ORAL PRESENTATION ABSTRACTS
TUESDAY, MARCH 3

St. Louis River Area of Concern: Progress and Updates

Presenter: Barb Huberty, MPCA
Co-Authors: Matt Steiger, WDNR; Melissa Sjolund; Rick Gitar, Fond du Lac Reservation

The St. Louis River Area of Concern (SLRAOC) Remedial Action Plan describes 80 management actions that must be completed in order to remove nine Beneficial Use Impairments (BUIs) and delist it. At this time, 46.3% of the management actions are complete, inching our way toward delisting the SLRAOC. In this past year, several construction projects were completed, a BUI removal was started, studies were nearer to conclusion and important interim project milestones were met. This presentation will highlight the past year's accomplishments, the current projected BUI removal timeline, planned 2020 field work and significant milestones expected in 2020.

Excessive Loading of Sediment and Nutrients: The Case for BUI Removal

Presenter: Matt Steiger, Wisconsin Department of Natural Resources
Co-Author: Barb Huberty, MPCA

The Area of Concern (AOC) agencies are recommending the removal of the Excessive Sediment and Nutrients Beneficial Use Impairment (BUI) for the St. Louis River AOC in 2020. This presentation will highlight the five management actions that have been completed and describe how the AOC agencies and a BUI Technical Team have justified the recommendation for BUI removal. Opportunities to review and participate in the BUI removal will be shared.

Long-Term Trends in St. Louis River Water Quality: 10 Years, a Historic Flood, and Some High Lake Water Later

Presenter: Joel Hoffman, U.S. EPA Office of Research and Development
Co-Author: Hannah Ramage, Lake Superior Reserve

Water quality impairments caused by sewage and industrial waste discharge into the St. Louis River have been a primary concern for cleanup efforts throughout the last century. Surveys dating back to 1928 reveal severely degraded water quality in much of the river below Fond du Lac dam. The Minnesota Pollution Control Agency (MPCA) began regular monitoring in 1953 at MN Hwy 23 Bridge and by 1973 were sampling at multiple locations in the lower river but discontinued monitoring in 2012. Subsequently, the Lake Superior National Estuarine Research Reserve began routine monitoring at some of the same stations previously monitored by MPCA. Long-term trends demonstrate a dramatic recovery in water quality throughout the lower river. Beginning in the mid-1970s, there has been a significant increase in dissolved oxygen concentrations, coupled with declines in total suspended solids (TSS) and total phosphorous (TP) concentrations. Notably, annual TP loads have decreased faster in the lower river than the upper river since the mid-1990s, implying a significant, positive change in nutrient dynamics in the lower river. Nevertheless, monitoring data indicate some persistent sources of phosphorous and nitrogen to the river between Hwy 23 Bridge and Blatnik Bridge. Even more recently, dry and wet cycles appear to influence contrasting periods characterized by relatively low (dry) versus high (wet) loadings of TSS and ammonium, albeit not for TP and nitrate. We conclude that the water quality record shows a dynamic evolution from a period strongly affected by unregulated discharges and poor land use practices to an era of recovery driven by hydrologic cycles.

Looking Back at 10 Years of the Lake Superior Reserve (and Looking Forward Too)

Presenter: Deanna Erickson, Lake Superior Reserve

The Lake Superior Reserve was designated in 2010 after a twelve-year designation process. This presentation provides a recap of progress at the Lake Superior Reserve as well as objectives for the future based on our new management plan. It also offers an invitation to researchers and land managers to become involved in a poetry, prose and art effort building towards a community-engaged celebration of National Estuaries Day in 2020.

Supporting Decision-Making Through the Analysis of Beneficial Use of Dredged Material in the St. Louis River

Presenters: Keahna Margeson and Sebastian Paczuski, U.S. EPA GLTED
Co-Author: Joel Hoffman, U.S. EPA GLTED

Dredging work and material management in the St. Louis River holds important implications for its remediation, restoration and revitalization. Each year, over 100,000 cubic yards of sediment are dredged from the St. Louis River, both for maintaining shipping channels and remediating sediment contamination. Dredged material must be managed, through either disposal or beneficial reuse placement. While disposal options are costly and limited, beneficial reuse of clean dredged materials offers potential for environmental, economic and social benefit. The stakeholders involved in the designing and permitting of the beneficial use of dredge must navigate a complex process of coordination to reach agreement for placement. This research aims to build understanding of stakeholder involvement and increase transparency in the beneficial reuse of dredge. Through this research, we have reviewed existing reports and worked with stakeholders to identify and inventory current and past examples of the beneficial use of dredged material while identifying the entities who generate and could benefit from the materials. These findings will be translated and applied using an existing decision-support tool created by U.S. EPA Region 5. The tool assesses relative valuation of ecological, economic and social benefits among different alternatives. We will refine the tool through a test scenario analysis of potential placement sites with Duluth-Superior Harbor stakeholders. Our initial results indicate that there are five categories or dimensions of criteria for decisions: governance, biophysical environment, built environment, economy and social criteria. This approach has utility because it links decision-making and action to objectives and impacts. The broad scope of these categories illustrates the wide-ranging effects beneficial reuse of dredge is connected to. The implications for this research include increased transparency between agencies and organizations when selecting sites for possible placement, development of base criteria necessary to consider a site or project for placement and greater translatability of information into action due to stakeholders informing data collection and tool development.

Duluth Urban Water Quality Impairments: *E. Coli* Study, Stream TMDLs Revised, and Beach TMDL Progress

Presenter: Jesse Schomberg, Minnesota Sea Grant
Co-Authors: Diane Desotelle, City of Duluth; Tom Estabrooks, MPCA

The Duluth Urban Area Streams Watershed is a focused geographic area designed to recognize the complexity and challenges in an urban center with a water-rich environment. It is defined by a series of small watersheds that are portions of three major watersheds: the Cloquet River, St. Louis River and Lake Superior South. All converge in Duluth and drain into the headwaters of the Great Lakes.

The Duluth Urban Watershed Advisory Committee (DUWAC) consists of the 10 local governing communities that lie within Duluth's Urban Area Streams Watershed and is focused on creating a regional approach to urban watershed management that recognizes its inherent shared nature. DUWAC has been actively involved with the Minnesota Pollution Control Agency (MPCA) on several impaired streams and beaches in which *E. coli* and/or total suspended sediment loads have reached levels that require a Total Maximum Daily Load (TMDL). Due to concerns raised by several communities, the TMDLs were revised over the past year to include near-channel sources of sediment and also additional information on *E. coli* sources within the impaired watersheds.

This talk will provide updates on the Duluth-area impaired waters projects. One project includes an MPCA-funded *E. coli* source assessment in the Keene and Tischer Creek watersheds, two of the seven streams impaired for *E. coli*, to better understand the sources and opportunities to address these impairments. The other project currently underway is the development of TMDLs for five impaired beaches within the Duluth Harbor and along the North Shore of Lake Superior. These beaches have aquatic recreation impairments due to high concentrations of *E. coli.* Several of the beaches are also listed as impaired for beneficial use (due to fecal bacteria) as part of the St. Louis River Area of Concern. The project provides an opportunity to evaluate the water quality impairments, complete pollutant source assessments with microbial source tracking and determine reductions needed to meet water quality standards for the impairments.

Come learn about the current work being conducted and the resources available to protect the Duluth Urban Area Streams Watershed!

An Overview of Recent NOAA Office for Coastal Management Activities

Presenter: Brandon Krumwiede, CSS Inc. (on contract to NOAA Office for Coastal Management)
Co-Authors: Heather Stirratt, NOAA Office for Coastal Management; Elizabeth Mountz, NOAA Office for Coastal Management; Rachael Franks-Taylor, CSS Inc. (on contract to NOAA Office for Coastal Management)

NOAA's Office for Coastal Management is engaged in multiple activities and projects within the St. Louis River Estuary and surrounding area. This presentation will highlight some of the more recent activities and accomplishments involving work with our partners in this region, including work on wild rice, Wisconsin Point, benthic mapping and final steps towards completion of NOAA's Habitat Blueprint.

Understanding the Influence of the Social Science Research in Shaping the Management of Great Lakes Resources: A Critical Analysis

Presenter: Sakib Mahmud, UW-Superior
Co-Author: Erika Washburn, Lake Superior Reserve

Recently, social science research is getting more traction for developing a better understanding of community resiliency against climate change-induced impacts in vulnerable coastal areas. However, there is a lack of awareness and insight regarding how social science research might be influencing the policies. Given the importance of this area of research, our paper explores the degree to which social science research is integrated with potential management and policy recommendations in the Great Lakes. Our study reviewed 20 years of scholarly literature published in the single most important peer-reviewed publication in this region—the *Journal of Great Lakes Research*—using a scoping review process. Our goal is to characterize research trends as published in this journal, identify any research gaps and identify priorities where management decisions could be improved using social science research in the coastal communities of the Great Lakes. We anticipate the findings from our scoping review process will identify additional questions for social science research, describe the extent of geographic scales covered or missing and the scope of existing studies, and identify end users or community stakeholders who participated in the social components research or who are critical to include in the future.

Bringing Environmental and Natural Science Education to the Masses Via Eco-Adventure Trips

Presenter: Clifford Langley, Swiftwater Adventures

This presentation discusses adventure recreation trips as a tool for environmental and natural science education, referred to as an "eco-adventure" trip. With a background and education in natural science and environmental education, coupled with 20 years of whitewater paddling and guiding experience, I wanted to find a way to create an experiential learning adventure. The St. Louis River corridor supplies a myriad of educational opportunities for life and earth sciences, as well as physical and cultural education. We have designed our eco-adventure trips, primarily whitewater rafting excursions, to serve people in two distinct ways: offer secondary school and college trips in which we work with teachers and instructors to implement their curriculum into the trip; and employ roving interpretive techniques to spark an interest in the local environment among tourists. Overall, we hope to foster a connection to the St. Louis River while supplying people with a wilderness, whitewater experience. We will discuss examples of this during the presentation and hope to collaborate with fellow educators and adventurers.

Rights of Nature for the St. Louis Estuary

Presenter: Nicolette Slagle, Community Organizer

Those of us that work on, live near and love the St. Louis River Estuary know firsthand the importance of environmental protection. Through the hard work and determination of numerous individuals, agencies and organizations the estuary has begun to rebound from decades of environmental degradation. What we also know is that there are currently more threats facing the estuary, including the changing climate. Internationally, scientists have stated that we need transformational change in the way we protect biodiversity and ecosystems. This requires a fundamental shift in how we view our dependence on nature and how we respect and protect nature. This means going beyond securing human rights to a healthy environment—it means securing, through laws, the right of nature to be healthy and thrive.

Our current environmental protection laws simply regulate how much pollution or destruction of nature can occur, and under the recent administration, we have seen these laws weakened even further. These laws and regulations fall short because they view nature as property, which permits the property owner to damage or destroy. Under a Rights of Nature framework, ecosystems and natural communities are recognized as entities that have independent and inalienable rights to exist and flourish. This understanding is analogous to Indigenous understandings of nature, and indeed, Indigenous communities have been at the forefront of the Rights of Nature movement.

In addition to the Indigenous communities internationally that have enacted Rights of Nature laws, in the United States we have seen four tribal governments take steps to pass rights of nature laws. This includes the White Earth band of the Chippewa, who passed a Rights of Manoomin (wild rice) law in 2018. This is the first law that secures the legal rights of a particular plant species. Inspired by this work, a small group of Duluth residents has begun to explore the potential of passing a Rights of the St. Louis Estuary locally. This community-led initiative would be focused on passing a charter amendment through a ballot initiative, keeping control of the amendment in the local community.

Waabizheshikana, The Marten Trail: Increasing Public Access to the River

Presenter: Lisa Luokkala, City of Duluth - Parks & Recreation

Overview: In 2016, the City of Duluth and community partners embarked on a master-planning process to define the future recreational use of 10 miles of public riverfront encompassing 1,200 acres of green space. Realizing the limited public access to the St. Louis River, the City's intent was to develop a plan that would enhance public access to the river via a 10-mile riverfront bike/pedestrian trail, improve existing water access sites and provide new water access sites tailored specifically for paddlers. By the end of 2019, Waabizheshikana: The Marten Trail Mini-Master Plan was complete— a river heritage trail concept that welcomes residents and visitors back to a restored river after the nearing completion of $400 million of federal/state cleanup.

