Agency  
Chelsea Hatzenbuhler, United States Environmental Protection Agency  
Joel Hoffman, United States Environmental Protection Agency  
Erica Keppel, Smithsonian Environmental Research Center  
Chris McMahon, Smithsonian Environmental Research Center  
Joey Miller, Smithsonian Environmental Research Center  
Kevin Mitchell, Smithsonian Environmental Research Center  
Timothy Mullady, Smithsonian Environmental Research Center  
Gabriel Ng, Smithsonian Environmental Research Center  
Monaca Noble, Smithsonian Environmental Research Center  
Greg Peterson, United States Environmental Protection Agency  
Luz Quiñones, Smithsonian Environmental Research Center  
Ben Rubinoff, Smithsonian Environmental Research Center

Brenda María Soler-Figueroa, Smithsonian Environmental Research Center  
Darrick Sparks, Smithsonian Environmental Research Center  
Brian Steves, Smithsonian Environmental Research Center  
Aubree Szczepanski, United States Environmental Protection Agency  
Matthew TenEyck, Lake Superior Research Institute of University of Wisconsin - Superior  
Anett Trebitz, United States Environmental Protection Agency  
Gregory Ruiz, Smithsonian Environmental Research Center

Introduced species cause substantial ecological and economic burden within the Great Lakes. Although significant management efforts are underway to prevent the arrival and spread of introduced species in waters of the Great Lakes, understanding the success of management requires standardized and repeated field-based measures to detect whether new invasions occur. The Great Lakes Introduced Species Sentinel Network (GLISSNet) aims to establish such a detection program, focused especially on non-native invertebrates in shallow waters across the Great Lakes. Organized by the Smithsonian Environmental Research Center, GLISSNet is a growing collaborative network and currently includes partners from the US Environmental Protection Agency (EPA), the Lake Superior Research Institute (LSRI) at the University of Wisconsin Superior, Fisheries and Oceans Canada, Moss Landing Marine Laboratories, EcoAnalysts, and the US Coast Guard. To launch GLISSNet, we began with intensive annual surveys of both the zooplankton and benthic community using a combination of morphological and genetic methods in the Saint Louis River Estuary (SLRE) near Duluth, Minnesota. Starting in 2021, we characterized the invertebrate community each year at 50 different locations within the SLRE with multiple sample types: benthic passive colonization devices (oyster crates and Hester-Dendy samplers), soft sediment samples collected by PONAR grabs, and zooplankton pump samples. Using these data, we evaluated the performance of the various components of our sampling effort and estimated the completeness of our sampling of non-native species in the region. In our first year of sampling, we detected 18 introduced species of 322 total taxa identified. Moreover, the combination of oyster crate, PONAR, and zooplankton sampling detected nearly all introduced species. We now plan to expand to other sites within the Great Lakes, beginning with Lake Erie in 2024, to assess both temporal and spatial invasion patterns. Concurrently, we are also evaluating changes in management of ships' ballast water across the Great Lakes. This Great Lakes sentinel network approach is designed in parallel to a program already established in coastal marine bays and estuaries, providing a critical data resource to evaluate invasion dynamics and community characteristics across these coastal ecosystems.

*Keywords: non-native invertebrates, sentinel sites, ballast water, zooplankton, benthos*

## **20. It only takes one! How to get AIS out of your boat**

Holly Wellard Kelly, Natural Resources Research Institute, University of Minnesota Duluth  
Dr. Valerie Brady, Natural Resources Research Institute  
Robert Hell, Natural Resources Research Institute  
Kari Pierce, Natural Resources Research Institute  
Paul Jeffrey, Natural Resources Research Institute  
Brennan Pederson, Natural Resources Research Institute  
Josh Dumke, Natural Resources Research Institute.

