Oral Presentations

*Student Presentations

Influence of Environmental Characteristics on *Procambarus clarkii* Burrowing in Southeast Michigan Waterbodies*

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Procambarus clarkii are the world's most widespread invasive crayfish species. First found in Michigan in 2017, *P. clarkii* are of high concern due to potential damage to human infrastructure caused by excessive burrowing, specifically waterbody bank erosion and an overall decrease in bank stability. Infrastructure most affected by burrowing includes earthen dams and wetland drainage systems. To assess these concerns our research aims to determine if soil and environmental characteristics of pond banks are correlated with *P. clarkii* burrow density. Whereas negative effects of *P. clarkii* burrowing center on the density of burrows, pond bank characteristics (such as soil type and slope) that influence burrow density in Michigan are unknown. I will measure soil characteristics and potentially influential environmental variables including bank slope, shading, and bank vegetation throughout the summer 2024 field season in invaded ponds. Burrow density will be calculated based on surveys conducted during the 2022-2023 field seasons and grouped by soil classification. Soil coring will be conducted to determine particle size and physical properties, which will be used to classify soils throughout invaded ponds. Burrow density will be compared to soil and environmental characteristics to quantify any relationships between and among variables using general linear models. Variable coefficients will be determined through a bootstrapping approach, where a portion of the ponds are used to generate coefficients. These will then be tested against the remainder to evaluate relationship robustness for estimating burrowing density in unsampled ponds. Results of this study will assist in developing prophylactic management strategies by identifying characteristics of areas subject to intense burrowing.

Retention of Passive Integrated Transponder Tags in Age-0 Lake Sturgeon

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Passive integrated transponder (PIT) tagging is a popular method used in fisheries mark-recapture studies to estimate population demographics, fish movement, and assess stocking programs. Studies suggest implanted tags have high retention rates and minimal effects on large-bodied fish, while larger tags in small-bodied fish may result in negative side effects (e.g., slower growth, high mortality after tagging) and tag loss. Since tag retention is dependent upon tag size and tag location, there is a need for species and size specific retention studies to understand tagging limitations and its implications to mark-recapture data. To determine if tag size influences retention, growth, and survival in age-0 Lake Sturgeon, we implanted three size classes (75-125mm - small, 125-175mm - mid, 175-200mm - large) with 8- and 12-mm PIT tags, with half the fish from each treatment group receiving VetBond at the tag insertion point. Fish were monitored daily for tag loss in a controlled hatchery environment for 84 days post-tagging. Tag loss decreased as fish size increased and was greatest in the 12mm VetBond treatment group. Tag loss in the 12mm VetBond treatment group was 4.2, 18.8, and 38.5 times higher than 12mm, 8mm VetBond, and 8mm treatment groups respectively. Differences in tag loss was not statistically significant across the other treatment groups. Tag loss was greatest within two to three weeks post-tagging, but fish continued to lose tags up to 63 days post-tagging. Our results indicate tag retention

increases as fish size increases and the addition of VetBond does not further improve tag retention. To maximize retention for mark-recapture estimates and stocking programs, holding fish up to 20 days post-tagging will help account for the highest percentage of expected tag loss and accommodate for tag replacements before fish are stocked.

Proactive Programs, how DNR Natural Rivers helps conserve critical aquatic habitat

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Government agencies are often perceived to be reactionary rather than proactive. Limitations in staffing, large workloads, and incredible responsibilities largely limit the ability to successfully manage or develop new programs for conservation. However, some programs are designed to prevent problems from happening in the first place, like the Natural Rivers Program. The Natural Rivers Program overlays a zoning district over the 16 designated natural rivers across the state. Natural Rivers is Part 305 of the Natural Resources and Environmental Protection Act (NREPA) and is designed to limit development in order to preserve and enhance a natural river's values such as: water conservation, its free-flowing condition, fish, wildlife, boating, scenic, aesthetic, floodplain, ecologic, historic, and recreational values and uses. Most projects (i.e., building a home, digging a septic, etc.), including those on private land, within the 400-foot Natural Rivers District requires a permit from the Department of Natural Resources (DNR) Natural Rivers Program (NRP). Depending on how much the project varies from Natural Rivers zoning standards, the project may require a variance and approval from the river's Zoning Review Board. The program also provides a protected-vegetative buffer (ranging from 25-75 feet), where live trees and vegetation that cannot be removed, to any newly developed space post-designation. A Natural River has not been designated since the early 2000s, however, DNR is currently scoping it's potential 17th Natural River which will be discussed during this presentation.