Process: The natural, cultural and human landscape of the corridor proved to add layers of complexity to the planning process. An initially one-year process morphed into three. Stakeholders presenting a wide breadth of community interests participated, along with a team of technical advisors that included a vast number of the people who work, study and advocate for the St. Louis River.

The Plan led to the following outcomes:

1. Rebrand the Western Waterfront Trail as a heritage trail, including renaming the trail to reflect and honor the cultural and historical significance of the area.
2. Initiate a separate heritage interpretive planning process to identify and articulate the stories of the river and the area.
3. Extend the existing trail to connect seven river corridor neighborhoods by way of a trail alignment that traverses the shoreline and nearby ridgeline.
4. Retain the entire existing LSMR rail line for excursion train use.
5. Improve three existing water access sites and develop three additional water access sites to increase public riverfront use.
6. Design all these facilities to ensure accessibility, regardless of income, age or physical ability.

Presentation Objectives:
In my presentation, I will discuss:

1. Final recommendations from the Master Plan.
2. Lessons learned in the planning process.
3. Moving into implementation and new opportunities for collaboration.

Using a Learning Approach to Enhance Discussion of R2R2R in Great Lakes AOCs

Presenter: Katie Williams, U.S. EPA Great Lakes Toxicology and Ecology Division
Co-Author: Joel Hoffman, U.S. EPA Great Lakes Toxicology and Ecology Division

Ecosystem services can provide a language to discuss the value of a place to different stakeholders. Researchers from the U.S. EPA's Great Lakes Toxicology and Ecology Division recognize the value of ecosystem services is, at least in part, a function of the connection between the environment (Area of Concern; AOC) and society (adjoining communities or place). Remediation to Restoration to Revitalization (R2R2R) can be considered the steps between the remediation of contaminated sediment, the restoration of aquatic habitat and the revitalization of the adjoining community. The first two steps in the process, or contaminated sediment remediation and habitat restoration (R2R), is most often guided by efforts to restore Beneficial Use Impairments (BUIs), which conceptually are analogous to ecosystem services (i.e., benefits from nature). We argue that to better realize the benefits of R2R, we need to determine which ecosystem services are affected by habitat degradation and sediment contamination to more effectively characterize the steps between improving environmental quality, changing ecosystem services (e.g., increasing recreational or cultural value) and revitalizing waterfront neighborhoods. To increase our understanding of these relationships across AOCs, we organized and facilitated a dialogue based on experiential learning principles at the U.S. EPA's Annual AOC meeting in 2016 with community members and advisers who are committed to the AOC program. In this session, participants were asked to reflect on the AOC program and their own community. Participants answered a series of questions about a variety of ecosystem services, including recreational use (e.g., kayaking and trails). As a result of this session, we expect AOC professionals and volunteers are becoming more aware of the important social indicators of the health and value of these resources. Through the discussion, we heard from participants that local leadership and planning is the most significant factor effecting changes on land. We conclude that to enhance public benefits from AOC projects, it is important to develop ways to discuss these waterways from different perspectives both in terms of water quality targets and as a valued resource from which people benefit.

Looking & Seeing: The St. Louis River in a Series of 1950s Architectural Portraits

Presenter: Jennifer Webb, University of Minnesota Duluth

In the 1950s, local sign painter and West Duluth resident, Art Fleming, painted a series of architectural portraits depicting the industries in the neighborhoods of western Duluth. Commissioned by the Crotty family, the paintings still hang in their original location, the Kom-on-Inn Bar on Grand Avenue in West Duluth. While most viewers focus on the attention Fleming paid to the buildings and the lost industrial histories they memorialize, several panels, painted from a birds-eye view, also include the St. Louis River. In this short talk, I will briefly introduce Fleming's larger project before turning to closer analysis of the panels that help us "see" the St. Louis Estuary in the 1950s. Study of these paintings is part of a longer research project that includes archival research and oral histories. I am interested in hearing what others "see" in Fleming's depiction of the river basin.

Lake Superior Manoomin Cultural and Ecological Characterization

Presenter: Nancy Schuldt, Fond du Lac Band of Lake Superior Chippewa
Co-Authors: Evelyn Ravindran, Keweenaw Bay Indian Community; Erin Johnston, Keweenaw Bay Indian Community; Karena Schmidt, Keweenaw Bay Indian Community; Eric Chapman, Lac du Flambeau Band; William Graveen, Lac du Flambeau Band; Nancy Schuldt, Fond du Lac Band; Roger LaBine, Lac Vieux Desert Band; E.J. Isaac, Grand Portage Band; Margaret Watkins, Grand Portage Band; Darren Vogt, 1854 Treaty Authority; Peter David, Great Lakes Indian Fish and Wildlife Commission; Heather Stirratt, NOAA OCM; Brandon Krumwiede, NOAA OCM; Albany Jacobson Eckert, BIA; Zachary Jorgenson, BIA; Harold Peterson, BIA; Erika Washburn, Lake Superior Reserve; Deanna Erickson, Lake Superior Reserve; Jimmy Camacho, Sea Grant; Deidre M. Peroff, Sea Grant; Sarah Dance, Sea Grant; Michael J. Friis, Wisconsin Department of Administration; Heather Hosterman, Abt Associates; Kaylene Ritter, Abt Associates; Olivia Griot, Abt Associates

Manoomin, wild rice, is integral to the culture, livelihood and identity of the Anishinaabeg, the indigenous peoples of Canada and the United States that include the Odawa, Ojibwe, Potawatomi and Algonquin peoples. In addition to the vital role Manoomin has in the lives of the Anishinaabeg, manoomin is recognized as being ecologically important, feeding migrating and resident wildlife species, providing a nursery for fish and nesting and breeding habitats for many waterfowl and muskrat, and stabilizing shorelines.

The Lake Superior Manoomin Cultural and Ecosystem Characterization Study is a project initiated by a team of Lake Superior Basin Anishinaabe communities, and federal and state agencies focused on documenting and characterizing (1) the perspectives, cultural identity, and cultural and spiritual practices of the Anishinaabe people with respect to manoomin, and (2) the critical ecological importance and functions of manoomin waters as indicators of a high-quality, high-functioning, and biodiverse ecosystem in the Lake Superior basin. The team developed a set of cultural and ecological metrics to characterize seven case study sites around Lake Superior. Based on these characterizations, the team used a Habitat Equivalency Analysis to determine the amount of restoration needed to counterbalance the lost manoomin habitat functionality. Preliminary results from this study highlight the difficulty in restoring the cultural and ecological functionality of degraded manoomin habitat and importance of preserving and protecting existing manoomin habitat.

Seeing Focus Areas: Leveraging GIS to Protect Lands Resilient to Climate Change

Presenter: Mike Koutnik, Michael A. Koutnik GIS Consulting

Private land trusts fill an important and unique role in protecting high-quality lands for conservation. They are often challenged to be strategic in protecting private lands. Landmark Conservancy is one of the largest private land trusts in Wisconsin, working mostly in 20 northwest Wisconsin counties, including Douglas, Bayfield and Ashland counties along the south shore of Lake Superior. Landmark has committed to proactively pursue protection of lands based on climate resiliency. To start turning that commitment into action, Landmark is using GIS to define "Focus Areas" based on The Nature Conservancy's Resilient and Connected Landscapes data. Based on the concept of "protecting nature's stage," the TNC data highlight areas that are more likely to continue to harbor high-quality, diverse ecological values, despite climate change. In this session you will also see which areas in the Wisconsin portion of the Lake Superior Basin are included in Landmark's Focus Areas. You will also learn how TNC's Resilient and Connected Landscapes data were used to define Landmark's Focus Areas.

Sturgeon Monitoring on the Lower St. Louis River

Presenter: Nick Bogyo, 1854 Treaty Authority

In 2011, the 1854 Treaty Authority and the Fond du Lac Band began a larval drift net survey to document the success of natural reproduction of sturgeon on the lower St. Louis River. Following the stocking efforts and habitat restoration projects of the Minnesota and Wisconsin Departments of Natural Resources, a spawning population is once again present in the estuary. This survey was implemented as a means of observing the success of these spawning individuals. A future goal of this survey is to eventually observe a correlation with the number of larval sturgeon captured in drift nets and the number of juvenile sturgeon captured in our trawl surveys. The 1854 Treaty Authority also conducts three seasonal trawl surveys each year. The goals of these surveys are to monitor native and non-native fish communities, monitor for new invasive species, and to document the survival of naturally reproduced sturgeon. New in the 2019 field season, a setline survey was conducted. The goal of this survey is also to document the survival of naturally reproduced sturgeon. Since 2016, the 1854 Treaty Authority has conducted a surgeon index gill net survey on Lake Superior to monitor recruitment, year class strength and population trends over time.

Someone Brings You a Fish...Now What?

Presenter: Josh Dumke, University of Minnesota Duluth, Natural Resources Research Institute

A 2017 survey of St. Louis River ice-anglers suggests we could expect high participation rates in a harvest-based fisheries research program, where anglers interact with researchers who collect data from harvested fish. I will briefly summarize the results of that work, as a manuscript is in press to the journal *Citizen Science: Theory and Practice*. Here I want to look forward and develop collaborations. If you had access to hundreds of fish, what would you do? Is it even the fish we are interested in, or is it the angler's beliefs, behaviors and habits? What research direction has legs? I will present several possible options for inspiration and call for interested parties to contact Josh Dumke (jddumke@d.umn.edu) at the University of Minnesota Duluth, Natural Resources Research Institute.

Progress Towards Larval Fish-Based Metrics to Assess Restoration Effectiveness

Presenter: Greg Peterson, U.S. EPA
Co-Authors: Ted Angradi, U.S. EPA; Mark Pearson, U.S. EPA; Anett Trebitz, U.S. EPA; Chelsea Hatzenbuhler, BTS; Jon Barge, NSSC; Bradley Dawson, U of MN, Duluth; Morgann Gordon, ORAU; Jon Launspach, CSRA; Joel Hoffman, U.S. EPA

Assessing habitat restoration effectiveness is fundamental to ecosystem-based management for Areas of Concern. Biological metrics that are responsive at the restoration site scale, such as vegetation- and benthic invertebrate-based measures of ecological integrity, are necessary to measure restoration effectiveness. A fish habitat condition metric would be useful; however, adult and juvenile fish-based metrics may not be responsive to project-scale change because the home range of adult and juvenile fish is often larger than the restored habitat. Larval fish, however, may serve as a sensitive biological indicator with the spatial fidelity to assess both degradation and restoration because larvae are less mobile than juveniles or adults. In July 2018 and 2019, we collected larval fish community and habitat data from shallow water stations at five "impaired" and five "reference" embayments along the St. Louis River Estuary (SLRE), including some current and potential restoration sites. Within each embayment, 6 to 10 sampling stations were randomly selected from the available area of shallow (≤1.5m depth) habitats. In the SLRE, these habitats are the focus of restoration efforts, support aquatic vegetation and are effectively sampled by our larval fish tow sled. Hydroacoustics and visual estimates were used to characterize and quantify submerged aquatic vegetation (SAV) at each station. Taxonomic identification of larval fish and habitat data processing are ongoing for the 2019 sampling, but preliminary analysis of 2018 data suggests that both larval fish abundance and species richness reflect both embayment and station level differences in density and composition of SAV. Results from this study will be used to evaluate larval fish community-habitat relationships aimed at developing metrics to identify habitat impairment and assess restoration effectiveness in addition to serving as a pre-restoration benchmark for sites where restoration is planned or ongoing.

ORAL PRESENTATION ABSTRACTS
WEDNESDAY, MARCH 4

Harbor Dredge Materials: Benefits of Reuse and Assessing Risk

Presenter: Philip Monson, MPCA

Maintenance of the St. Louis River harbor includes removal and disposal of materials dredged from shipping lanes. This material has an added benefit for reuse in restoration of habitat and augmenting structural features within the harbor and estuary. This beneficial reuse is predicated on compliance with federal Clean Water Act (401) certification if material is to be placed within the aquatic environment. Certification requires a risk assessment of known contaminants within these dredge materials to ensure that reuse does not cause additional exposure risk to aquatic life or humans.