Preventing the spread of aquatic invasive species (AIS) among waterbodies is a high priority because AIS can have significant impacts on aquatic ecosystems. Fully drying boats and gear (which may take 5+ days) is the most effective method for preventing AIS spread, but it is not always feasible or even possible in some weather conditions. Boat launches sometimes provide self-service tools to remove AIS from boats. The methods available vary from no tools (e.g., AIS inspectors and hand removal), to waterless tools (e.g.,

vacuum, wipe, or air blower), to low pressure water hoses. In addition, the effectiveness of the different cleaning methods at removing AIS from the interior of boats is uncertain; most research has focused on boat exteriors and trailers. We tested the effectiveness of 4 different cleaning methods on the interior and livewell of a typical angling boat. The methods were: 1) hand removal alone; 2) waterless tools (e.g., cloth wipe, air blower, or vacuum); 3) low-pressure rinse (i.e., garden hose); and 4) combinations of all methods. We found that using a combination of all methods (hand removal + vacuum + low pressure rinse) or just using the vacuum removed the highest proportions of surrogate AIS from the interior of boats, followed by the low-pressure water rinse or hand removal. For livewell cleaning, using additional tools such as a drying wipe, vacuum or low-pressure water rinse increased the removal of surrogate AIS over hand removal alone. The effectiveness of different methods depended on the type of surrogate AIS being removed (e.g., spiny water fleas [SWF] versus plant matter), with some tools performing better on SWF and others on plant matter. Our results provide guidance to managers and agencies on the best cleaning tools to provide at boat launches to prevent the spread of AIS.

*Keywords: AIS Cleaning Methods, fishing boats, spiny water flea, invasive vegetation*

## **21. New perspectives on spatial and temporal distributions of legacy and emerging contaminants in Lake Superior**

Amber McRae, Natural Resources Research Institute  
Devin R. Edge, Natural Resources Research Institute, University of Minnesota Duluth  
Sophia K. Nelson, Natural Resources Research Institute, University of Minnesota Duluth  
Hunter J. Peterson, Natural Resources Research Institute, University of Minnesota Duluth  
Riley E. Brunner, Natural Resources Research Institute, University of Minnesota Duluth  
Kathryn M. Schreiner, Large Lakes Observatory, University of Minnesota Duluth  
Chan Lan Chun, Natural Resources Research Institute, University of Minnesota Duluth  
Euan D. Reavie, Natural Resources Research Institute, University of Minnesota Duluth  
Christopher T. Filstrup, Natural Resources Research Institute, University of Minnesota Duluth  
Bridget A. Ulrich, Natural Resources Research Institute, University of Minnesota Duluth

Many legacy and emerging organic contaminants are resistant to environmental degradation and are known to accumulate in sediments. We aim to advance understanding of relationships between environmental distributions of persistent bioaccumulative toxic contaminants (PBTs) and overall ecosystem health in the Great Lakes, as part of the US EPA's Great Lakes Sediment Surveillance Program. This presentation will focus on the spatial and temporal trends for legacy and emerging organic contaminants in Lake Superior. A total of 90 sediment samples (30 surface sediments and 60 samples from 3 sediment core profiles) were collected in 2021 from the R/V Lake Guardian, and 138 legacy and emerging contaminants (including polychlorinated biphenyls, polychlorinated dibenzodioxins, and polychlorinated dibenzofurans) were analyzed in the sediments via gas chromatography triple quadrupole mass spectrometry (GC QQQ-MS). Comparison of the new sediment core data with historical data from the same sites show that concentrations change over time for several analytes. These findings provide important context for interpretation of historical sediment data in conjunction with data from contemporary ecological surveys.

