Upper Midwest Environmental Sciences Center

October 2024 – April 2025 Activity and Publication Report

List of Projects

Biological Threats and Invasive Species

- Evaluation of a Carbon Dioxide Fish Barrier Through Numerical Modelling
- Silver Carp Experience Metabolic and Behavioral Changes when Exposed to Water from the Chicago Area Waterway
- Webpage: Invasive Carp Open Data Hub
- Spatial Variation of eDNA Detection Across an Invasion Gradient for Invasive Species Monitoring Programs

Conservation Ecology and Planning

- Rapid Butterfly Declines across the United States during the 21st Century
- Prioritizing Chemicals of Emerging Concern in the Great Lakes Basin using Covariance of Chemical Concentrations and Diverse Biological responses from a Variety of Species
- Macro- and Micronutrient effects on Phytoplankton in Green Bay, Lake Michigan and the Western Basin of Lake Erie
- Bacteriological Analysis of Unionid Hemolymph Collected from Freshwater Mussel Populations in the Pacific Northwestern United States
- Additional Common Milkweed Would Help Canada Meet its Share of the Trinational Eastern Migratory Monarch Butterfly Recovery Target
- Possible Influence of Water Level Management on Nutrient Flux in Nearshore Sediments of Kabetogama Lake, Minnesota, USA
- Effects of River Floods and Sedimentation on a Naturally Dynamic Great Lakes Estuary
- An Assessment of N, P, Fe, Zn, Ni and Mo Limitation on Suspended Nutrient Diffusing Substrates in Nearshore Areas of Lake Michigan and Lake Erie
- Sediment Nutrient Dynamics in Selected Milwaukee Metropolitan Area Streams, Wisconsin, 2022
- A Case for Assemblage-Level Conservation to Address the Biodiversity Crisis

Upper Mississippi River Restoration

- Spatial Differences in Predicted *Phalaris arundinacea* (Reed Canarygrass) Occurrence in Floodplain Forest Understories
- Identifying Recruitment Sources Across Trophic Levels in a Large River Food Web

Fish and Wildlife Health

- Identifying Strategies to Manage Boreal Forests: Simulating Moose and Timber Management Scenarios at a Landscape Scale in the Face of Changing Environmental Conditions
- Effect of Copper Mill Waste Material on Benthic Invertebrates and Zooplankton Diversity and Abundance

Other

- The MIEM Guidelines: Minimum Information for Reporting of Environmental Metabarcoding Data

Acronyms used throughout report

GLSC – Great Lakes Science Center

NOAA – National Oceanic and Atmospheric Administration

USGS – United States Geological Survey

USFWS – United States Fish and Wildlife Service

UMESC – Upper Midwest Environmental Sciences Center

UMID – Upper Midwest Water Science Center

Grasslands at the Upper Mississippi River Environmental Sciences Center La Crosse, Wisconsin. Photo: USGS

Biological Threats and Invasive Species

Evaluation of a Carbon Dioxide Fish Barrier Through Numerical Modeling

USGS scientists holding a tagged invasive bighead carp on the Mississippi River. Photo USGS

Aaron Cupp (UMESC) and Ryan Jackson (Central Midwest Water Science Center) partnered with United States Army Corps of Engineers to determine if carbon dioxide is an effective way to deter invasive species from migrating from the Mississippi River to the Great Lakes. Currently, electrical barriers are installed in the Chicago Sanitary Ship Canal to prevent the movement of invasive fish species. However, electrical barriers require regular maintenance and shutdown, creating an opportunity for invasive fish species to move up stream and into the Great Lakes. This study evaluated the feasibility of using a carbon dioxide infusion system to deter invasive fish movement during the maintenance of the electrical barrier. For more information contact Aaron Cupp (acupp@usgs.gov).