Evaluating the Performance of Random Forest Models Using a Simulation Test*

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Random forest modeling is a machine learning technique known for its ability to handle large amounts of data, its robustness to correlation among predictor variables, and its ability to determine variable importance. Random forest models have become popular in fisheries science, especially for determining variables that drive variation in recruitment, population size, and other processes or states. Despite this method's popularity, the "black box" nature of random forests can limit interpretation of model outputs. Additionally, random forest models can require a substantial amount of data to make accurate predictions. We conducted a simulation test to assess a random forest model's ability to accurately analyze the study system and produce reliable variable importance outputs. We simulated lognormal fish recruitment data based on walleye (*Sander vitreus*) recruitment in the western basin of Lake Erie (1978-2021), as well as three climate variables of known effect size. These climate variables represented total annual degree-days, spring warming rate, and maximum annual ice coverage. We fit random forest models to recruitment and climate data of time series lengths spanning 1–200 years, as well as with

different amounts of variance in recruitment. The model's variable importance outputs were then compared to the relationships and effect sizes of the variables used in the simulation, determining how the model performed under each circumstance. The random forest model showed promise in its ability to detect strong influences on recruitment; however, weak influences required a large amount of data (>100 years) to be properly recognized. Our results highlight both uses and limitations for random forest models and suggest that they may be useful tools for evaluating the effects of climate change on fish recruitment in data rich systems like Lake Erie walleye.

Disentangling impacts of climate change on body size across species in freshwater fish communities

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One global response to climate change across taxa is shrinking body size. Several existing hypotheses contribute to our understanding of climate-driven changes in body size: Bergmann's Rule – body size is inversely related to temperature (directly related to latitude), Temperature-Size Rule – at higher temperatures ectotherms will have higher juvenile growth rates, but small overall bodies, and metabolic theory that posits metabolic rates scale with mass and increase exponentially as temperatures rise. However, empirical support for climate-induced shrinkage is mixed with some species growing larger under warming temperatures, and underlying mechanisms are under debate. To address these inconsistencies, we used boosted regression trees (BRTs) to model mean length-at-age for different age classes of 14 freshwater fish species over 75 years (1945-2020) to disentangle impacts of climate change from other environmental factors. BRTs revealed that climate (degree days, water surface temperature), lake area and volume, and latitude were important predictors of age-at-length. Unsurprisingly, day of year was important for juveniles. Support for different hypotheses surrounding changes in body size depended on a species' trophic and thermal guild. These results can be used to predict future changes in body size under different climate scenarios and to make trait-based management decisions for species not included in our models.

Strengthening the field of fisheries: the importance of belonging

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The recently formed Michigan AFS Diversity, Equity, Inclusion, Justice, and Belonging (DEIJB) Committee introduced their work at the 2023 chapter meeting. As a follow-up, we summarize current research in support of a diverse, equitable, and inclusive fisheries and conservation workforce. We identify historical and current barriers and provide strategies to become allies and advocates for diversity, equity, and inclusion in the field. Finally, we will emphasize the importance of "belonging" for the fisheries field and the chapter.

Eastern Lake Michigan Reef Assessment Plan

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Great Lakes reefs are important spawning areas for many native fish species and these open water reefs are impacted by a variety of factors. Very little is known about the influences these factors have on reef productivity and their physical status and condition. Historically management has focused on promoting fish production using stocked fish to maintain fish populations. However, there is a growing interest in understanding the role of spawning reef habitats and impacts of habitat degradation on native fish recruitment across the Great Lakes and whether egg survival and larvae production can be enhanced through reef management. A multi-agency collaboration was established to execute this plan throughout Lake Michigan. The goal of this project is to better understand the status and condition of approximately 22 Lake Michigan reefs, and the aquatic communities that utilize them. Reef complexes were mapped and characterized primarily using drop camera imagery and supplemented with diver ground truthing. For each reef complex we describe their location, size, bathymetry, and substrate composition. We use the CMECS classification method to classify substrate composition across the complex and developed an interstitial scoring index to estimate interstitial depth. Drop camera imagery was also used to calculate surface cover of dreissenid mussels and Cladophora. Divers collected cobbles that were scraped at the surface to sample benthic invertebrate communities and dreissenid mussel density. In fall, egg mats were deployed to measure the relative abundance of egg deposition for Lake Trout (*Salvelinus namaycush*), Lake Whitefish (*Coregonus clupeaformis*), and Cisco (*Coregonus artedi*) across each reef complex. At the conclusion of this project, we will develop a summary of each reef complex that describes the physical status and biotic composition This data will help improve our understanding of spawning reefs in the Great Lakes to inform future reef protection and restoration.