*Keywords: PBTs, Contaminants, Sediments, Lake Superior*

## **22. Approaches for System Level Habitat Classification of the Lake Superior National Estuarine Research Reserve in Google Earth Engine**

Cole Wilson, University of Wisconsin-Madison, Wisconsin State Cartographer's Office

Mutlu Özdoğan, University of Wisconsin-Madison

Monitoring habitat changes occurring within the Lake Superior National Estuarine Research Reserve (LSNERR) provides unique challenges due to its size and seiches causing variable water levels. Using open-source, remotely sensed data from the platform Google Earth Engine, this analysis sought to create a map of the LSNERR at the system level according to a hierarchical NOAA classification scheme. This analysis used 1-meter resolution National Agricultural Imagery Program (NAIP) data from 2020, a normalized difference vegetation index (NDVI) derived from 2020 NAIP data, and LiDAR derived products from 2015 in a non-parametric random forest classifier using 150 trees. Digitized polygons (n=786) collected by the Wisconsin State Cartographer's Office and LSNERR served as training and accuracy assessment data. The random forest classifier created a map of the LSNERR which had an overall accuracy of 70%. Forested wetlands proved difficult to distinguish from other classes and were most commonly mis-classified as upland forests. Adding inputs to the classifier derived from short-wave infrared bands of Sentinel 2 satellite data, such as a normalized difference water index, could help to differentiate forested wetlands from upland forests. This study seeks to provide an initial system level classification of the LSNERR and examine solutions to frequently encountered problems in wetland classification.

*Keywords: Habitat, Classification, Remote Sensing*

### **23. Exploring Nutrient Input Dynamics in Lake Superior's South Shore Streams Amidst Urbanization and Land Use Change**

Rob McManus, University of Minnesota - Duluth  
Robert Sterner, University of Minnesota - Duluth

The area along the southwestern shore of Lake Superior, from Duluth to the Apostle Islands, plays a crucial role in transporting terrestrial nutrients into Lake Superior, an otherwise nutrient-poor system. As this region has recently become susceptible to coastal cyanobacterial blooms, evaluating nutrient input into Lake Superior has become a priority. Prior studies in the region have focused on the biogeochemistry of inflowing streams and rivers mainly in the lesser developed watersheds in the eastern part of this larger landscape unit. The more intensely human-modified western streams in and near Superior, WI have not been adequately assessed. We sampled ten streams, 15-25 times, along the south shore of Lake Superior over three years between 2021 and 2023, including the variously urbanized Newton, Poplar, Faxon, Bear, and Dutchman Creeks as well as the Nemadji River and some lesser urbanized systems to the east. Stream biogeochemistry data included chlorophyll-a, total suspended solids, silicate, taxa fluorescence, particulate and dissolved carbon, as well as all of the major chemical species for phosphorus and nitrogen. Many individual, in-flowing waters showed distinct chemistry from each other. We then correlated stream chemistry data with catchment land use information, followed by multiple ordination analyses, to identify chemical similarities between streams, spatially and temporally. This work extends our spatial understanding of land-lake connections in southwestern Lake Superior and estimates the role of urbanized streams in nutrient delivery to the southwestern part of the lake.

*Keywords: Streams, Biogeochemistry, Nutrients, Land-use*

### **24. Effective Rusty Crayfish Removals to Protect Wild Rice**

Brennan Pederson, Natural Resources Research Institute  
Brennan Pederson, Natural Resources Research Institute  
Josh Dumke, Natural Resources Research Institute



Tyler Kaspar, 1854 Treaty Authority  
Matt Santo, 1854 Treaty Authority  
Liz Anderson, Lake County Soil and Water Conservation District  
Amanda Weberg, Cook County Soil and Water Conservation District  
Hannah Hill, United States Department of Agriculture  
Bob Hell, Natural Resources Research Institute  
Holly Wellard Kelly, Natural Resources Research Institute  
Paul Jeffrey, Natural Resources Research Institute  
Kari Pierce, Natural Resources Research Institute  
Valerie Brady, Natural Resources Research Institute