BNSF Railway Under-Ice Coal Reconnaissance and Removal in the St. Louis River

Presenter: Rick Gitar, Fond du Lac Reservation - Office of Water Protection

On February 16, 2019, a BNSF Railway 121-car coal train derailed 38 cars adjacent to the St. Louis River on the Fond du Lac Reservation with six cars landing on the ice of the river. The ice fractured and the coal from those cars spilled into the river. The ice subsequently refroze, trapping the released coal on the bottom of the river, as well as between layers of ice. BNSF, Fond du Lac, U.S. EPA, MPCA and several consulting companies worked together for several weeks to develop and execute a plan for locating and removing the coal with minimal disturbance to the river bottom. The presentation will center on the reconnaissance phase, which will use a remote-operated vehicle, and the removal phase, which will use heavy machinery to cut the ice and scrape the river bottom.

Great Lakes Legacy Act: Sediment Remediation of Howards Bay

Presenter: Bradly Benson, U.S. EPA
Co-Authors: Diana Mally, U.S. EPA; Bradly Benson, U.S. EPA; Joe Graham, WDNR

This presentation will provide a progress update on the planned cleanup of impacted sediment and habitat restoration in Howards Bay.

The Howards Bay project area, located on the eastside of the St. Louis River, contains a federal navigation channel, three slips and two dry docks along the south shore and is historically home to shipyards, grain terminals and commercial fishing operations.

Great Lakes Restoration Initiative funds are being used under the Great Lakes Legacy Act cost share program with contributions from Fraser Shipyards, City of Superior and Wisconsin Department of Natural Resources, which are non-federal sponsors. The project will remediate approximately 75,000 cubic yards of impacted sediments in the St. Louis River Area of Concern.

The sediment cleanup consists of two primary phases. First, strategic navigation dredging will be performed within the federal navigation channel. Secondly, environmental dredging will address the areas of impacted sediments and clean cover material will be placed strategically to enhance the benthic habitat. Dredge materials from environmental dredging will be placed at the Wisconsin Point Landfill for the beneficial use of repairing the existing landfill cap.

The project team is working on securing permits and making contract considerations. If work proceeds without major delays, mobilization of equipment to the site could take place this year. The cleanup and habitat restoration will take one to two years to complete. The project team is coordinating with many stakeholders to ensure that this project is a success for the Great Lakes and for the St. Louis River community.

Retrospective of Sediment Metals in the St. Louis River Estuary

Presenter: Meagan Aliff, University of Minnesota Duluth, Natural Resources Research Institute
Co-Authors: Euan D. Reavie, Natural Resources Research Institute; Elizabeth E. Alexson, Natural Resources Research Institute

Geochemical analyses applied to sedimentary records can reveal the history of metal pollution and effects of remediation. The St. 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. We undertook this study to describe the history of metals pollution in the SLRE, characterize recovery and identify potential continuing stressors. According to the International Joint Commission, the estuary sediments were contaminated with As, Cr, and Cu. Based on sediment core data, sediment quality criteria for these metals were exceeded in the oldest sediments in some locations. Notably, levels of Cr exceeded "severe" levels in Pokegama Bay in the 1750s, which was likely before any major human impact. Cluster analysis of the SLRE samples divided the metals into five 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. Thankfully, sediment profiles revealed reductions in these metals since they peaked in the 1970s. As we complete this work, we will follow up with additional details on the natural and anthropogenic circumstances of the SLRE's geochemical record.

Evaluating Riparian Wetlands as a Methylmercury Source to an Industrially Influenced Great Lakes Estuary

Presenter: Nate Johnson, University of Minnesota Duluth
Co-Authors: Amber White, University of Minnesota Duluth; Bruce Monson, MPCA; Joel Hoffman, EPA Midcontinent Ecology Division; Jeff Jeremiason, Gustavus Adolphus College; Marissa Castro, University of Minnesota Duluth

The St. Louis River Estuary (SLRE) is one of many coastal wetlands that are important recreational resources, spawning grounds and significant exporters of mercury to the Great Lakes. Despite a largely remote regional setting, the SLRE and its watershed have hosted industrial and resource extraction activities for over 120 years. Levels of mercury (Hg) in biota of the SLRE are higher than those recorded in other parts of the watershed and are the basis for restrictive fish consumption advice. The study herein provides an analysis of whether shallow, riparian wetland habitats, largely confined to the upper SLRE, represent a potential source of Hg to the surface water and food web. While sediment in some areas of the lower SLRE contain Hg higher than background levels, many of these locations lack conditions conducive to the production of bioaccumulative methylmercury (MeHg). In the upstream portion of the SLRE, abundant shallow, riparian wetland habitats have lower quantities of total Hg in the sediment but possess carbon-rich, oxygen-depleted environments that promote the production of MeHg. Along a transect away from the Lake Superior, spatial patterns in some biota with high spatial fidelity show higher MeHg quantities in the upper portion of the SLRE, beyond the reach of dilution by Lake Superior water. At a finer scale, biota, surface water and sediment in nearshore, shallow, riparian wetland habitats of the upper SLRE have higher MeHg than that in the open-channel areas. This suggests that these nearshore, shallow, riparian wetland habitats are potential sources of MeHg to the SLRE surface water and food web. The balance between MeHg loading from the St. Louis River and shallow, riparian wetland habitats in the SLRE likely varies with season and remains a question that has not been fully resolved. The ultimate origin of Hg present in these shallow, riparian wetland habitats cannot be unambiguously identified with the methods employed in this study; however, understanding locations where mercury is transformed into its bioaccumulative form is important for determining potential mitigation strategies.

Understanding Sources and Cycling of Mercury in the St. Louis River Using Stable Isotope Approaches

Presenter: Sarah Janssen, USGS Upper Midwest Water Science Center
Co-Authors: Joel Hoffman, U.S. EPA Office of Research and Development; Greg Peterson, U.S. EPA Office of Research and Development; Ryan Lepak, U.S. EPA Office of Research and Development; Mark Pearson, U.S. EPA Office of Research and Development; Anne Cotter, U.S. EPA Office of Research and Development; David Krabbenhoft, USGS Upper Midwest Water Science Center

Mercury (Hg) contamination within the St. Louis River Estuary (SLRE) is of long-term concern because fish Hg concentrations are elevated above human health and wildlife guidelines. In addition, it is known that Hg concentrations in SLRE sediments are higher than those observed elsewhere in the region and that game fish Hg concentrations in the estuary are double that of Lake Superior. However, it is unclear whether legacy Hg contamination within the SLRE contributes to these high Hg concentrations in fish and sediments. The aim of this study was to address that specific understanding gap, as well as to compare Hg concentrations in water, sediment and biota to a reference site, the Bad River. To understand the relative contributions of legacy versus contemporary Hg contributions, we included the use of Hg stable isotopes as tracers of Hg sources within the SLRE food web. Total mercury (HgT) was found to be higher in sediments, waters and game fish from the SLRE in comparison to the Bad River. Organic carbon played an important role in the control of methylmercury (MeHg) production in the sediments as well as the transport of aqueous Hg, suggesting that both systems have similar controls on Hg transport and methylation despite concentration differences. Stable isotope analysis showed that sediments within the SLRE with the highest concentrations were associated with an enrichment in 202-Hg, which is commonly observed in legacy contaminated sites. This signature was also observed in invertebrates and prey fish from SLRE, indicating that legacy Hg in the SLRE is an important Hg source that is bioaccumulating into the food web. Corresponding samples from the Bad River were absent of this signature and indicative of signatures derived from atmospheric Hg. The isotopic Hg source to game fish was shown to be dependent on fish migration and feeding habits, with individuals feeding in Lake Superior displaying a source signature similar to precipitation. The Hg concentrations and isotopic measurements of sediment and biota from the SLRE suggest the presence and active cycling of legacy Hg within the system as well as the contribution of offshore Hg sources in migratory fish.

Seasonal Drivers Influence Dissolved Organic Matter Composition in a Northern Minnesota River

Presenter: Lucy Rose, University of Minnesota Twin Cities
Co-Author: Diana Karwan, University of Minnesota Twin Cities

The spring snowmelt period is an important time for dissolved organic matter (DOM) export to rivers in the peatland/wetland-dominated systems of northern Minnesota. Spring melt can influence riverine DOM composition by routing water across a range of soil depths as soils thaw; this can mobilize organic matter from various soil depths into surface waters. From April to June 2018, we conducted a study in West Swan River to examine seasonal variations in riverine DOM composition beginning at the onset of spring snowmelt and continuing through the early growing season. West Swan River flows into the St. Louis River just below its confluence with East Swan River near Toivola, MN. Using continuous discharge records, a suite of natural solute tracers and molecular characteristics of DOM samples collected in West Swan River, we observed the greatest contributions of "fresh," easily metabolized DOM to the river during the main snowmelt period. After the melt, DOM composition became increasingly recalcitrant as the growing season began. We attribute this seasonal transition in riverine DOM composition to increasing soil water flow through deeper layers as soils thawed. Temporal shifts in dissolved Ca, Mg, K, Na, and P concentrations in West Swan River also support the idea of a shift from shallower to deeper soil water flowpaths as the active melt period ends and the growing season begins. These results highlight the importance of seasonal temperature and hydrologic drivers on DOM composition in rivers of the St. Louis River watershed.

Measuring our Success: Updates from the Habitat Workgroup—Working Toward a Healthy River Ecosystem Supporting a Thriving Human Community

Presenters: Hannah Ramage, Lake Superior Reserve; Rick Gitar, Fond du Lac Reservation - Office of Water Protection
Co-Authors: Brandon Krumwiede, CSS Inc (on contract with NOAA Office for Coastal Management); Dara Fillmore, WDNR; Tom Hollenhorst, U.S. Environmental Protection Agency, Office of Research and Development, Great Lakes Toxicology and Ecology Division; Molly Wick, Oak Ridge Institute for Science and Education; Pat Collins, MDNR

In 2002, the St. Louis River Citizens Action Committee prepared the Lower St. Louis River Habitat Plan. This document, along with the 2011 Strategies Implementation Planning worksheets, crafted by many dedicated individuals, detailed the foundational strategies for how our river communities can better understand, protect and restore the St. Louis River. It is a guiding document, both encouraging and facilitating action toward conservation within and outside of the Area of Concern boundary. The St. Louis River Habitat Workgroup formed to facilitate partnerships to achieve these goals. How are we doing? We have reached remarkable milestones, with >2,000 acres protected and >1,000 acres restored. But our work is not done. After nearly 20 years, some identified strategies in the Habitat Plan need revival and some need a new lens given the changing threats and stressors to our landscape. The Habitat Workgroup is working toward updating the dynamic plan so it can continue to be a vision for the future long after the SLR AOC has been delisted. And you can help by providing updates on your projects and/or getting involved with the workgroup. Help us measure and celebrate our success! This presentation will share where we are with the Plan and its trajectory as we look toward the future.

Fish Community Changes in Radio Tower Bay Following the Removal of Historical Wood Waste

Presenter: Mark Pranckus, Cardno

Radio Tower Bay is a sheltered bay located near Boy Scout Landing in the St. Louis River Estuary. In the late 19th century, two sawmill operations located on the bay had the practice of casting out wood waste into the bay, resulting in reduced water depths and loss of habitat diversity. Wood waste continued to negatively impact the bay for over one hundred years. Fish sampling in 2012 indicated that the Radio Tower Bay fish community was less diverse, composed of smaller individuals, and had higher proportions of insectivorous and pollution tolerant fish when compared to North Bay, a reference sheltered bay in the estuary.

From 2014 to 2015, dredging removed approximately 115,000 cubic yards of wood waste and accumulated sediment from approximately 29 acres of Radio Tower Bay. Average water depths increased from 0.8 feet to 3.7 feet. The project also created 5.5 acres of deepwater habitat with an average depth of 7.5 feet to provide off-channel overwintering habitat for fish. Excavation created a narrow but deep channel to provide a direct connection to the main river for fish throughout the year, including the winter.

In 2018, the fish community in Radio Tower Bay was re-assessed approximately three years following restoration. Sampling indicated that when compared to pre-restoration conditions, fish species diversity in both spring and early summer increased. Other changes included an increase in the average size of fish, an increase in the proportion of the fish community composed of piscivore species and a decrease in the proportion of pollution-tolerant fish species. Data suggest that the current condition of the fish community in Radio Tower Bay is more similar to the fish community in North Bay, the reference condition, than it is to itself prior to restoration. Preliminary results indicate that the restoration of Radio Tower Bay has resulted in improved habitat conditions and fish populations, which support efforts to address Beneficial Use Impairment – Loss of Fish and Wildlife Habitat in the St. Louis River Area of Concern.