Politano, M., **Cupp, A.**, Smith, D., Schemmel, A., **Jackson, P. R.**, & Zuercher, J. (2024). Evaluation of a carbon dioxide fish barrier through numerical modelling. Meccanica. https://doi.org/10.1007/s11012-024-01865-4

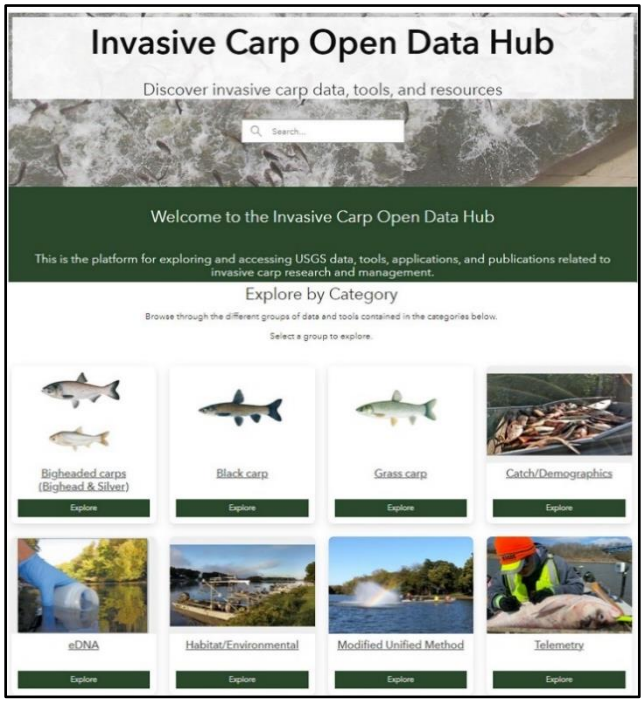
Silver Carp Experience Metabolic and Behavioral Changes when Exposed to Water from the Chicago Area Waterway

Aaron Cupp (UMESC) partnered with the University of Illinois and University of Texas Austin to determine if contaminants in the Chicago Area Waterway System influence the movement of Silver Carp (*Hypophthalmichthys molitrix*) upstream. Researchers collected water from the Chicago Area Waterway System and exposed Silver Carp and one native species to the collected water. Researchers looked at fish activity, behavior, avoidance, and metabolic rates to quantify the impact contaminated water has on invasive carp movements. For more information contact Aaron Cupp (acupp@usgs.gov).

USFWS electrofishing while silver carp jump from the water. Photo: USFWS

Schneider, A. E., Esbaugh, A. J., **Cupp, A. R.**, & Suski, C. D. (2024). Silver carp experience metabolic and behavioral changes when exposed to water from the Chicago Area Waterway. Scientific Reports, 14(1), 24689. https://doi.org/10.1038/s41598-024-71442-y

Webpage: Invasive Carp Open Data Hub



Invasive Carp Open Data Hub Homepage. Photo: USGS

UMESC scientists have published the Invasive Carp Open Data Hub creating an easy-to-use repository for USGS invasive carp research. Users can filter searches by species, catch, eDNA, habitat, methods, data type and location including Great Lakes, Illinois River, Mississippi River and the Southeast Sub-basin. Users can also learn about some of the USGS project that are preventing the spread up the Mississippi River and other tributaries. For more information contact Jamie Schoen (jschoen@usgs.gov).

Webpage can be accessed by clicking the link here, or use the QR code below

Spatial Variation of eDNA Detection Across an Invasion Gradient for Invasive Species Monitoring Programs

Stephen Spear (UMESC) and Richie Erickson (UMESC) partnered with USFWS, and South Dakota State University, to examine environmental DNA (eDNA) gradients for bighead carp and silver carp in the Illinois River Basin. Using data from an eDNA-based survey conducted in 2015, researchers examined changes in detections across the invasion gradient. The authors found spatial and temporal patterns in detection rates and these findings affect the design of eDNA-based monitoring programs. Associated data and code for the project are also available. For more information contact Stephen Spear (sfspear@usgs.gov).

USGS scientist holding an invasive silver carp. Photo: USGS

Peterman, L., Tuttle-Lau, M., DeHaan, P. W., Coulter, D. P., **Spear, S. F.**, & **Erickson, R. A.** (2024). Spatial Variation of eDNA Detection Across an Invasion Gradient for Invasive Species Monitoring Programs. Journal of Fish and Wildlife Management, 15(2), 350–360. https://doi.org/10.3996/JFWM-23-038

Rapid Butterfly Declines across the United States during the 21st Century

Eastern tiger swallowtail perched on a thistle flower. Photo: USGS

Wayne Thogmartin (UMESC) and Jay Diffendorfer (Geosciences and Environmental Change Science Center) partnered with the USFWS and state agencies as well as many university and professional societies to research the population trends of many butterfly species across the United States. Researchers determined overall and species-specific trends using 12.6 million individual butterflies from >76,000 surveys across 35 monitoring programs. Between the years 2000 and 2020, total butterfly abundance declined by 22% across the 554 species in this study. For more information contact Wayne Thogmartin (wthogmartin@usgs.gov).