Wild rice is culturally and ecologically important to Minnesota, but its range and distribution have diminished over the last century. While several factors are responsible for this decline, herbivory by rusty crayfish can reduce wild rice growth. Wild rice is most susceptible to rusty crayfish grazing during germination and submerged aquatic phases of growth in the early summer. Around 30 wild rice lakes in northern MN have been invaded by rusty crayfish. Whole-lake eradication of rusty crayfish is unrealistic because methods that would kill rusty crayfish would also have adverse effects on native species. Currently, the best strategy for long term rusty crayfish control is to remove enough individuals to control the population size, but it is unclear what the most effective trapping strategies are near wild rice beds. We set out to find the best trapping strategy that the public could use to reduce rusty crayfish densities. We tested three different trap types and three different bait types. We trapped crayfish at three lakes in May/June when rice is vulnerable to grazing and in July/August when crayfish activity increases. The three trap types tested were standard sized baited minnow traps, extra large baited minnow traps, and unbaited refuge shelters. We used hot dogs, cat food, and frozen smelt to test which bait attracts the most rusty crayfish. The average catch, including native and rusty crayfish, across all lakes and trips was about 5 crayfish per trap in the standard sized baited minnow traps, about 4.5 crayfish per trap in the extra large baited minnow traps, and 0.1 crayfish per trap in the unbaited refuge shelters. Native crayfish (n=182) preferred frozen smelt while rusty crayfish (n=2574) preferred hot dogs. Our results will help managers choose the most effective rusty crayfish trapping methods to protect critical habitats like wild rice.

*Keywords: rusty crayfish, wild rice, bait, trap*

## **25. Using eDNA Methods to Detect Rusty Crayfish (*Faxonius rusticus*) in Manoomin (Wild Rice) Watersheds**

Hailey Anderson, Fond du Lac Tribal and Community College  
Tyler Selin, Fond du Lac Tribal and Community College

Manoomin (wild rice) is culturally significant to the Anishinaabeg people, and it is interwoven within many stories that have been passed down through an extensive oral tradition. Most of the harm that is afflicted to wild rice occurs when the plant is in its "floating leaf" stage, when the plant is extremely vulnerable and hasn't produced offspring. One biological agent that can negatively influence the health of Manoomin is rusty crayfish (*Faxonius rusticus*), an invasive species that can disrupt surface sediments, causing a detrimental effect on aquatic vegetation. Rusty crayfish infestations are difficult and time-consuming to detect via manual trapping, so populations can increase significantly before being detected. We hypothesized that environmental DNA (eDNA) could be used to detect Rusty Crayfish in their early stages and small populations. Sensitive sites were sampled in waterbodies around the Fond du Lac (FDL) Reservation and the 1854 Ceded Territory in partnership with FDL Resource Management. At each sampling site we collected eDNA samples, in addition to setting manual traps. We filtered and preserved the eDNA samples in the lab before sending them to an external lab for analysis. Over the past three field

seasons, we have expanded from lakes and going into streams, culminating in examining eDNA detection's effectiveness in a variety of aquatic ecosystems. In those three years, we did not capture any crayfish in the traps but had 23 positive eDNA detections, none of which were within the FDL reservation's boundary. This may mean eDNA is more effective than trapping, especially for early detections. This year's fields season had no detection from eDNA sampling or traps for rusty crayfish. Future monitoring should increase the number of replicates at each sampling site to increase the possibility in detection for rusty crayfish.

*Keywords: eDNA, invasive, crayfish, rice*

## **26. Using eDNA Methods to Detect Rusty Crayfish (*Faxonius rusticus*) in Manoomin (Wild Rice) Watersheds**

Tyler Selin, Fond du Lac Tribal Community College  
Hailey Anderson, Fond du Lac Tribal Community College