Competition between Round Goby and Slimy Sculpin in a Laboratory Setting*

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Slimy Sculpin populations have dramatically declined in many of the Great Lakes coincident to invasive Round Goby increasing in abundance. One hypothesis for the decline is that the Round Goby is outcompeting Slimy Sculpin for spawning habitat and feeding opportunities. However, behavioral interactions between these species have never been directly observed, and other coincident ecosystem changes in the Great Lakes could also contribute to Slimy Sculpin declines (e.g., increases in dreissenid mussel abundance and decreases in Diporeia). Our work informs this knowledge gap within a laboratory setting by comparing spawning success, aggressive behavior, artificial spawning shelter occupancy, and growth of Slimy Sculpin pairs when Round Goby are present or absent. We maintained 20 tanks at 4–6°C for one to two months and analyzed video footage of Slimy Sculpin pairs utilizing artificial spawning shelters in the presence or absence of Round Goby. Our observations indicate that interactions between

these two species may not be as one-sided as previously hypothesized, but the threat of larger gobies displacing Slimy Sculpins from shelter could affect their spawning success.

Case Study: Mussel survey and relocation considerations for an impounded stretch of the Huron River

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The Huron River in Washtenaw County, Michigan is classified as a Group 3b water course based on the historical presence of the federally endangered Snuffbox mussel (*Epioblasma triquetra*). Planned construction on the US-23 overpass over the Huron River (southeast of Ann Arbor) would potentially impact aquatic resources over an approximately 10,000 square meter (m^2) area. Traditional semi-quantitative or quantitative mussel surveys over such a large area would be costly and potentially span multiple field seasons, which could impact project budgets and construction timelines. In addition, Snuffbox have not been documented in Washtenaw County since 1982. The project site is also just upstream of a dam, which significantly alters the flow regime of this stretch of the Huron River and impacts the habitat suitability for diverse mussel populations. Following agency and client deliberation, a substrate evaluation and semi-quantitative mussel survey were conducted at this site in 2023, yielding 26 live mussels representing seven species. Of the seven species found, four are classified as Michigan special status, with shell material from the state endangered Lilliput (*Toxolasma parvus*) also observed. The presence of Michigan listed species presents a unique challenge, as this site had generally low mussel abundance with no particular “hot spots” of high mussel density. This presentation will focus on the unique characteristics of this site and the methods used to generate mussel community data to support project permitting.

Survival and growth of young-of-the-year sea lamprey produced in the lab: implications for species management

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Sea lamprey (*Petromzyon marinus*) are a species of management concern, both in the Great Lakes where they are non-native and in the Atlantic basin where they are native. One major impediment to sea lamprey management is access to and knowledge of certain life stages, such as young-of-the-year (YOY) and parasitic juveniles. Recently, a sea lamprey aquaculture initiative was established to fill these knowledge gaps by generating sea lamprey in the lab and attempting to complete the life cycle in captivity. Sea lamprey were spawned in 2022 and 2023 and reared under a range of conditions to establish survival and growth rates for the first 12 months of life. We found that static (58%) and flow-through (74%) set ups were suitable for high survival to hatching, more so than static water with water exchanges (44%). Density was the major factor influencing growth and survival of YOY sea lamprey. Growth rate was negatively correlated with density, and 2-3x greater rates of growth were observed in

YOY reared at density of 0.15 – 5 larvae per m^2 compared to 15 m^2. Larvae grew to an average of 55 mm in just 6 months, and 71 mm after 12 months, values several times greater than is observed in the wild. Survival was greatest at densities < 5 larvae per m^2 (72 – 100%) whereas survival at 15 larvae per m^2 was just 3%. These data indicate early life stage survival can be high under certain conditions and growth can be rapid. Both factors could influence how sea lamprey managers make decisions.