Progress Update for the Spirit Lake U.S. Steel Sediment Project

Presenter: Diana Mally, U.S. EPA
Co-Author: Caitie Nigrelli, IL-IN Sea Grant; Bradly Benson, U.S. EPA

This presentation will provide a progress update on the planned cleanup of impacted sediment and habitat restoration in Spirit Lake.

Spirit Lake is a large open water body in the St. Louis River Area of Concern near the former U.S. Steel Duluth Works site and plays an important role for local people. Spirit Island, a sacred place for the Fond du Lac Band, is located within the lake. The island was a stopping place in the southwest migration of the Anishinaabe people. Spirit Lake is also important to the Morgan Park neighborhood, which began as a company town for U.S. Steel plant workers.

Although many cleanup projects around the former plant have reduced risks to public health and the environment, impacts remain in Spirit Lake sediment, including heavy metals, PCBs, PAHs, and dioxins. A Great Lakes Legacy Act sediment remediation and habitat restoration project is on the horizon. The project team is finishing up the design stage, and a project agreement for a $75 million cleanup between U.S. Steel and U.S. EPA has been signed. The remedy calls for dredging 770,000 cubic yards and placing dredge material onsite in secure containment via three confined disposal facilities. The remedy includes capping approximately 117 acres and a sand cover for 40 acres of lightly impacted area, as well as enhanced natural recovery and the creation of two shallow, sheltered bays.

The cleanup will remove and contain pollution to benefit people, aquatic life and the ecological system. The project will restore both in-water and shore habitat, including the creation of protective, sheltered bays for fish, birds, frogs, plants and more.

The project team is working on securing permits and making contract considerations. If work proceeds without major delays, mobilization of equipment to the site could take place this year. The cleanup will take two to three years to complete with habitat restoration performed alongside the project and after. The project team is coordinating with many stakeholders to ensure that this project is a success for the Great Lakes and for the St. Louis River community.

SLRAOC DIVER Data: Finding the Information You Are Looking For

Presenters: Diane Packett and Kirk Wythers, WDNR/MPCA

Accessing, visualizing and analyzing data are critical for SLRAOC staff to make decisions about proposed remediation and restoration projects in support of the St. Louis River Area of Concern (SLRAOC) Remedial Action Plan (RAP). In addition, scientists and staff with an interest in the estuary also benefit from this information.

After Great Lakes Restoration Initiative funding became available in 2010, the pace of chemical and biological investigations in the SLRAOC accelerated, creating a large volume of data collected by many different entities. Since 2014, NOAA and collaborators from Exadata, IEc, WDNR and MPCA have been developing the web-based Great Lakes Data Integration, Visualization, Exploration and Reporting (GLDIVER) application. The GLDIVER database collects a variety of publicly available contaminant, bioassay, water quality, vegetation and macroinvertebrate data together in a single repository, in a consistent and standardized structure. Registered users of DIVER can also access file collections including quality assurance plans, reports and data files.

DIVER's query and mapping tools allow users to explore, visualize and download data to support AOC decisions. Data can be exported and analyzed, mapped and interpreted through a variety of query and visualization tools. In addition to GLDIVER's capabilities, further analytical, statistical and visualization capacity is being developed with Tableau and Tableau Server applications that provide near-real-time data connections.

This presentation will help potential data users learn how to access data and related information in DIVER's file collections, export data and metadata, visualize complex derived data products and understand how they can be used to evaluate project needs. Queries of chemical and biological data will be demonstrated and recent additions and improvements highlighted.

Avian Habitat Conservation Initiative in the St. Louis River Important Bird Area

Presenter: Gini Breidenbach, Minnesota Land Trust
Co-Authors: Daryl Peterson, Minnesota Land Trust; Nat Miller, Audubon Great Lakes; Alexis Grinde, UM-NRRI; Annie Bracey, UM-NRRI; Luis Ramirez, Audubon Minnesota

The St. Louis River Estuary is well-known as a globally important migratory corridor for birds and is designated as an Audubon Important Bird Area (IBA). While some important efforts are being undertaken to restore habitat for specific avian species, such as the piping plover and common tern, very little focus has been given to addressing avian habitat needs estuary-wide.

The Minnesota Land Trust, Audubon Great Lakes, University of Minnesota Duluth Natural Resources Research Institute, Wisconsin Department of Natural Resources and partners of the St. Louis River Restoration Initiative are beginning an initiative focused on birds in the estuary. This is a collaborative effort building on recent land-side (i.e., City of Duluth's St. Louis River Natural Area designation) and the water-side (i.e., St. Louis River Restoration Initiative projects and the St. Louis River Area of Concern remediation and restoration work) achievements. This initiative will promote understanding of and comprehensive planning and restoration for bird conservation on an estuary-wide basis for the first time.

Over the next 10 years, our objective is to identify and optimize the range, distribution and quality of avian habitats for globally and regionally important bird guilds in the St. Louis River IBA. We will develop and implement restoration strategies adaptive to the area's long-term land ownership and management objectives, climate change effects and municipal development objectives. We will develop and implement an IBA Blueprint to protect and restore bird habitats throughout the IBA as well as to inform municipal and industrial development decision makers.

We are excited to announce this initiative, the implementation of which will require collaboration among a vast suite of partners in the estuary—St. Louis River-style! This presentation is intended to assist in fostering synergies and project collaborations.

Prioritizing Wetland Restoration for Marsh Birds Within the St. Louis River Estuary

Presenter: Stephanie Beilke, Audubon Great Lakes
Co-Authors: Joanna Grand, National Audubon Society; Sarah Saunders, National Audubon Society; Nat Miller, Audubon Great Lakes; Joanna Wu, National Audubon Society; Chad Wilsey, National Audubon Society; Nicole Michel, National Audubon Society; Brad Kasberg, Audubon Great Lakes

There is an urgent need to protect and restore remaining Great Lakes coastal wetlands for the wildlife and people that depend on freshwater resources and the diverse, high-quality habitats of our Great Lakes. In order to determine where to prioritize conservation actions along the Great Lakes, Audubon Great Lakes and Audubon's National Science Team developed a spatial prioritization that identified the most important U.S. Great Lakes coastal wetlands for 14 species of marsh birds representing high-quality, hemi-marsh habitat characterized by a mix of emergent vegetation and open water. Some of the most critical coastal wetlands we identified for marsh birds were located along the western coast of Lake Superior, including the St. Louis River Estuary. The St. Louis River Estuary is one of twelve priority areas that also experienced a history of environmental degradation and loss of wildlife communities. To ensure the estuary recovers and continues to provide habitat for wildlife, it is crucial to manage existing threats such as invasive species and build resiliency to future environmental threats due to climate change. In turn, targeted management actions will help restore marsh bird populations that are declining across the state and the region, such as American bittern, black tern and blue-winged teal. We propose to collaborate with conservation partners and invigorate collective interests in the St. Louis River Estuary region to strategically restore and enhance marsh habitat at high priority coastal wetlands such as Allouez Bay and Radio Tower Bay. As a partner, Audubon Great Lakes brings bird monitoring and scientific expertise, experienced leadership in wetland restoration projects, and our connections to local communities through the Audubon chapter network. We look forward to strengthening and growing our diverse partnerships with land managers, government agencies, universities, other non-profit organizations and community members that share our goal of restoring coastal wetlands for birds and people in the St. Louis River Estuary and beyond.

Great Lakes Piping Plover Recovery and the Significance of the St. Louis River Estuary

Presenter: Reena Bowman, U.S. Fish and Wildlife Service

Piping plovers once nested along the shoreline of all of the Great Lakes and were once considered locally common. The species has experienced significant declines over the past 100 years, partly due to increased human use of nesting habitat and shoreline development. When Great Lakes piping plovers were listed as endangered in 1986, only 17 pairs remained. In Minnesota and Wisconsin, no nesting piping plovers were documented from the mid-1980s through the late 1990s. As a result of protection and monitoring efforts by federal, state, university and local partners, the species has recently expanded to new sites in Wisconsin. Piping plovers have been nesting in lower Green Bay since 2016. In 2019, piping plovers nested in two new locations at the Apostle Islands National Lakeshore. Piping plovers historically nested in the St. Louis River Estuary. In recent years, they have been documented using the estuary as stopover habitat. However, with the newly created habitat at the Wisconsin Point Bird Sanctuary, piping plovers may once again nest in the estuary. This presentation will provide an overview of piping plovers, collaborative recovery efforts and the significance of the St. Louis River Estuary.

How Foraging Behavior Influences Methylmercury Exposure to Common Terns (*Sterna hirundo*) Breeding in the St. Louis River Estuary

Presenter: Annie Bracey, University of Minnesota Duluth, Natural Resources Research Institute
Co-Authors: Joel Hoffman, U.S. EPA; Matthew Etterson, U.S. EPA; Fred Strand, WDNR (retired); Sumner Matteson, WDNR; Gerald Niemi, NRRI; Francesca Cuthbert, UMN

The population of common terns (*Sterna hirundo*) breeding in interior lakes of North America is declining. This includes the Great Lakes region, where significant decreases in the number of nesting pairs and colony sites has occurred over the past several decades. There are currently only two longtime active nesting colonies on Lake Superior: Interstate Island in the Duluth-Superior Harbor and Ashland Island in Chequamegon Bay, Ashland, WI. Common terns often nest in highly urbanized coastal environments where ongoing habitat loss and fragmentation, increased human population density and pollution contribute to ecosystem degradation. The Great Lakes region is widely contaminated with mercury, and fish-eating birds, including common terns, are known to be at greatest risk of exposure to mercury, which has been linked to reduced reproductive success, behavioral changes and motor skill impairment. To determine if mercury exposure is a potential threat to these Lake Superior breeding colonies, we quantified within and among seasonal differences in total mercury (THg) concentrations in blood and feather tissues of adults and chicks and documented spatial and temporal variation in exposure risk using geospatial tracking devices and stable isotopes. THg concentrations were lowest in winter-grown feathers, highest in chick feathers and increased with an estuarine-based diet. Our results suggest that adults can effectively eliminate mercury during annual molts and egg production and that adult foraging behavior may mitigate adult exposure on the breeding grounds. Chick feather concentrations at Interstate Island often exceeded 5 μg/g, a threshold associated with toxicological risk, suggesting Hg exposure may be an important stressor for chicks, even if effects are sub-lethal, and underscores the importance of local contamination with respect to exposure and risk. Long-term monitoring of this species in the St. Louis River Estuary will be important to determine exposure risk post-restoration and AOC delisting.

Restoring Wild Rice in Allouez Bay

Presenter: Amy Eliot and Kelly Beaster, UWS Lake Superior Research Institute

Local anecdotal accounts indicated that wild rice was once present in the shallow, protected embayment located at the southeast end of the St. Louis River Estuary, known as Allouez Bay. Allouez Bay is included in the Wisconsin Ceded Territory's Manoomin Inventory as a date-regulated harvest water, which suggests that wild rice was once abundant enough for harvesting. It was assumed, however, that wild rice had been extirpated from Allouez Bay until a Northland College study found remnant beds in 2009.

With restoration funding and technical assistance from the Great Lakes Indian Fish and Wildlife Commission, the UWS Lake Superior Research Institute (LSRI) began exploring the possibility of restoring wild rice to Allouez Bay in 2010. It conducted a small pilot study using plots seeded with green wild rice. The results indicated that wild rice seeded into Allouez Bay would reach maturity, although it was likely that herbivory would be a limiting factor.

From 2015 to 2017, LSRI worked with tribal, federal, state, and local partners, on an effort to restore 25 acres of wild rice in Allouez Bay. Seventy-six wire exclosures were installed and 4250 pounds of green rice was seeded over 3 years. Browse of emergent vegetation outside of the exclosures was ubiquitous; however, wild rice grew to maturity both inside and outside of the protective fencing each year. Efforts to install seine nets across two inlets to protect wild rice from carp damage was later abandoned due to limited impact and issues with keeping the nets securely in place. In the third year of restoration, researchers observed that mature wild rice stalks growing in open water were not as robust as the few stems of rice growing in the emergent vegetative mat. At the same time, it was becoming apparent that rising water levels were limiting suitable wild rice seeding areas because water depths were exceeding 3 feet.