Manoomin (wild rice) is culturally significant to the Anishinaabeg people, and it is interwoven within many stories that have been passed down through an extensive oral tradition. Most of the harm that is afflicted to wild rice occurs when the plant is in its "floating leaf" stage, when the plant is extremely vulnerable and hasn't produced offspring. One biological agent that can negatively influence the health of Manoomin is rusty crayfish (*Faxonius rusticus*), an invasive species that can disrupt surface sediments, causing a detrimental effect on aquatic vegetation. Rusty crayfish infestations are difficult and time-consuming to detect via manual trapping, so populations can increase significantly before being detected. We hypothesized that environmental DNA (eDNA) could be used to detect Rusty Crayfish in their early stages and small populations. Sensitive sites were sampled in waterbodies around the Fond du Lac (FDL) Reservation and the 1854 Ceded Territory in partnership with FDL Resource Management. At each sampling site we collected eDNA samples, in addition to setting manual traps. We filtered and preserved the eDNA samples in the lab before sending them to an external lab for analysis. Over the past three field seasons, we have expanded from lakes and going into streams, culminating in examining eDNA detection's effectiveness in a variety of aquatic ecosystems. In those three years, we did not capture any crayfish in the traps but had 23 positive eDNA detections, none of which were within the FDL reservation's boundary. This may mean eDNA is more effective than trapping, especially for early detections. This year's fields season had no detection from eDNA sampling or traps for rusty crayfish. Future monitoring should increase the number of replicates at each sampling site to increase the possibility in detection for rusty crayfish.

*Keywords: eDNA, invasive, crayfish, rice*

## **27. Where and when does interference with total phosphorus colorimetric methods lead to inaccurate concentrations in aquatic ecosystems?**

Eva Hendrickson, Natural Resources Research Institute  
Becca Marston, Natural Resources Research Institute  
Peter Birschbach, Natural Resources Research Institute  
Jerry Henneck, Natural Resources Research Institute  
Beth Bernhardt, Natural Resources Research Institute  
Christopher T. Filstrup, Natural Resources Research Institute

Total phosphorus (TP) concentrations are routinely measured to assess ecosystem health because phosphorus commonly limits primary productivity in freshwater ecosystems. While interferences with standard colorimetric methods (i.e., ascorbic acid-molybdenum blue method) are well known, it is unclear

what factors contribute most to these interferences, making it difficult to determine where and when corrections for interferences are needed. Recently, we observed that several water samples from the St. Louis River Estuary (SLRE) had an orange tint with cloudy sediment after digestion that could be interfering with TP quantification, but did not affect soluble reactive P (SRP). To identify where and when this was a problem in the SLRE, we measured TP with and without ascorbic acid from eight sites, and more intensively at two sites, Pokegama Bay and Allouez Bay, where interferences were strong. We anticipated that the interference was due to the presence of clay from the Nemadji River. Through our analyses we found where there may be interferences (Pokegama and Allouez bays) that led to overestimation of TP concentration in samples. Although these interferences may be related to snow melt and heavy rain events pushing turbid stream water and run-off into the estuary, we are still determining temporal dynamics. TP values corrected for interference were shown to be significantly lower when compared to unadjusted TP concentrations. Our findings suggest that TP interferences could contribute to aquatic ecosystems incorrectly being assessed as unhealthy or impaired, and potentially lead to costly management interventions being implemented where they may not be effective.

*Keywords: total phosphorus, interference, water chemistry, estuary*

## **28. Stream flow and water quality estimation from minimal measurements: application of sparse sensing**

Kun Zhang, University of Minnesota Duluth  
Wasif Bin Mamoon, Marquette University  
Mitul Luhar, University of Southern California  
Anthony J. Parolari, Marquette University

High-dimensional states can often leverage a latent low-dimensional representation. This inherent compressibility enables those high-dimensional states to be reconstructed or predicted from sparse measurements through sparse sensing. As a promising technique in data compression, reconstruction, and prediction, sparse sensing has not been widely used in environmental engineering and geosciences. In this talk, some recent efforts in reconstructing and/or predicting streamflow and water quality (e.g., nitrate and phosphorus concentrations) time series across watersheds using sparse sensing will be introduced. These works focused on exploring the applicability of sparse sensing on reconstructing time-series and pursuing effective strategies to reduce the required sampling efforts. Other potential applications of sparse sensing include sensor location optimization and making predictions, especially through integration with data fusion.