Manistee River Lake Sturgeon: 20 Years of Restoration

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[1]Little River Band of Ottawa Indians

An overview of 20 years of Little River Band of Ottawa Indians Manistee River Lake Sturgeon restoration efforts and evaluation of stream side rearing success. This presentation will give an overview of where Manistee River stream side stocking has been over the years, attempts to document juvenile/adult recruitment, characterization of the adult spawning population, and where/how population monitoring might evolve. The overview will include presenting trends in larval drift sampling, juvenile sturgeon survey results, and total stream side released sturgeon. Population estimates through physical sampling and genetic tissue sample analysis throughout the years. Continuing work towards successful recruitment of stream side reared sturgeon to adult populations through collaborative PIT tag antenna array installations, monitoring adult movement through acoustic tagging, and collaborative sea lamprey control treatments and Save-our-Sturgeon removal efforts.

Evaluating potential effects of the New Zealand mudsnail (*Potamopyrgus antipodarum*; NZMS) on macroinvertebrate assemblages in Michigan water

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The New Zealand mudsnail (*Potamopyrgus antipodarum*; NZMS) is a widespread invasive species that was first discovered in Michigan's inland waters in 2013 and since then they have been detected in high quality trout streams including the Au Sable, Boardman, Manistee, Pere Marquette, and Pine Rivers. NZMS are included on Michigan's watchlist and are a priority species for response action under Michigan's interdepartmental AIS response policy and procedure. Surveys to document their spread and densities in Michigan rivers have been ongoing since 2014, but there is a need to better understand long-term effects of NZMS on the ecology of northern Michigan rivers. Therefore, the objectives of this study were to: (1) evaluate changes in macroinvertebrate assemblages over time across river systems with NZMS using historical data, (2) characterize benthic macroinvertebrate assemblages across a gradient of NZMS densities in northern Michigan rivers, and (3) understand inter-seasonal effects on macroinvertebrate assemblages. In summer 2023, surveys of benthic macroinvertebrates were conducted at 41 sites representing a gradient of NZMS densities across multiple rivers. Sites were sampled in May and in August to assess inter-seasonal variation. Preliminary results suggest that sensitive benthic macroinvertebrates (Ephemeroptera, Plecoptera, and Trichoptera) that are indicators of high water quality remain prevalent, but they decreased compared to historical records. NZMS reached higher densities than previously recorded in northern Michigan rivers, with some sites exceeding over 30,000 per m^2. Inter-seasonal variation was observed, with NZMS densities being significantly higher in August compared to May. It appears that NZMS populations have increased after the initial invasion, and

may be replacing native invertebrates. However, additional research will be conducted to evaluate the ecological impacts.

Walleye Long-Term Monitoring in the 1836 Ceded Territory

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[1]Michigan DNR

The Michigan DNR's Tribal Coordination Unit has developed a long-term monitoring program for a subset of the Walleye Lake Systems in the 1836 Ceded Territory as identified in the 2007 Consent Decree. We currently lack robust, long-term datasets on individual inland Walleye populations in Michigan, but this type of data will help us better understand population trends and dynamics, as well as potential impacts of climate change and invasive species. Through the long-term monitoring program, data will be collected from seven selected lakes over the next 15-20 years with annual surveys and data collection including fall walleye index surveys, limnology, water quality, and habitat. On a 5-year rotation, Walleye population estimates and Status & Trends surveys will be conducted on all selected lakes. The goal of this program is to evaluate trends in Walleye population dynamics and examine relationships between population trends and both biotic and abiotic data collected to better understand Walleye populations in the selected lakes and apply these results to inland lakes throughout Michigan.