Edwards, C. B., Zipkin, E. F., Henry, E. H., Haddad, N. M., Forister, M. L., Burls, K. J., Campbell, S. P., Crone, E. E., Diffendorfer, J., …, **Thogmartin, W.**, Schultz, C. B. (2025). Rapid butterfly declines across the United States during the 21st century. Science, 387(6738), 1090–1094. https://doi.org/10.1126/science.adp4671

Prioritizing Chemicals of Emerging Concern in the Great Lakes Basin using Covariance of Chemical Concentrations and Diverse Biological responses from a Variety of Species

Christine Custer (UMESC), Luke Loken (UMID), and Steven Corsi (UMID) partnered the Environmental Protection Agency, NOAA, and USFWS and universities to address one of Great Lakes Restoration Initiative's research goals by furthering the understanding of contaminants of emerging concern. To address this, researchers monitored 784 contaminants in fathead minnows, tree swallows and golden clams in the Maumee River, OH from 2016 to 2017. Researchers used the collected data to determine if there were patterns in chemical-bioeffect relations across the dataset that indicated high or low hazards to aquatic and terrestrial life. This research helped highlight contaminants with little or no traditional toxicity test data allowing researchers to use limited resources on those chemicals. For more information contact Christine Custer (ccuster@usgs.gov).

Tree swallow studied by USGS scientists. Photo: USGS

Vitense, K., **Loken, L. C.**, Maloney, E. M., Blackwell, B. R., Collette, T. W., **Corsi, S. R.**, **Custer, C. M.**, Davenport, E. D., Kohno, S., & Hummel, S. L. (2025). Prioritizing chemicals of emerging concern in the Great Lakes Basin using covariance of chemical concentrations and diverse biological responses from a variety of species. Environmental Toxicology and Chemistry, 44(3), 764–776. https://doi.org/10.1093/etojnl/vgae094

Macro- and Micronutrient effects on Phytoplankton in Green Bay, Lake Michigan and the Western Basin of Lake Erie

Satellite image of Lake Erie during an active harmful algae bloom (bright green). Photo: European Space Agency downloaded from the NOAA website

James Larson (UMESC) and Sean Bailey (UMESC) partnered with Kent State University to address how phytoplankton communities respond to macro and micronutrients. Researchers collected water from active harmful algae bloom sites and non-blooming sites. The samples were divided out into groups and spiked with different forms of phosphorus and/or nitrogen and incubated. Nitrogen enhanced samples saw an increase in the toxin creating algae, *Microcystis aeruginosa*. The overarching results suggest that controlling harmful algae blooms by limiting phosphorus run off may not be as effective as we originally thought. For more information contact James Larson (jhlarson@usgs.gov).

Stoll, J. T., **Larson, J. H.**, **Bailey, S. W.**, Blackwood, C. B., & Costello, D. M. (2024). Macro- and micronutrient effects on phytoplankton in Green Bay, Lake Michigan, and the western basin of Lake Erie. Journal of Phycology, 60(6), 1514–1527. https://doi.org/10.1111/jpy.13519

Bacteriological Analysis of Unionid Hemolymph Collected from Freshwater Mussel Populations in the Pacific Northwestern United States

Diane Waller (UMESC) and Susan Knowles (National Wildlife Health Center) partnered with the USFWS and universities to examine known mussel mortality events in Washington and Oregon. Mussels from healthy and unhealthy populations were sampled and analyzed to determine the bacteria present within these populations. Within the unhealthy populations the bacteria *Acinetobacter* spp. was found within 82% of dying mussels. Elevating the need for future work to understand pathogenic impacts on freshwater mussel populations. For more information contact Diane Waller (dwaller@usgs.gov).