*Keywords: nutrient monitoring, water quality, ungauged basins, sparse sampling, signal reconstruction*

## **29. Mesocosm assessment of the invasion risk from non-native, ballast-borne protists**

Abigail Latanich, Natural Resources Research Institute  
Mal N. Granmo, Natural Resources Research Institute  
Matthew L. Julius, St. Cloud State University  
Courtney E. Larson, University of MN Duluth and U.S. Environmental Protection Agency  
Euan D. Reavie, Natural Resources Research Institute

Ballast water transport has overwhelmingly contributed to the introduction of aquatic invasive species (AIS) in the Laurentian Great Lakes and its surrounding estuaries. AIS in ballast water can be detrimental to receiving native ecosystems and difficult to detect and control. As a major freshwater port, ballast-borne invasive species introduced via discharge can threaten the St. Louis River Estuary, the harbor, and western

Lake Superior ecosystems. Understanding invasion risk is imperative to protecting native communities and an understanding of this risk across multiple species and seasons is needed. Using mesocosms, propagule pressure and establishment are investigated to understand risk-release relationships of several protist species. To mimic ballast discharge events, protist densities of 0 - 100 cells/mL were inoculated into 20-L mesocosms filled with Duluth-Superior Harbor water and sampled weekly for 4 weeks. Experiments evaluated five surrogate “invaders”: *Haematococcus pluvialis*, *Trachelomonas abrupta*, *Chryso-sphaerella* sp., *Merismopedia elegans*, and *Gymnodinium fuscum*. Logistic models predicted the minimum surrogate protist densities resulting in successful establishment, thereby providing information on ballast water risk-release relationships and the validity of our mesocosm approach. Ongoing work will couple DNA with morphological counts to develop a potential tool for molecular detection of non-native species in ballast or environmental samples. This research will provide insight into risk-release relationships and support aquatic management that relies on protective discharge criteria.

*Keywords: mesocosm, risk-release, protists*

### **30. Classifying Visitor Activity from Trail-camera Data at the Pickle Ponds Restoration Site Using the TRail Activity Classification Tool (TRACT)**

Jesse Engebretson, Environmental Protection Agency  
Terry Brown, Environmental Protection Agency  
Tom Hollenhorst, Environmental Protection Agency  
Jennifer Joesphs, Argonne National Laboratory  
Meghan Klasic, Environmental Protection Agency  
Amber Sample, Environmental Protection Agency

Reliable image classification tools are needed to efficiently organize visitor-use monitoring data for improved management decisions in parks and protected areas. Visitor-use monitoring is a systematic strategy to document visitation trends over time, such as changes in visitor-use levels and user activity types. Visitor-use monitoring can also serve as the basis for empirically-informed short and long-term management decisions. Land managers can use visitor-use monitoring to document and evaluate changes in social conditions of the lands they steward, as well as assess the effects of management actions they take. Well-designed monitoring protocols can provide scientifically defensible and transparent information to guide management of parks and protected areas and can inform stakeholders and the public about the status and trends in valued resources and experiences. Visitor-use monitoring is costly in terms of time and money, as it requires training human observers and analysts, and manually organizing and analyzing large amounts of data. Traditional approaches also require accounting for bias introduced by observer subjectivity. The TRail Activity Classification Tool (TRACT) is a software tool developed by the U.S. Environmental Protection Agency that may help ameliorate some of these challenges. TRACT is free open-source software that allows users to assign customized observable attributes to images from a trail camera or similar site monitoring image source and enables the efficient and clear organization of image-based data. These attributes include date, time, activity, and visitor group composition, etc. Further, TRACT facilitates the grouping related images (e.g. subjects coming and going) to characterize duration of visits. In this presentation, we apply TRACT to images gathered at Pickle Pond in Superior, WI, a recreational area undergoing a remediation/restoration project to address contaminated sediments and restore fish and wildlife habitat. Further, we discuss the benefits and limitations of TRACT as it relates to visitor-use monitoring and other possible applications, including wildlife behavior.