In 2018, LSRI and the St. Croix Chippewa Indians of Wisconsin implemented an experimental approach to wild rice restoration in Allouez Bay. The area targeted for seeding was concentrated to 10 acres and moved closer to the vegetative mat where water levels were below 3 feet. In addition, 41 distinct patches of invasive hybrid cattail (Typha x glauca) were cut out of the mat by hand and removed to provide open areas for seeding. Researchers speculated that the thick cattail mat growing between the separate patches might serve as a natural barrier to herbivory. They also speculated that if wild rice could out-compete perennial vegetation, the patches could ultimately be connected through further removal of cattail to create a large enough patch to withstand herbivory.

To enhance protection of seeded rice, 80 wire exclosures were installed. Seven were placed around the cut cattail patches. In fall of 2018 and 2019, wild Rice was seeded directly into the cattail patches as well as the shallow open water areas.

In fall of 2019, 73 of the open water exclosures were monitored for density. The average number of stalks per 0.5 m^2 quadrat was 4.7. Fifty-nine (80%) of the open water exclosures monitored had rice present either inside or outside of the quadrat.

The cut patches could not be assessed for density due to accessibility. Photo monitoring of 14 of the cut patches, however, clearly showed that wild rice was present in 11. Out of the 11, five were enclosed with fences and six were not. This suggests that habitat where cattail has invaded is suitable for wild rice if the cattail are removed. In addition, mature stalks were observed frequently growing in unseeded and uncut areas of the vegetative mat where hybrid cattail was absent and native plants–especially burreed–were more prevalent.

Browse was observed again in 2019 and wild rice within exclosures still exhibited greater density and growth rates compared with rice outside of exclosures. However, from limited data from 2017, we believe wild rice populations were higher than subsequent years, and browse did not harm the rice as much as it had in previous years.

Although it may be too early to predict success, researchers are optimistic that further cattail control and continued seeding efforts in Allouez Bay has the potential to support a large stand of wild rice that can endure moderate herbivory.

POSTER ABSTRACTS

Why Should Social Workers Care?

Presenter: Amber Arnoldy, College of St. Scholastica
Co-Authors: Jordan Bright, College of St. Scholastica; Samantha Arneson, College of St. Scholastica

Throughout the state of Minnesota, our waters play a pivotal role in the success and growth of recreation, industry and Minnesota pride; however, 40% of the lakes and rivers do not meet basic quality standards for bacteria or nutrient content (Sullivan, 2019). The St. Louis River Estuary is one of many rivers that does not meet quality standards for a healthy water source in the state. There has been extensive work conducted along the estuary that is helping to clean the water. What you may not be aware of is that social workers also play a role and care about water quality.

Water is a huge part of every human life. We use water to become replenished and for hygiene; it helps us to exercise, and is a vital resource in our day-to-day activities. When water is not properly cared for, it can become contaminated and, in turn, affect human life. "Water scarcity not only has a direct debilitating effect on health and a host of associated diseases; it also has an indirect, but significant bearing on the perceived well-being of individuals"(Narang, 2014). According to Dan Siegel and the Healthy Mind Platter, the mind encompasses connections with people, communities and the natural world. A healthy connection to all can enhance an individual's well-being.

This poster will examine and present to the reader the importance of clean water within the St. Louis River Estuary and how it affects individual wellbeing and in turn the community of Duluth. This poster will introduce Attachment Theory and its connection to the St. Louis Estuary and the Twin Ports community. Clean water affects all parts of human life through consumption, interaction and connection. Being aware of one's relationship with nature will not only assist individuals in improving this relationship, it will also help in maintaining the relationships individuals currently have.

Post-Restoration Assessment of Habitat And Aquatic Biota in a Lake Superior Estuary

Presenter: Risa Askerooth, Lake Superior Reserve
Co-Authors: Hannah Ramage, Lake Superior Reserve; Deanna Erickson, Lake Superior Reserve; Pat Farrell, University of Minnesota Duluth

The degradation of coastal wetlands in the Laurentian Great Lakes has made them the target of numerous restoration efforts, which require long-term monitoring to evaluate success. We assess the impact of restoration on biota in a sheltered bay within the St. Louis River Estuary. By removing 115,000 cubic yards of remnant wood waste, restoration efforts increased water depth and exposed native substrate. We ask how partial wood waste removal, four years ago, restored substrate for aquatic vegetation establishment and created viable habitat for two young-of-the-year sunfish species (*Lepomis macrochirus* and *L. gibbosus*) by using a non-degraded sheltered bay as a reference site. We find no significant difference between the two bays in plant species richness, weighted coefficient of conservatism (wC) score or water quality through a t-test or non-parametric equivalent. Additionally, a principal components analysis shows that remaining wood waste, as measured by organic matter content in sediment cores, is positively correlated with wC score, indicating no negative impact on vegetation. Lastly, fish length-weight relationships are similar between bays, although fish are slightly larger in our reference bay. Results indicate that restoration successfully reestablished aquatic vegetation, although more research is needed to determine the utilization of habitat by young-of-the-year fish.

An Analysis of Road-Stream Crossing Passibility in the Minnesota Lake Superior Basin

Presenter: Victoria Bockenstedt, Lake Superior Reserve and UMD Department of Geology and Philosophy
Co-Authors: Andrew Stevens, U.S. Fish and Wildlife Service

Aquatic connectivity is imperative to native brook trout (*Salvelinus fontinalis*) in the Lake Superior basin. Inadequate road-stream crossings can cause high water velocities, low water depths, leap barriers and unnatural stream grades that may prevent passage by brook trout and other native fishes. These barriers can impede access to temperature refugia, spawning grounds and productive feeding habitats critical for the life history of brook trout. We surveyed 211 road-stream crossings located in 20 priority sub-watersheds along Minnesota's North Shore, using a rapid assessment inventory protocol. We identified 33 problematic culverts which likely present passability barriers based on peer-reviewed performance thresholds for swimming and leaping by adult and juvenile brook trout. Further collection of updated salmonid community and stream temperature data will help rank and prioritize these 33 problematic crossings for funding to replace culverts. Collectively, these inventory data and a ranked project list will help guide efforts to restore aquatic connectivity by local agencies and the U.S. Fish and Wildlife Service's National Fish Passage Program.

Measuring a St. Louis River Estuary in Recovery

Presenter: Dan Breneman, MPCA

Physical, chemical and biological indicators of environmental health are being measured throughout the St. Louis River Estuary in order to document conditions, track progress, and eventually remove beneficial use impairments. Quantifying pre- and post-construction environmental health helps establish project goals and documents progress towards reaching "reference" targets. When complete, aquatic field sampling alone will have compiled thousands of observations describing sediment characteristics, community dynamics and bioaccumulative risk, to name a few. Besides striving to maintain productive riparian habitats and robust aquatic populations, overall AOC Program success will ultimately be influenced by realizing advances in human well-being. By developing multiple lines of evidence to describe revitalization of a resource, progress towards delisting the St. Louis River as an AOC will be based on environmental recovery, as well as those connections to economic and social prosperity.

Adsorption of Diuron and BPA on Photodegraded Polymers

Presenter: Raven Buckman, University of Minnesota Duluth
Co-Authors: Ries Trenary, Faith Murphy, Dr. Melissa, Maurer-Jones

Every year, 380 million tons of plastics are produced around the world with upwards of 32% ending up in the natural environment. Once in the environment, these plastics are exposed to various environmental stressors and begin to weather or chemically transform. These plastics, including microplastics, can act as a substrate for small molecule organic pollutants to adsorb to, which may ultimately be ingested by fish or be suspended in water bodies that are used for drinking water. The aim of our research is to quantify the adsorption of diuron and bisphenol A (BPA) on the surface of photodegraded polyethylene (PE) and polyethylene terephthalate (PET) that have been weathered with UV light. The polymers were photolyzed with 254 nm UV light for 24, 48 and 72 hours and placed in aqueous solutions with differing concentrations of either diuron or BPA.The adsorption was characterized by employing liquid chromatography (UPLC) to monitor the change in the solution concentration of the pollutant, and distribution coefficients were determined using a Langmuir isotherm. Our data suggest that the distribution coefficient for diuron on PE was highest for the 24-hour irradiation then decreased for the 48-hour irradiation and 72-hour irradiation. For diuron on PET, the distribution coefficient was highest for the non-irradiated PE then decreased until the 48-hour irradiation then increased again for the 72-hour irradiation as hypothesized. For BPA the distribution coefficient was greatest for the non-irradiated PE and PET then decreased for the irradiated PE and PET. These changes to distribution coefficient can be attributable to changes in the polymer materials properties. Through this work, we can better understand the implications for plastic waste in our environment.

Sulfate Reduction by Chemical Precipitation for Wild Rice Waters

Presenter: Meijun Cai, UMD NRRI
Co-Authors: Shashi Rao, UMD NRRI; Lucinda Johnson, UMD NRRI; Adrian Hanson, Civil Engineering Department, UMD; George Hudak; Chan Lan Chun; Jerry Henneck; Beth Bernhardt; Tobin Deen; Matt Santo; Sara Post

Historically, the St. Louis River Estuary was one of the perfect places having the richest concentrations of wild rice in northern Minnesota. However, rice area was significantly reduced over the past 125 years due to industrial development, pollution and logging. Sulfate is one of the pollutants that could affect the growth and viability of wild rice at high levels. The Minnesota Pollution Control Agency (MPCA) has established a restrictive standard for sulfate of 10 mg/L in wild rice waters. This poses a significant challenge for wastewater treatment facilities, small businesses, mining and paper industries. Existing technologies (e.g., reverse osmosis and ultrafiltration) can achieve this standard but are expensive and generate significant waste products. We are using chemical precipitation technology for removing sulfate cost-effectively while also reducing the need for significant waste handling.

Sulfate removal via barite precipitation has recently gained attention, as sulfates readily precipitate with barium salts as insoluble barium sulfate. We are testing chemical precipitation processes for treating municipal wastewater. However, it is not clear whether this application can be used effectively because this waste is dilute relative to other industrial waters. Through batch experiments and a bench-scale continuous flow laboratory study, we demonstrated that it is practical to use barium chloride to precipitate sulfate (barite method) to levels below 10 mg/L. The successful lab test is leading to an upscale pilot system—a trailer-based demonstration system. This system will be implemented in two wastewater treatment plants for two seasons. We envision this cost-effective solution will be available within the next few years to address Minnesota's unique wild rice standard.

Spatial Variability of Mercury in the St. Louis River Watershed Across Four Landscape Types

Presenter: Hope Calogero, Fond du Lac Tribal & Community College
Co-Authors: Edward Defoe, Fond du Lac Tribal & Community College; Stephanie Keinanen, Fond du Lac Tribal & Community College; Emily Lockling, Fond du Lac Tribal & Community College; Cade Kowalczak, Fond du Lac Tribal & Community College; Courtney Kowalczak, Fond du Lac Tribal & Community College; Andrew Wold, Fond du Lac Tribal & Community College; Marissa Castro, University of Minnesota Duluth; Nathan Johnson, University of Minnesota Duluth

Mercury (Hg) is an element found naturally in ecosystems that is converted to its highly toxic form, methylmercury (MeHg), leading to adverse health effects in humans. Methylmercury's ability to bioaccumulate causes game fish to have higher concentrations of mercury and can prompt consumption advisories. This is particularly important for the Indigenous community because fish are a large component of the traditional diet. In conjunction with Tribal Resource Managers, efforts are being made to understand how mercury cycles through different landscape types, especially those found within reservation boundaries. Our study investigates the spatial variability of mercury in the St. Louis River watershed, located in Northeast Minnesota, through four distinct landscape types: ditched peatland, forest, wetlands, and reservoirs. We hypothesize that there are no notable differences in MeHg concentrations in dragonfly larvae (odonates) throughout these different landscapes. We evaluate THg and MeHg in surface water and odonate tissue. Additionally, we evaluate other geochemical parameters that can influence the production and transport of mercury. Preliminary analysis of the 2018 data suggests no notable relationship between surface water THg and odonate THg, or between surface water MeHg and odonate MeHg. Odonates in ditched peatland had almost double the MeHg concentrations and had the highest variability of all landscape types; however, there is no apparent difference in average odonate MeHg concentration across all landscape types. Our finding that odonate Hg is not directly related to surface water Hg is surprising considering that other studies in the region have suggested higher Hg in water does translate to higher Hg in biota. Our results suggest that DOC is correlated with THg in surface water, but that MeHg in surface water is variable. MeHg concentrations in odonates were relatively constant across a range of surface water MeHg. This suggests variation in bioaccumulation among the sites, a pattern that has been related to DOC in prior studies. For our continued research we will also look at differences of Hg concentrations between odonate families to determine variability between the families.