Native snuffbox mussel on the river bottom. Photo: USFWS

Leis, E. M., Dziki, S., Blevins, E., **Waller, D. L.**, Richard, J. C., **Knowles, S.**, & Goldberg, T. L. (2024). Bacteriological analysis of unionid hemolymph collected from freshwater mussel populations in the Pacific northwestern United States. Invertebrate Biology, 143(4), e12441. https://doi.org/10.1111/ivb.12441

Additional Common Milkweed Would Help Canada Meet its Share of the Trinational Eastern Migratory Monarch Butterfly Recovery Target

Monarch butterfly on Milkweed. Photo: USFWS

Wayne Thogmartin (UMESC) and colleagues partnered to research the role common milkweed (*Asclepias syriaca*) in Canada has in the declining population of eastern migratory monarch butterfly (*Danaus plexippus*). The average eastern monarch butterfly requires ~29 stems of common milkweed to grow to an adult. Researchers estimated the number of common milkweed plants and eastern monarch butterflies. Overall, Canada's common milkweed population needs to increase by 61% to support a recovering eastern monarch butterfly population. For more information contact Wayne Thogmartin (wthogmartin@usgs.gov).

Mitchell, G. W., Kirby, P., Duffe, J., Fahrig, L., Girard, J., Johnston, M. K., Larrivée, M., Martin, A. E., Momeni-Dehaghi, I., Pasher, J., Rezek, E., Shapiro, E. D., **Thogmartin, W. E.**, & Pouliot, D. (2025). Additional common milkweed would help Canada meet its share of the trinational eastern migratory monarch butterfly recovery target. FACETS, 10, 1–14. https://doi.org/10.1139/facets-2024-0063

Possible Influence of Water Level Management on Nutrient Flux in Nearshore Sediments of Kabetogama Lake, Minnesota, USA

James Larson (UMESC) Sean Bailey (UMESC) Victoria Christenson (UMID) and Erin Stelzer (Ohio-Kentucky-Indiana Water Science Center) partnered with the National Park Service and University of Georgia to examine the impact water level management has on harmful algae blooms in Voyagers National Park. When near shore sediment is periodically exposed and re-inundated, alterations to the flux of nutrients from sediment to water column can occur. Sediment was collected at multiple sites and incubated to examine the phosphorus and nitrogen levels. Models produced using the collected data determined recent water level management regimes within Voyagers National Park reduced organic nitrogen (9% - 13%) and phosphorus (5.9% - 9.8%). For more information contact James Larson (jhlarson@usgs.gov).

Dead fish floating in a lake near a harmful algal bloom. Photo: USGS

Larson, J. H., **Bailey, S. W.**, Maki, R. P., **Christensen, V. G.**, **Stelzer, E. A.**, Smith, J. C., LeDuc, J. F., & McWhorter, S. (2025). Possible influence of water level management on nutrient flux in nearshore sediments of Kabetogama Lake, Minnesota, USA. Ecosphere, 16(2), e70176. https://doi.org/10.1002/ecs2.70176

Effects of River Floods and Sedimentation on a Naturally Dynamic Great Lakes Estuary

Flooding on a Lake Superior tributary in 2016. Photo: Bureau of Indian Affairs

USGS scientists (UMESC and UMID) partnered to study the impacts of inundation and sedimentation of streams flowing into the Great Lakes. In 2016, a major flood caused total inundation of the 46-km^2 Bad River estuary. The frequency of severe flooding like this one has increased in the last decade causing more shoreline erosion. This research predicts intense flooding events will increase in the coming years, heavily impacting the inundation and sedimentation of streams in the Great Lakes Region. For more information contact Angus Vaughan (aavaughan@usgs.gov).

Fitzpatrick, F. A., **Vaughan, A.**, **Dantoin, E. D.**, **Sterner, S. P.**, **Reneau, P. C.**, & **Roland, C. J.** (2025). Effects of river floods and sedimentation on a naturally dynamic Great Lakes estuary. Journal of Great Lakes Research, 51(1), 102458. https://doi.org/10.1016/j.jglr.2024.102458

An Assessment of N, P, Fe, Zn, Ni and Mo Limitation on Suspended Nutrient Diffusing Substrates in Nearshore Areas of Lake Michigan and Lake Erie

James Larson (UMESC), Sean Bailey (UMESC), and Mary Anne Evans (GLSC) partnered with Kent State University to study how important heavy metals are to harmful algae bloom toxin production. Some metals, such as nickel, molybdenum, zinc, and iron, can prevent the uptake of limiting nutrients (nitrogen and phosphorus) in offshore waters that are isolated from stream inputs and sediment. Researchers collected water from sites both inside and outside active harmful algal blooms and diffused metals into the samples. Two of the harmful algae bloom sites, one in Green Bay and one in Sandusky Bay, showed co-limitations to various metal. For more information contact James Larson (jhlarson@usgs.gov).