*Keywords: visitor-use monitoring, areas of concern, park management, image classification*

### **31. A review of social indicators of environmental restoration**

Meghan Klasic, U.S. Environmental Protection Agency, Office of Research and Development, Great Lakes Toxicology and Ecology Division

Katie Williams, U.S. Environmental Protection Agency, Office of Research and Development, Great Lakes Toxicology and Ecology Division

Jesse Engebretson, U.S. Environmental Protection Agency, Office of Research and Development, Great Lakes Toxicology and Ecology Division

Restoration is a hallmark of environmental work. Regulatory and voluntary programs across multiple levels of governance aim to improve or “restore” environments. In the United States, there are 25 federal statutes implementing more than 134 restoration programs that equate to about \$1B in spending each year. Environmental restoration can lead to immediate short-term pollution controls and promote long-term ecosystem health and climate benefit. Much research has been aimed at measuring pollution concentrations and toxicity before and after restoration projects. An often-overlooked area of environmental restoration is the social impact of these projects. Social indicators and measures can help quantify and qualify key benefits of restoration projects to individuals and communities. Using Sciome Workbench for Interactive computer-Facilitated Text-mining (SWIFT), a tool for searching, categorizing, and prioritizing bodies of literature, we systematically review articles and technical reports to identify social indicators of restoration projects in the United States. We then evaluate social indicator trends across geographies and topics (e.g., lake, wetland). This meta-analysis review provides a broad perspective on how to incorporate social indicators into restoration project monitoring and impact assessment, towards the goal of a more holistic social-ecological systems approach.

*Keywords: environmental restoration, social indicators, systematic review*

### **32. Pollen influx into Lake Superior is a significant source of carbon**

Jake Zunker, Large Lakes Observatory, University of Minnesota Duluth, Duluth, MN

Kathryn Schreiner, Large Lakes Observatory and Department of Chemistry and Biochemistry, University of Minnesota Duluth

Lily Karg, Department of Chemistry and Biochemistry, University of Minnesota Duluth. Christopher Filstrup, Natural Resources Research Institute, University of Minnesota Duluth

Chan Lan Chun, Natural Resources Research Institute and Department of Civil Engineering, University of Minnesota Duluth.

While lacustrine systems contain a small fraction of the world’s water, they collectively account for nearly half of the world’s annual total organic matter (OM) burial. Recent years have brought considerable efforts to fully understand the carbon cycle of lacustrine environments with increasing emphasis on anthropogenic impacts. With such an important role in the global carbon cycle, it is critical to fully understand the function of carbon influx and storage in these systems. The carbon cycle and general composition of OM in waters of the Laurentian Great Lakes have been widely studied, yet there remains a large knowledge gap in carbon inputs and the fate and transport of sedimentary organic matter (SOM) in each lake. To address this, we have characterized the chemical composition and source of OM spatially in the sediments of Lakes Superior. Surface sediments were collected at 30 sites in Lake Superior and analyzed for lignin-phenol biomarkers using gas chromatography-mass spectrometry (GCMS). Nearshore sediments exhibited low SOM degradation extent relative to high offshore SOM degradation extent suggesting prominent lateral transport mechanisms. High lignin-phenol proxy ratios in offshore SOM may be attributed to airborne pollen as a major contributor of terrestrially-derived SOM, suggesting that previously overlooked aeolian influx of

pollen into Lake Superior may constitute a significant unquantified carbon input. This study advances our understanding of carbon inputs and transport in Lakes Superior by characterizing sedimentary OM spatially.