Environmental Education: The Role of Nature-Based Learning in Today's School System

Presenter: Melissa Clark, College of St. Scholastica
Co-Authors: Amanda Glunz, Shana Crouse

The benefits of nature are profound, and evidence continues to suggest that exposure to the outdoors can benefit the body and mind greatly and that people who feel connected to nature and their environment are much more likely to preserve it and take care of it. As education requirements continue to become more demanding, behavior in our youth continues to become more aggressive. Nature-based learning allows children the opportunity to know their physical world firsthand and experience the joy and wonder within it. According to Richard Louve, "Time in nature is not leisure time; it's an essential investment in our children's health" (Louv, 2008). By exploring alternatives to standard education, we have the opportunity to provide our next generation with the necessary tools to create a more sustainable future and overall wellbeing.

Our poster presentation will explore the role of environmental education in the school setting along with the benefits of student behavior and the creation of environmental stewards through experiential learning.

Determination of Fecal Contamination in the Skunk Creek Watershed

Presenter: Lisa DeGuire, University of Minnesota Duluth
Co-Authors: Chan Lan Chun, University of Minnesota - Duluth; Randall Hicks, University of Minnesota - Duluth; Derrick Passe, Lake County Soil and Water Conservation District; Emily Nelson

Fecal contamination of waterways and beaches continues to be a widespread and pervasive problem along the south shore of Lake Superior. Several streams are listed as "impaired" for the fecal indicator *Escherichia coli*, and recreational advisories for Lake Superior beaches due to elevated levels of *E. coli* are an issue of concern for both residents and tourists alike. This project aims to differentiate between sources of fecal contamination within the Skunk Creek watershed using culture-independent microbial source-tracking methods and to explore the relationships between elevated levels of *E. coli* and the ancillary water quality parameters along a watershed gradient. Water samples were collected from eight sites along the impaired waterways during base flow and storm events. Water chemistry, namely major ion compositions and the levels of *E. coli*, were measured along with physicochemical water quality parameters. Potential fecal sources were determined using quantitative polymerase chain reactions with human (HB and Lachno3) and avian biomarkers (GFD). Our results identify hotspots and potential sources of fecal contamination: greater levels of human biomarkers at downstream sites and increased levels of the avian biomarker, iron concentrations, water temperature and turbidity in upstream sites. Additionally, levels of *E. coli* were correlated with stormwater events, while human fecal sources appear to be site-specific and independent from storm events. The findings are essential in developing mitigation and management strategies to *E. coli* impairments and applicable to other Duluth streams experiencing similar stressors.

Bench-Scale and Molecular Analysis Approaches to Evaluate the Risks of Pathogen Introductions Into the St. Louis River Estuary

Presenter: Lisa DeGuire, University of Minnesota Duluth
Co-Authors: Julia Zimmer, University of Minnesota - Duluth; Randall Hicks, University of Minnesota - Duluth; Matt TenEyck, Lake Superior Research Institute; Chan Lan Chun; Christine Polkinghorne; Heidi Saillard; Kelsey Prihoda

Ballast water has been identified as a major vector for the spread of invasive species, and the Duluth-Superior Harbor (DSH) receives the most ballast discharge of any Great Lakes port. While most of the attention surrounding invasive species has concerned larger organisms like animals and plants, microbial communities have been largely overlooked. Two approaches were used to investigate microbial communities in treated ballast water and the receiving waters of the DSH and lower St. Louis River Estuary (SLRE). The use of indicator bacteria in ballast management practices was explored in a bench-scale experiment using two common treatment techniques (ultraviolet light and chlorination) on spiked and ambient water samples collected from the DSH. Culture-based quantification, qPCR analysis and direct prokaryotic counts were performed on day-of-treatment samples, as well as samples five days after treatment to check for bacterial regrowth. Both treatment techniques showed 99% reductions in culturable indicator bacteria in all samples immediately following treatment, though results also indicated that regrowth of *E. coli*, total coliforms, and heterotrophic bacteria occurred in the spiked samples after five days in field and lab incubations. Initial qPCR results indicated that chlorination was the more immediately effective disinfectant treatment. Ongoing work analyzing 16S rRNA gene sequences will help determine if the post-treatment fate of other potentially harmful bacteria is similar to indicator bacteria. A quantitative molecular analysis approach was used to determine if DNA from *Piscirickettsia salmonis* (pathogen responsible for muskie pox) was present in different regions of the SLRE—primarily in highly visited shipping docks. Surface water and sediment samples were taken throughout the estuary in summer 2019, including four dock areas and several estuary locations known for their abundant muskellunge presence. Overall, this research will help evaluate some of the risks and treatment options for potentially harmful bacteria in ship ballast water discharge.

Environmental Education Professional Development for Teachers: A Study of the Impact and Influence of Mentoring

Presenter: Deanna Erickson, Lake Superior Reserve
Co-Author: Dr. Julie Ernst, University of Minnesota Duluth Environmental Education program

Rivers2Lake helps teachers learn to provide watershed educational experiences for students through a summer institute followed by mentoring. Teacher focus groups were conducted to investigate the impact of mentoring, as well as toward understanding what was influential in bringing about those impacts. Mentoring impacted teachers in affective ways and helped them use what they learned at the institute. The influential nature of the mentoring may be due to the mentors providing a sense of accountability and personalized support, as well as encouragement of reflection and assistance with navigating barriers. Teachers also articulated qualities of effective mentors: invested, flexible and responsive. With teachers varying in the degree to which they felt they could continue R2L implementation without the support of mentors, implications are discussed.

Trail Camera Animal Population Study in Pearl Street Woods

Presenter: Jess Gagne, Grade 4 Churchill Elementary School

A fourth grade class from Churchill Elementary School is studying a forest near the St. Louis River in Cloquet, MN. They named the forest the "Pearl St. Forest." They wanted to know about the population of the animals in this forest. The students started studying the forest in fall 2019. They wanted to study animals like foxes, squirrels, skunks, deer and many more, especially predators like wolves and bobcats. They wanted to know if there are more animals present in the center or edge of the woods. They used four trail cameras. They placed two cameras in the center and two cameras near the edge of the woods. They discovered that there are more animals in the center than at the edge. They found a fox den and detected fox and skunk near the den.

Habitat Use by Lake Sturgeon (*Acipenser fulvescens*) Using Acoustics and Stable Isotopes

Presenter: Morgann Gordon, ORAU/EPA National Student Services Contractor
Co-Authors: Kayden Estep, Idaho Department of Fish and Game; Dan Wilfond, Minnesota Department of Natural Resources; Justin VanDeHey, University of Wisconsin-Steven's Point; Joel Hoffman, U.S. EPA

Lake Sturgeon are a long-lived, migratory fish species native to the Great Lakes region that were extirpated from the St. Louis River during the early 1900s. Beginning in the 1980s, Minnesota and Wisconsin DNRs initiated intensive restocking efforts in the lower river. Despite these intensive efforts, there has only been limited evidence for successful natural reproduction. Understanding habitat use by lake sturgeon is an important step to address the potential environmental factors, including legacy contaminants, that are potentially limiting the recovery of lake sturgeon in the lower St. Louis River. Therefore, our goal was to use both physical (acoustic tags) and chemical (carbon and nitrogen stable isotopes) tags to characterize habitat use and movements of lake sturgeon. Both types of tags revealed strong variations among individuals in habitat use, including some fish exhibiting near exclusive use of Lake Superior, harbor, and riverine habitats, as well as other fish using different combinations of these three habitats. Notably, we did not find a significant correlation between habitat use as characterized by either method, suggesting that the fish readily switch habitats, or that feeding areas and residency areas are independent and distinct, or some combination of both. Further decoupling of these tracking methods will aid resource managers in determining how restoration of the St. Louis River will affect the population and contribute to recovery.

Restoring Superior's Pickle Pond; Providing Diverse Fish and Wildlife Habitat

Presenter: Joseph Graham, Wisconsin Department of Natural Resources
Co-Author: Dara Fillmore, Wisconsin Department of Natural Resources

This poster will provide an update on the Pickle Pond Restoration under the Great Lakes Restoration Initiative, a project being pursued as part of the broader effort to address beneficial use impairments in the St. Louis River Area of Concern. The Pickle Pond is an approximately nine-acre enclosed area of water located along the shoreline of Superior, Wisconsin. This pond feature was created when a rail embankment was built along the St. Louis River in the late 19th century, cutting off a portion of Superior Bay.

Over time stormwater runoff, polluted sediments, invasive species and limited water connection to the St. Louis River have resulted in degraded habitat in the Pond. The Pond is an important and unique sheltered shallow-water habitat in an otherwise highly developed shoreline.

The Pond is adjacent to Barker's Island, which is a recreation, tourism and education staple for the City of Superior. Project design is focused on improving habitat for fish (especially muskie and northern pike spawning habitat) and wildlife, cleanup of contaminated sediment and providing recreational benefits to the community.

Status of Contaminated Sediment Sites in the Wisconsin Portion of the St. Louis River Area of Concern

Presenter: Joseph Graham, Wisconsin Department of Natural Resources

This poster will provide a broad-level overview of the status of efforts to identify and clean up contaminated sediment sites in the Wisconsin portion of the St. Louis Area of Concern (AOC). Contaminated sediments at these sites contribute to one or more beneficial use impairments including fish consumption advisories, restrictions on dredging activities, degraded benthic communities, body contact restrictions and loss of fish and wildlife habitat. Actions need to be taken at these sites to address sediment contamination in order to remove designated restrictions on beneficial uses and ultimately delist the AOC.

Creating a Database to Determine AOC Project Effectiveness and Community Benefits in the Great Lakes

Presenter: Sophia Green, U.S. EPA
Co-Authors: Joel Hoffman, U.S. EPA, GLETD; Theodore Angradi, U.S. EPA, GLETD; Thomas Hollenhorst, U.S. EPA, GLETD; Jonathan Launspach, U.S. EPA, GLETD

Over time, the Great Lakes Restoration Initiative (GLRI) federal agencies and their state, tribal, local and private partners have sought to remediate, restore, and delist Areas of Concern (AOCs)—areas designated as the most contaminated sites on the Great Lakes under the 1987 Great Lakes Water Quality Agreement. Cleanup of AOCs is achieved through management actions such as remediation and restoration work, which then leads to removing beneficial use impairments. Remediation to Restoration to Revitalization (R2R2R) is a framework to identify ecological and policy-based relationships between sediment remediation projects, habitat restoration projects, and community revitalization. To examine R2R2R across Great Lakes AOCs, we need to understand the ecological effect of the program, as well as the community response. But owing to the nature of AOC sediment remediation and habitat restoration projects, which typically include many partners and stakeholders and are varied with respect to size, goals and data availability, the effectiveness of remediation and restoration efforts is challenging to assess. Moreover, while it is broadly recognized that these projects are contributing to community revitalization, the varied nature of the projects and data presents a challenge to measure the impact. Therefore, to establish a common foundation to characterize both project effectiveness and community impact, we are in the process of establishing a database aimed at developing and validating metrics for sediment remediation, habitat restoration and community revitalization effectiveness. The database will include, at a minimum, the linework and metadata for U.S. AOCs; all past, ongoing and planned remediation and restoration projects; and various other polygons related to the social, health and economic benefits of remediation and restoration. The St. Louis River Area of Concern has been considered as the model case study for this project because the AOC includes some of the first projects with remedy, restoration and revitalization data. This is a collaborative and inclusive effort seeking community and stakeholder input on data types and data sources.

Piping Plover Habitat Creation at the Wisconsin Point Bird Sanctuary

Presenter: Cherie Hagen, Wisconsin Department of Natural Resources

Fourteen acres of critical habitat have been created for the endangered piping plover on Wisconsin Point. Avian experts have collaborated with WDNR, U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers to complete this habitat project as part of the St. Louis River Area of Concern. Project methods and habitat requirements were designed specifically to attract piping plover to nest at this site. Details will be shared on the design features, methods, dredge material use, monitoring and habitat maintenance.