Active harmful algae bloom on Lake Erie. Photo: USGS

Larson, J. H., Costello, D. M., Stoll, J. T., Fitzgibbon, A. S., **Bailey, S. W.**, & **Evans, M. A.** (2024). An assessment of N, P, Fe, Zn, Ni and Mo limitation on suspended nutrient diffusing substrates in nearshore areas of Lake Michigan and Lake Erie. Journal of Freshwater Ecology, 39(1), 2405748. https://doi.org/10.1080/02705060.2024.2405748

Sediment Nutrient Dynamics in Selected Milwaukee Metropolitan Area Streams, Wisconsin, 2022

Cement lined river in Milwaukee, Wisconsin. Photo: USGS

USGS researchers (UMESC, UMID, WSC) published a USGS scientific investigations report about streambed sediment nutrient dynamics in 32 streams in the Milwaukee Metropolitan area. In their report, they assessed the potential for nitrogen removal, phosphorus storage, or nutrient release in streambed sediments. Their study, which was funded by the Milwaukee Metropolitan Sewerage District, provides managers information about the potential for streambed sediment to either impair (nutrient source) or improve (nutrient sink) water quality at stream sites across the Milwaukee area. For more information contact Rebecca Kreiling (rkreiling@usgs.gov).

Kreiling, R.M., **Bartsch, L.A.**, **Gierke, K.J.**, **Perner, P.M.**, **Fitzpatrick, F.A.**, and **Olds, H.T.** (2025). Sediment nutrient dynamics in selected Milwaukee metropolitan area streams, Wisconsin, 2022: U.S. Geological Survey Scientific Investigations Report 2025–5012, 34 p., https://doi.org/10.3133/sir20255012.

A Case for Assemblage-Level Conservation to Address the Biodiversity Crisis

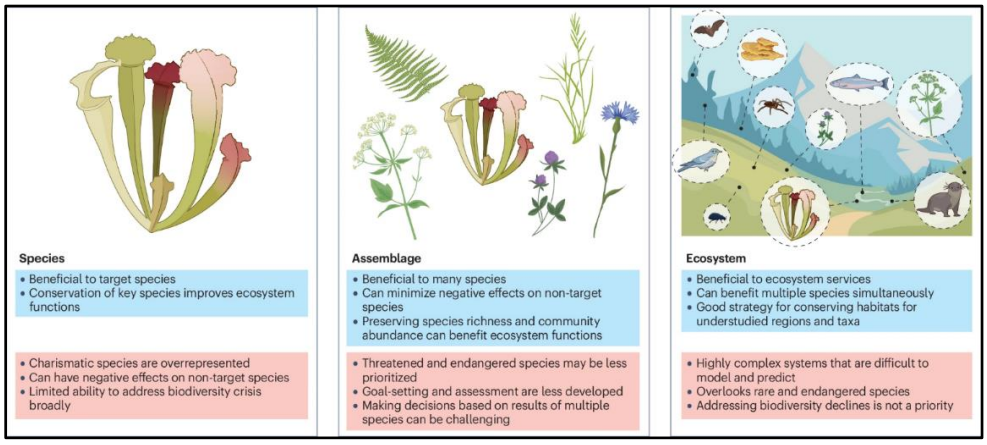


Figure from the article showing the three different conservation methods including single-species, assemblage-level, and ecosystem-level. Figure: USGS

Wayne Thogmartin (UMESC), Toni Lynn Morelli (Northeast Climate Adaptation Science Center), academic colleagues, USFWS, and Bat Conservation International make the case for assemblage-level conservation as a means for bridging species- and ecosystem-level conservation concerns. Management efforts focused on the assemblage level might be able to deliver conservation gains that are not possible at higher and lower levels of ecological organization. For more information contact Wayne Thogmartin (wthogmartin@usgs.gov).