*Keywords: Pollen, lignin, carbon, input, transport*

### **33. Adhesion of Cyanobacteria to Microplastic Surfaces and Influence on Microplastic Transport**

Fuad Shatara, University of Wisconsin-Madison  
Saurabh Gupta, University of Wisconsin-Madison  
James Rice, University of Wisconsin-Madison  
Nimish Pujara, University of Wisconsin-Madison  
Erica Majumder, University of Wisconsin-Madison

The increase in agricultural and urban runoff contributes to Harmful Algal Bloom (HAB) formation in the Great Lakes and nearby water systems by providing nutrients and pollutants to stimulate growth of HAB causing species. Microplastic pollutants are being detected at increasing concentrations in this runoff and downstream in lakes and surrounding watershed. However, the direct effect of microplastic pollutants on HAB formation and microbe and small molecule transport are largely unknown. Preliminary experiments have shown that polymer type and size influence growth rates of cyanobacteria, and adhesion to the polymer surface was noted across a variety of polymer types and sizes. In order to investigate the potential for cyanobacteria and the toxins that they produce to adhere to the surface of microplastic and transport across water ways, toxin producing species of cyanobacteria isolated from Lake Erie will be cultured in a turbulence tank in the presence of polymers of varying physical characteristics. Additionally, sampling across Lake Superior's southern shore using a novel sampling device has allowed for the enrichment of particle bound microbes, which will be further analyzed for their abilities to adhere to microplastic surface in the turbulence tank. Results from these studies will allow for characterization of microbe-plastic complexes and their influence on the buoyancy and fate microplastics and their associated microbial communities within these aquatic systems.

*Keywords: Microplastics, HABs, Lake Superior*

### **34. An Overview of the Content and Status of the Environmental Sensitivity Index (ESI) datasets of the Great Lakes**

Nicolle Rutherford, National Oceanic and Atmospheric Administration (NOAA)

Environmental Sensitivity Index (ESI) datasets are a NOAA product that provide a concise summary of coastal resources that may be at risk in a given geographic area. They combine information about shoreline sensitivity with biological and human-use resources, including threatened and endangered species and culturally significant sites, enabling planners and responders to consider all factors jointly when evaluating protection and clean-up priorities. Originally developed as a tool for oil and chemical spill responders, ESIs are now also used across public and private sectors to assist in activities ranging from natural resource damage assessment, restoration planning, environmental permitting and compliance, vessel traffic routing, port development, marine debris removal, hurricane response, and selection of marine sanctuary sites and conservation site targets. ESIs exist for the entire U.S. coast, including the Great Lakes and the U.S. Territories. The Great Lakes ESI datasets are among the oldest in the nation, dating back to the 1980s and early 1990s. The dataset for Lake Superior has not been updated since its creation in 1994. Recently, NOAA received funding from the Great Lakes Restoration Initiative (GLRI) and the U.S. Coast Guard to update the ESI maps for all of the great lakes. The new ESI datasets will reflect the GLRI restoration sites among other

essential environmental data, ensuring awareness of these critical areas by oil and chemical spill responders, as well as other coastal planning entities. This presentation will provide an overview of the ESI product and information regarding the content, timing, and availability of the updates.

*Keywords: ESI, GLRI, Planning, Great Lakes*

### **35. Plastic Debris: is a problem in Superior, WI?**

Mateo Abarca, University of Wisconsin-Superior  
Dr. Lorena Rios, University of Wisconsin-Superior

Plastic debris has emerged as a significant environmental concern over the past two decades. The disposal of plastic waste in landfills has become a prevalent practice, resulting in environmental pollution encompassing water bodies such as rivers, lakes, oceans, and even polar regions. This research aims to examine the methodologies employed by the City of Superior for plastic waste collection and recycling. The data sourced from the Wisconsin Department of Natural Resources, were analyzed to know type of plastic debris and other components of the waste. In this study, an exploratory data from plastic debris generated by students from UWS was analyzed, and the data were extrapolated to the Superior City population, Wisconsin State and all The United States.

*Keywords: Plastic debris, environmental pollution, microplastics, land field, garbage*

### **36. Water Quality through a 5th Grade Lense**

Matthew Peck, Lowell Elementary School

Three groups of 5th graders collected and tested water samples from their neighborhood creeks, ponds, rivers and more. They then tested their samples for pH, Conductivity and Dissolved Oxygen. The results were averaged to determine the quality of each of the sources.

*Keywords: Water Quality, Duluth, Community Science*