St. Louis River Estuary as Possible *Dreissena veliger* Source to Western Lake Superior

Presenter: Chelsea Hatzenbuhler, Contractor supporting U.S. EPA
Co-Authors: Jon Barge, Contractor supporting U.S. EPA; Anne Cotter, U.S. EPA; Joel Hoffman, U.S. EPA; Christy Meredith, Postdoc supporting U.S. EPA; Greg Peterson, U.S. EPA; Sara Okum, Contractor supporting U.S. EPA; Erik Pilgrim, U.S. EPA; Barry Wiechman, Contractor supporting U.S. EPA; Anett Trebitz, U.S. EPA

Dreissena mussels have been established in the St. Louis River Estuary (SLRE) since 1989 and are readily transported via ballast water and boat hull attachment. Their lack of establishment in Lake Superior proper was thought to be due to inhospitable physiochemical conditions, but that notion has been challenged by recent Dreissena finds in the Apostle Islands (APIS) region. Motivated by National Park Service concerns surrounding these finds, the U.S. EPA in 2017 conducted an intensive sampling campaign of APIS waters (100 sites, multiple sampling gear) aimed at understanding dreissenid prevalence and distribution. This survey did not find any new settled Dreissena, but did find low densities of planktonic veligers in almost half the zooplankton samples. Since these veliger finds were primarily on the western side of APIS and the SLRE (about 100 km further west) is the only substantial Dreissena population in the region, we wondered whether these veligers were spawned within APIS or transported there from the SLRE by long-shore currents. We followed up in 2019 with a study designed to assess this possibility by examining changes in veliger numbers and size as well as general zooplankton composition along the SLRE to APIS gradient. This effort consisted of eight locations, each sampled three times two weeks apart with plankton tows, mesh colonization banners and environmental DNA samples. This poster will summarize findings from the 2017 effort and present preliminary results from the 2019 effort.

Modeling PCB Residues in Fish Tissue Based on Sediment PCB Concentration

Presenter: Joel Hoffman, U.S. EPA Office of Research and Development
Co-Authors: Lawrence Burkhard, U.S. EPA Office of Research and Development; Greg Peterson, U.S. EPA Office of Research and Development; Tom Hollenhorst, U.S. EPA Office of Research and Development; Anne Cotter; Jon Launspach

In the St. Louis River Area of Concern, an important natural resource management goal is to reduce or eliminate fish consumption advisories by remediating contaminant sediments and restoring aquatic habitat. One of the two contaminants of concern is polychlorinated biphenyls (PCBs), which are distributed heterogeneously in sediments throughout the lower St. Louis River. Owing to this heterogenous distribution, it is recognized that PCB concentrations in fish tissue vary widely, presumably due to differences in both habitat use and life history. Therefore, to understand the potential impact of remediation and restoration on fish tissue concentrations, we developed a habitat-specific, geospatial Biota-Sediment Accumulation Factor (BSAF) model that predicts fish tissue residues based on sediment PCB concentrations and habitat quality. We conducted a field validation of the model based on a random, stratified sampling and found the model had a high degree of accuracy for predicting fish tissue residues. We then developed a high-resolution (10 m) version of the model using a Monte Carlo-style approach to support decision-making for the Munger Landing remediation. We conclude this approach has strong potential to be used for PCB hot-spot confirmation, estimating remediation project footprints, and to estimate a project's potential impact to improve the quality of the fishery.

EPA's EnviroAtlas: Providing GeoSpatial Data and Easy-to-Use Tools to Better Understand Ecosystem Services, Environmental Stressors and Impacts on Human Health

Presenter: Tom Hollenhorst, EPA Office of Research and Development
Co-Authors: David Bolgrien, EPA Office of Research and Development, Great Lakes Toxicology and Ecology Division; Jonathon Launspach, EPA Office of Research and Development, Great Lakes Toxicology and Ecology Division; Sophia Green

EPA's EnviroAtlas provides a wealth of U.S. geospatial data and easy-to-use tools to help scientists, natural resource managers, health professionals and the public better understand the relationships between ecosystem services, environmental stressors and human health. Here we will focus on how the EnviroAtlas can help Great Lakes Area of Concern (AOC) communities better understand their project areas, nearby communities and the challenges they face as they work to delist the associated beneficial use impairments in their areas. EnviroAtlas presents data for two primary extents: national and community. The national component of EnviroAtlas summarizes data for the 48 mainland U.S. states by 12-digit hydrologic codes (HUCs) or at a 30 m pixel resolution (i.e., one data point for every 30 square meters on the ground). The community component of EnviroAtlas summarizes data by census block group or at a 1 m pixel resolution, providing high resolution data that can be compared across selected communities. The EnviroAtlas Interactive Map incorporates demographic and supplemental data to better understand the context of ecosystem services within specific populations, environmental conditions or geographic areas. Supplemental data layers include ecological, watershed and political boundaries; conservation areas; EPA-assessed and impaired waters and other available national datasets. Community data include 1-meter land cover data (i.e., one data point for every one square meter on the ground). The data are organized into 20 topic areas and further linked to seven ecosystem service benefit categories. Topic areas include engagement with the outdoors, near-road environments, pollutant reduction, and health and economic outcomes. Using U.S. Census Bureau data and spatial boundaries, the community component data layers help address the distribution of ecosystem services to specific sectors of the population allowing users to see potential disparities, prioritize future projects and address unmet needs. The EnviroAtlas also includes an interactive Eco-Health Relationship Browser that helps the user explore the linkages between ecosystems, the services they provide and their impact on human health and wellbeing. The browser is based on over 700 journal articles and includes links to the supporting literature.

Inputs to Lake Superior from the St. Louis River Estuary: Results from a 3-D Hydrodynamic Model of the Estuary

Presenter: Richard Kiesling, USGS Hydrologist
Co-Authors: Erik Smith, USGS; Paul Reneau, USGS

Discharge from the St. Louis River Estuary (SLRE) to Lake Superior is affected by inflows from multiple tributaries and water exchanges with Lake Superior through two connecting ship entries. Five index-velocity stream gauges were installed in 2015 to continuously monitor water levels, flows and velocity profiles in the SLRE. Water-budget calculations for 2016–2018 indicate significant contributions from the St. Louis, Nemadji and Pokegama Rivers as well as from smaller tributaries. Large inflow events produced brief synchronous discharge peaks out of the two connecting channels into Lake Superior, but synchronous outflows were frequently followed by a complex mixture of inflows through Duluth Entry and outflows through the Superior Entry. As a result, approximately 70% of SLRE net discharge flows through the Superior Entry. Total 2016 and 2017 discharge and heat flux to Lake Superior were simulated using an Environmental Fluid Dynamics Code (EFDC) model. Simulations of total daily discharge from the SLRE during the 2016 calibration year had a Nash-Sutcliffe (N-S) coefficient of 0.80, with N-S coefficients for the Duluth and Superior entries of 0.41 and 0.57, respectively. Hourly simulations of Duluth Entry temperature for 2016 had a N-S of 0.71. The model has been validated against 2017 data and used to support restoration projects in the SLRE.

The St. Louis River Estuary as Migratory Stopover Habitat for a Rapidly Declining Songbird

Presenter: Steve Kolbe, University of Minnesota Duluth, Natural Resources Research Institute
Co-Author: Alexis Grinde, Natural Resources Research Institute - UMD

Rusty blackbirds (*Euphagus carolinus*) are experiencing one of the most rapid population declines of any North American bird. This species is strongly tied to forested wetlands where they feed on insects and seeds found on the ground. Wetland-forest edges in the St. Louis River Estuary provide prime migratory stopover habitat; significant concentrations of this species utilize the estuary during spring and fall while migrating between their boreal forest breeding grounds and bottomland forest wintering grounds. Surveys completed in 2018 and 2019 with support from the Great Lakes Restoration Initiative, the City of Duluth, and the Minnesota Ornithologists' Union documented hotspots that are heavily used by this species, times of day these areas are used and date ranges the species is present in the estuary. Since migratory periods are some of the most vulnerable times of the annual cycle, the St. Louis River Estuary likely holds extreme importance for this declining songbird.

Relationship Is Mutual: Exploring the Role of the Child in the Natural Environment

Presenter: Emilie Kuenzel, The College of St. Scholastica
Co-Authors: Tonya Jo Rein, The College of St. Scholastica; Hylan McLaughlin, The College of St. Scholastica

With the advent and present ubiquity of the World Wide Web and the endemic popularity of video gaming, youth in America and the world have arguably lost the majority of valuable contact and connection with nature. Ask most children what is a rose, an estuary, or the difference between a toad and a frog, and they will happily Google an answer. What do our children know about the world and how do they understand it? The negative effects and disconnect between ourselves, and more importantly, our children and the natural environment are well documented, as shown in the book *Transforming Community: Stories of Connection Through the Lens of Relational-Cultural Theory* (2018). What is less clear is how to most effectively and efficiently "reconnect" to create meaningful and mutually beneficial relationships that restore the "natural balance" needed between humanity and nature.

This poster is based upon the tenets of Relational-Cultural Theory, some Indigenous thinking, and the writings in Richard Louv's book *The Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder* (2008). The presenters explore the disconnect between youth and the environment and how reconnection with the natural world in mutually beneficial relationships heals children in the present and creates the knowledge and skills within youth to respect and properly care for the natural world as they mature into responsible, compassionate adults. The presenters explore the present-day connection, or disconnection, of youth to nature in order to create avenues for reconnection. This will create channels for healthier children now and more knowledgeable, lively humans and a flourishing environment in the future.

The wellbeing of humans and the natural world rely heavily on the collaboration of people to protect and restore the environment. Community relationships including the Duluth River Rovers are appreciated, and our hope is their actions continue to inspire mutual healing. This presentation offers a conceptual framework to discuss the importance and benefits of the relationship between humans and nature. Through teaching youth about mutuality, protecting and respecting the natural environment, they will grow up to be adults who understand the world around them and commit to its restoration.

Minnesota Contaminated Sediment Remediation Progress in the St. Louis River Area of Concern

Presenter: LaRae Lehto, MPCA

The St. Louis River Estuary is the second largest of 43 locations throughout the Great Lakes that were designated Areas of Concern by the International Joint Commission, requiring cleanup of contaminated sediments. Due to decades of uncontrolled pollution before modern pollution laws went into effect, riverbed sediments are contaminated with mercury, dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals. These pollutants have settled out in sediments at the bottom of the St. Louis River Estuary and continue to threaten public health, contaminate fish and wildlife and make waterfronts unusable in Duluth and other coastal communities along Lake Superior. The availability of federal funds has accelerated cleanup efforts and is helping communities fulfill the promise of economic revitalization, increase property values and improve quality of life.

Minnesota's cleanup plan is now underway, thanks to years of collaborative work by dozens of partner organizations from local, state, tribal, and federal units of government, nongovernmental groups, businesses, research institutions and community groups. The plan outlines the work needed to restore the water quality and natural resources of the St. Louis River Estuary by 2025.

Minnesota has secured partnerships with the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers to provide technical, planning, engineering and financial assistance in implementing this plan. The cooperating partners are coordinated to accelerate Minnesota's remediation work. To date, three contaminated slips have been remediated with engineered caps, while the remaining seven sites are in remedy selection or remedy design phases. Learn about the progress being made on management and cleanup of contaminated sediments on the Minnesota side of the St. Louis River.

Microplastic and PAH Pollution in the St. Louis River Estuary

Presenter: Daniela Leon, UW-Superior
Co-Author: Dr. Lorena Rios Mendoza, UW-Superior

On April 26, 2018 the explosion of the Husky Superior Refinery occurred. Incomplete combustion reactions, which result in production of toxic compounds such as polycyclic aromatic hydrocarbons (PAHs), were left after this event. Research was developed based on the identification and quantification of PAH contaminants adsorbed on natural and synthetic debris. Samples were collected at four different points in Newton Creek (NC) and St. Louis River Estuary (SLRE). The project was divided into three major steps. The first one was an assessment of microplastic (MPs) pollution in NC and SLRE. The second step was the separation and identification of synthetic debris based on their spectral signatures, which was obtained using Fourier Transform Infrared Spectrometer with Attenued Total Refractance (FTIR-ATR). The third step involved the extraction and concentration of PAH compounds. The last step involved the identification and quantification of PAHs found in each of the natural and synthetic debris. Results showed that MPs were found in NC and SLRE, and 75% of the total samples contained plastic in either fiber or fragment form. However, fibers were the most common type of MPs detected. Cotton and polyester were found in the same percentage range in both locations.