Belitz, M. W., Campbell, C. J., Drum, R. G., Leuenberger, W., **Morelli, T. L.**, Nail, K., Shirey, V., **Thogmartin, W.**, & Zipkin, E. F. (2025). A case for assemblage-level conservation to address the biodiversity crisis. Nature Reviews Biodiversity, 1(2), 134–143. https://doi.org/10.1038/s44358-024-00014-9

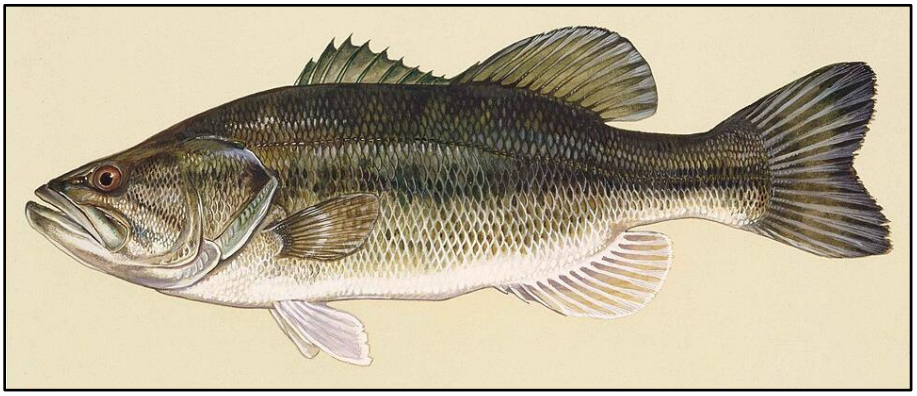
Spatial Differences in Predicted Phalaris arundinacea (Reed Canarygrass) Occurrence in Floodplain Forest Understories

Invasive reed canarygrass in the Mississippi River floodplain. Photo: USGS

USGS UMESC scientists published an article in Ecosphere that outlines the methods and results of a reed canarygrass habitat suitability model for Upper Mississippi River floodplains from Navigation Pools 3-13. The reed canarygrass habitat suitability pixel map generated in this study can be used to better understand the extent of invasion, prioritize restoration efforts, and develop further research. For more information contact John Delaney (jdelaney@usgs.gov).

Delaney, J. T., **Van Appledorn, M.**, **De Jager, N. R.**, **Bouska, K. L.**, & **Rohweder, J. J.** (2024). Spatial differences in predicted Phalaris arundinacea (reed canarygrass) occurrence in floodplain forest understories. Ecosphere, 15(12), e70138. https://doi.org/10.1002/ecs2.70138

Identifying Recruitment Sources Across Trophic Levels in a Large River Food Web



One of the species studied, largemouth bass. Rendition: USFWS

Kristen Bouska (UMESC) partnered with Ohio State University and Southern Illinois University-Carbondale to determine the role river tributary connectivity plays in recruitment (reproduction) across multiple trophic levels. Researchers used trace element analysis, allowing researchers to identify small qualities of elements in a sample of fish stomach content and otoliths (fish ear bones) collected from Pool 4, 8, and 13 of the Mississippi River. Researchers highlighted that the tributaries connected to the mainstem of the river contributed both predator and prey recruits to the mainstem. For more information contact Kristen Bouska (kbouska@usgs.gov).

Valentine, S. A., **Bouska, K. L.**, & Whitledge, G. W. (2025). Identifying Recruitment Sources Across Trophic Levels in a Large River Food Web. Ecology and Evolution, 15(4), e71208. https://doi.org/10.1002/ece3.71208

Fish and Wildlife Health

Identifying Strategies to Manage Boreal Forests: Simulating Moose and Timber Management Scenarios at a Landscape Scale in the Face of Changing Environmental Conditions

Bull moose at Isle Royale National Park. Photo: USGS

Nathan De Jager (UMESC) partnered with university scientists to support management decision making for moose (*Alces alces*) populations and forest habitat. Forest regeneration is sensitive to the browsing pressure that is cause by large ungulate species (e.g., moose). To understand the impacts of increases or decreases to the browsing pressure, researchers simulated 18 different combinations of moose harvest rates and forest management to determine which strategy would provide the best outcomes over time. For more information contact Nathan De Jager (ndejager@usgs.gov).