Let the Birds Guide You: How Bird Use Can Inform Land Management in the St. Louis River Estuary

Presenter: Alexis Liljenquist, UMD NRRI
Co-Authors: Alexis Grinde, UMD NRRI; Annie Bracey, UMD NRRI

The St. Louis River Estuary (SLRE) is the largest and most biologically productive wetland and aquatic complex in western Lake Superior, and it supports a high level of bird diversity during both migration and the breeding season. The ecological integrity and habitat quality of the SLRE has been impacted by historical and current threats including habitat loss, increased sedimentation, development, invasive species and contaminant exposure from industrial activity. We used a long-term data set on breeding and migrating bird communities, along with local vegetation characteristics and land classification data to characterize habitat availability and identify priorities for restoration. Our results show that the SLRE supports a wide variety of species throughout the year. A total of 134 species were documented during spring migration: 120 species during the breeding season, and 130 species during fall migration. Management recommendations include restoration efforts that promote the long-term maintenance of hemi-marsh conditions (ratio of open water to emergent vegetation), planting of native perennial vegetation to provide food and cover for a variety of bird species and using islands to increase mudflat availability for migrating shorebirds. These results should be used to inform site-level restoration activities and to guide current and future landscape-scale restoration efforts in the SLRE.

Using the R3 Paradigm to Understand Decision-Making in the Beneficial Use of Dredged Material Projects

Presenter: Keahna Margeson, Oak Ridge Associated Universities
Co-Authors: Kathleen Williams, U.S. EPA; Joel Hoffman, U.S. EPA

Remediation to Restoration to Revitalization (R3 or R2R2R) is a paradigm used by the EPA to describe the process of environmental cleanup and community revitalization. In Duluth and other Great Lakes Areas of Concern (AOC), applying the R2R2R paradigm to specific projects can enhance our understanding of the ways those projects extend beyond remediation to sustainable revitalization. This presentation employs the R3 framework to identify the decision contexts and criteria to be considered for beneficial reuse of dredged material in and near the St. Louis River AOC. Specifically, we use R3 as an ideal management framework to identify the series of actions contributing to restoration processes, focusing on each process as a part of an interconnected system. Beneficial reuse of dredged materials can be an integral part of these processes, as traditionally relied upon Confined Disposal Facilities are near capacity and the State of Ohio banned open water placement beginning this year. The result is increasing pressure on states and the United States Army Corps of Engineers to identify beneficial reuses of the clean sediment with minimal guidance and decision-support based on previous reuse cases. To address this information gap, we reviewed existing reports and documents throughout project planning and implementation. We also worked with stakeholders to identify and inventory current and past uses of beneficial use and identify authorities that generate and could benefit from dredged materials. After identifying representative examples involving biological and social components, we completed a comparative case study of the Duluth-Winnipeg-Pacific Railroad Roundhouse, 40th Avenue West and Atlas Cement remediation projects. This project is ongoing, and we are currently working to translate the study results into a database of beneficial use projects and a decision-support tool to assist and inform stakeholders and decision makers considering reusing dredged material in projects. These outcomes can be used to inform future local decision-making through maximization of positive social and environmental outcomes.

Our Healing Connection: Growing with the Environment We Protect

Presenter: Ina Newton, St. Scholastica MSW program
Co-Authors: Alisha Smith, St. Scholastica MSW program; Shelby Chmielecki, St. Scholastica MSW program

As humans, we are part of a collective ecosystem, and we all need to play a role in honoring and protecting our environment. Social workers have a unique lens of viewing the intersections between human well-being and the environment. There is growing research that supports how nature heals. Direct and indirect exposure to nature contributes to our emotional and physical well-being. The University of Minnesota published findings that state: "Being in nature, or even viewing scenes of nature, reduces anger, fear, and stress and increases pleasant feelings" (University of Minnesota, 2016).

The St. Louis River Estuary plays a pivotal role in providing often unknown or ignored support to our Twin Ports community. Humans pose a great risk to aiding in the destruction of the water quality, which impacts not only the human residents but the species that rely on it. As social workers, it is our responsibility to provide psychoeducation on the healing powers of our local natural surroundings so others can become stewards in the efforts to protect it.

This poster will provide information on the growing research of environmental impacts on mental health. The presenters will also define cultural beliefs, traditional gatherings and personal experiences that support the need for healing through nature and water.

System-Wide Monitoring Program (SWMP) 2019 Annual St. Louis River Report: Water Quality Trends in the Estuary

Presenter: Hannah Ramage, Lake Superior Reserve
Co-Author: Anna Hall, Lake Superior Reserve

The Lake Superior Reserve's System-Wide Monitoring Program (SWMP) measures short-term variability and long-term changes in water quality on the St. Louis River Estuary. Since 2013, the program has collected seven parameters (temperature, conductivity, salinity, dissolved oxygen, pH, turbidity, and depth), at four sites, every 15 minutes. This dataset now amounts to over 3.5 million singular water quality measures. We compared 2019 data to this long-term dataset to assess trends over time and document specific water quality phenomena. In May through August 2019, estuary temperatures were generally cooler than the long-term average. Three sites in the main stem river channel were 0.6 to 1.3°C below the long-term average. In contrast, the Pokegama River, a tributary to the St. Louis River, experienced temperatures 0.7°C above average. The Pokegama River also experienced 126 total hours of hypoxia (dissolved oxygen <3.0 mg/L) in July and August. Additionally, we report several small storm events and their associated turbidity and conductivity spikes, although 2019 had fewer large rain events than previous years. SWMP will continue to monitor estuary water quality over time to assess if these relatively short-term observations are attributable to any long-term trends in estuary water quality.

Hot off the Press: North Shore Homeowner's Guide to Managing Stormwater

Presenter: Tiffany Sprague, MN Sea Grant
Co-Authors: Jesse Schomberg, MN Sea Grant; Marie Thoms, MN Sea Grant

Predictions of increased precipitation across Minnesota got you down? Wishing you could better manage your property's stormwater but not sure where to start? Has Google left you confused? Look no further! Minnesota Sea Grant recently released the North Shore Homeowner's Guide to Managing Stormwater, helping you on the journey to better manage your stormwater with northern climate-approved green infrastructure practices. We know a resilient region is one in which communities, businesses and individuals have the capacity to survive, adapt and grow in response to stress and change. We also know green infrastructure is one tool to help us strengthen resilience to climate challenges such as predicted increases in the severity and frequency of storms. And, we know it is discouraging to look at hundreds of Google images for green infrastructure practices built in moderate climates and seemingly impractical for our cold and snowy region. This book is an action-oriented guide to green stormwater infrastructure, highlighting practical and manageable projects the Minnesota homeowner or business can do to slow and reduce runoff from their property. General costs covered? Check. Degree of maintenance included? Check. Background to help educate that neighbor? Of course. Cute graphics? Have we ever. Ultimately, this guide provides the public with an awareness of the value of green stormwater infrastructure from the perspective of their own residence/business—an awareness Sea Grant is spreading in 2020 with outreach to North Shore communities regarding publication and use of this guidebook.

Barker's Island Beach Restoration: Reducing *E. coli* and Transforming a Public Space

Presenter: Matt Steiger, Wisconsin Department of Natural Resources
Co-Authors: Linda Cadotte, City of Superior; Heidi Saillard, UW-Superior LSRI

A collaborative project between the City of Superior and WDNR has transformed the Barker's Island Beach into a more usable swimming beach. This project used *E. coli* and DNA data to design features to reduce beach closures. UW-Superior Lake Superior Research Institute is working with the WDNR and city to evaluate the success of the project. Beach restoration features and year one monitoring results will be presented. Completion of this project contributes to the removal of the Beach Closings and Body Contact Restrictions Impairment in the St. Louis River Area of Concern.

Establishing a Relationship Between Riparian Wetlands and Mixing Regimes on Internal MeHg Loads in the St. Louis River Estuary

Presenter: Marissa Torrez Castro, UMD
Co-Authors: Nathan Johnson, UMD; Amber White, UW–Madison

The St. Louis River Estuary (SLRE) is a dynamic wetland with variable hydrologic and biogeochemical conditions across its 12,000-acre span. The St. Louis River is an important recreation and spawning area in the region; however, predator fish within the estuary have higher levels of methylmercury (MeHg) than those recorded in other parts of the watershed. Initial observations revealed that the highest levels of surface water MeHg occur in the far reaches of some of the attached embayments in the upper portion of the SLRE. In this region of the estuary, shallow, riparian habitats are more abundant and with it provide carbon-rich, anoxic conditions conducive to MeHg production. Currently, the influence of these nearshore riparian habitats, in comparison to upstream sources, is unknown; however, determining the fate of the pollutant to the greater system can aid in future management decisions. This study seeks to describe the net effect of MeHg inputs and surface water mixing to explain observed concentrations in surface water. Preliminary results suggest that areas of the SLRE with greater riparian area and higher residence times contain more MeHg in the surface water. Mixing in these nearshore areas is greatly influenced by the diffusion-like exchange induced by the seiche in Lake Superior, which can displace up to 20% of water each day. By utilizing water depth and vegetation as a proxy for net methylmercury production and conservative ions to distinguish mixing regimes in individual embayments, we can begin to understand the relative impact of these processes on exporting MeHg to the larger system. By using this framework on a variety of scales, we can understand internal MeHg production and its influence across the entire system and provide a basis for comparing internal loading to upstream loads.

Particle Tracking in Lake Superior Using FVCOM with Focus on Apostle Islands

Presenter: Grace Weber, UMD Large Lakes Observatory
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This study explores the movement of micro-plastics and other particles in far western Lake Superior. It was motivated by a desire to understand the transport and fate of particles originating near the region's population centers and their potential impact on the Apostle Islands National Lakeshore. Particle movements were determined using the Finite Volume Coastal Ocean Model (FVCOM) configuration developed by the Large Lakes Observatory at the University of Minnesota Duluth. FVCOM solves the Naiver-Stokes equations and uses realistic meteorology as forcing. When exploring vertically averaged monthly output for the years 2015 and 2018, particles (which could include microplastic particles or suspended sediments) were modeled as passive drifters and advected using model output during each month. The initial month-long runs showed that drifters originating in the St. Louis and Nemadji estuaries move predominantly towards the Apostle Islands. The drifter tracks suggest that if a micro-plastic or other neutrally buoyant particle is deposited inside of the estuary, assuming no large wind events, it will most likely end up in the Apostle Islands within 3 months, especially during the late summer months. The results of this analysis will help researchers to better understand the source, transport and fate of microplastics in Lake Superior.

Factors Impacting the Perception of Safety at Grassy Point

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Abstract: A growing body of literature supports that urban nature positively impacts health and wellbeing, yet underserved neighborhoods frequently exhibit a lack of equitable access to green space. The benefits one experiences in urban nature can be dependent on a person's preferences, impressions, and experiences of a natural space. Habitat restoration may improve the quality of the conditions, and thereby the experiences, within a green space. To understand how habitat restoration and neighborhood preferences are interconnected, we plan to study Grassy Point, a public green space that borders the St. Louis River and which lies adjacent to two underserved neighborhoods in Duluth, MN. A 2019 Health Impact Assessment (HIA) led by the Environmental Protection Agency (EPA) on the Kingsbury Bay-Grassy Point habitat restoration found that multiple factors impact the perception of safety at Grassy Point Park. Based on this input, we hypothesize that degraded environmental characteristics, property damage, and the lack of a planned physical connection to Grassy Point may be impacting the perception of safety. These conditions can prevent the site from being used for its intended purposes and may negatively impact perceived benefits to the users. This study will identify what features or conditions would make the neighborhood and recreational users of Grassy Point feel safe. Data collection will take place in the form of a literature review and two workshops. The first workshop will use participatory mapping to collect data and the second workshop will be used to share the results of our research with the participants and decision makers. Through our research, we hope to be able to provide information to the users and decision makers on creating a safer and more equitable green space to the underserved neighborhoods adjacent to Grassy Point.