De Jager, N. R., Neumann, W., Girona, M. M., Hjältén, J., & Hof, A. R. (2025). Identifying strategies to manage boreal forests: Simulating moose and timber management scenarios at a landscape scale in the face of changing environmental conditions. European Journal of Forest Research. https://doi.org/10.1007/s10342-025-01775-4

Effect of Copper Mill Waste Material on Benthic Invertebrates and Zooplankton Diversity and Abundance

USGS researchers (UMESC, GLSC, UMID, and CERC) worked to determine the impact of stamp sands on larval fish communities in Lake Superior. The stamp sands contain copper, a toxic heavy metal, that move up the food web via aquatic insects and plankton. Researchers collected sediment, aquatic insects, and plankton from areas of high, moderate, and low concentrations of stamp sands as well as stamp sand free sites. Researchers found that as copper concentrations increased, there is a decreased in aquatic insect density and diversity. For more information contact James Larson (jhlarson@usgs.gov).

Dark-colored, course-grained stamp sands under a microscope. Photo: USGS

Larson, J. H., **Lowe, M. R.**, **Bailey, S. W.**, **Bell, A. H.**, & **Cleveland, D. M.** (2025). Effect of copper mill waste material on benthic invertebrates and zooplankton diversity and abundance. PLOS ONE, 20(3), e0318980. https://doi.org/10.1371/journal.pone.0318980

Other

The MIEM Guidelines: Minimum Information for Reporting of Environmental Metabarcoding Data

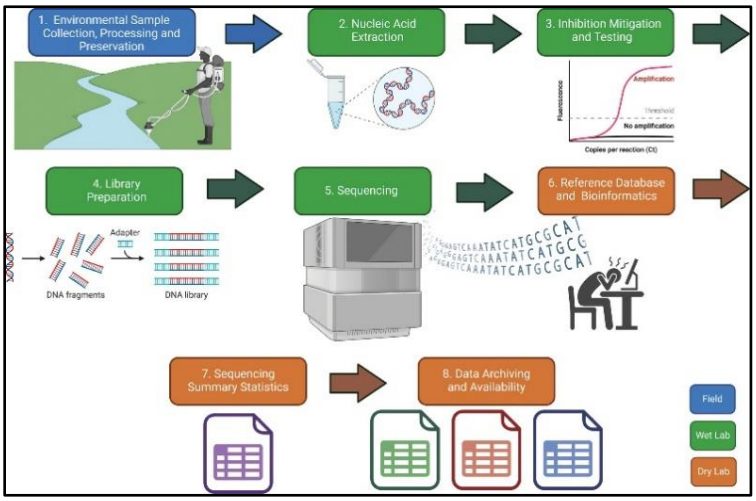


Diagram of an environmental metabarcoding study workflow, including the field (blue), wet laboratory (green) and dry laboratory (orange) components. Figure: USGS

USGS scientists including Yer Lor (UMESC), Christopher Merkes (UMESC), Stephen Spear (UMESC) Katy Klymus (CERC), Margaret Hunter (WARC), Devin Jones (NOROCK), and Adam Sepulveda (NOROCK) partnered with other government agencies and universities to produce a standard minimum reporting guideline for environmental DNA and RNA coding. Environmental DNA and RNA metabarcoding (running one analysis to identify many species) has become a popular tool to determine if invasive, rare or illusive species are inhabiting an ecosystem. These methods allow for standardized workflows and reporting for metabarcoding research allowing for efficient uptake of information to make essential management decisions. For more information contact Stephen Spear (sfspear@usgs.gov).

Klymus, K. E., Baker, J. D., Abbott, C. L., Brown, R. J., Craine, J. M., Gold, Z., **Hunter, M. E.**, Johnson, M. D., **Jones, D. N.**, Jungbluth, M. J., Jungbluth, S. P., **Lor, Y.**, Maloy, A. P., **Merkes, C. M.**, Noble, R., Patin, N. V., **Sepulveda, A. J.**, **Spear, S. F.**, Steele, J. A., … Theroux, S. (2024). The MIEM guidelines: Minimum information for reporting of environmental metabarcoding data. Metabarcoding and Metagenomics, 8, e128689. https://doi.org/10.3897/mbmg.8.128689