Modeling water temperature in the Au Sable River: Information to manage for resiliency with changing climate*

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Conserving rivers under changing climate necessitates comprehensive understanding of socio-cultural priorities, economic priorities, and ecological potential, particularly for rivers with multiple users and uncertainty in future conditions. Since 2021, our team has worked with a diverse group of stakeholders to understand conditions within and priorities for the Au Sable River, an iconic, cold-water river in Michigan supporting a renowned trout fishery along with multiple other uses. We applied structured decision-making to identify shared priorities of the river's stakeholders and knowledge gaps associated with the river's current and future conditions. Because sections of the river are theorized to have warmed over the last decade and because the river is expected to continue to warm, stakeholders prioritized understanding water temperature as a critical need. In support of this, we compiled historical water temperature data, and we supplemented that effort with intensive data collection in summer 2023. We will then use boosted regression trees to predict magnitude and variability of summer temperatures for the entire system from a variety of landscape factors including geology, soils, riparian vegetation, and current climate variables. These models will pinpoint factors important to current summer water temperatures, and, with projected climate data, allow us to identify spatially explicit changes likely to occur. Our approach has resulted in critical information for managing the Au Sable, and it has led to greater consensus among the region's diverse stakeholders on challenges facing the river as well as courses of action, ultimately contributing to great chances of successful conservation of this iconic fishery.

Evaluating survival of surrogate fish species using multiple incubators: Continuing efforts towards reintroducing Arctic Grayling (Thymallus arcticus) into Michigan Streams

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Arctic grayling (*Thymallus arcticus*) have been successfully reintroduced to the Upper Missouri River Basin of Montana using Remote Site Incubators (RSI). Although the RSI operates efficiently in high gradient streams of Montana, RSI performance as part of reintroduction efforts in Michigan is challenged by streams that have lower flow and gradient which complicates deployment. In this study we evaluated the utility of an alternative instream rearing device described as a Floating Basket Incubator (FBI). Specifically, we directly compared the survival of rainbow trout (*Oncorhynchus mykiss*) as an Arctic grayling surrogate between RSI and FBI in both stream and hatchery environments. In addition, we directly compared how abiotic and biotic factors influenced rainbow trout survival within FBIs among 3 natural streams. Overall, we found that mean survival of rainbow trout was significantly different among incubator types ($F(2,15) = 21.3$, $p=<0.001$). The mean survival of rainbow trout within RSIs was 82.4% and was 16.3 % and 9.7% higher than 12-cell FBI ($p<0.001$) and 3-cell FBI ($p=0.002$), respectively. When comparing among locations, we found that mean survival of rainbow trout ranged from 53.1 – 57.2% at Big Creek, 71.2 – 77.7% at Cedar Creek and 66.1 – 81.4% at Cherry Creek. Linear mixed effect model results suggested that survival of rainbow trout was best explained by incubator type and stream location. The proportion of variation explained by the incubator type was low ($mR2=0.05$), relative to the random effect of stream location ($cR2=0.71$). Our results suggest that although FBI had lower survival than RSI, the magnitude of this difference was small enough that FBI should be considered as a tool when reintroducing Arctic grayling.

Finding Fish Fanatics: Fishing for Futures

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Fishing for Futures is an outreach initiative focused on recruiting underrepresented groups that historically have been excluded from conservation jobs into United States Fish and Wildlife Service careers (USFWS). USFWS partners with the Detroit River Western Lake Erie Cooperative Weed Management Area and the Detroit River International Wildlife Refuge to engage local students with the opportunities the Service can offer. Students participate in hands-on activities that highlight specific programs and are able to converse one-on-one with staff about volunteer events, career opportunities, and barriers that might prevent the student from pursuing a similar career. The Fishing for Futures program targets the 'Recruitment and Hiring' objective mentioned in the Service's Diversity and Inclusion Implementation Plan (DIIP). Our first event was held at Ecorse High School (Ecorse, MI), located less than a mile from the shores of the Detroit River. With a minority enrollment of 92%, and 70% of students considered economically disadvantaged, future partnerships with schools similar to Ecorse High School have the potential to close the workforce diversity deficit, a stated goal of USFWS. The program is in its early stages but shows promise. Future endeavors include broadening partnerships with minority-serving academic institutions and increasing recruitment focused outreach events. Exposing local youth to opportunities in their backyards, coupled with career talks, makes obtaining fisheries related careers

more tangible to students that lack experience and knowledge of the outdoors. Exposing high school and college students to nontraditional career paths can spur a future generation of conservation stewards that have diverse backgrounds, identities, and experiences.

Comparison of cisco (Coregonus artedi) aerobic scope and thermal tolerance across a latitudinal gradient

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U.S. Geological Survey

The cisco Coregonus artedi is a coldwater fish that is distributed throughout much of Canada and the northern United States, including the Laurentian Great Lakes. Cisco historically supported large commercial fisheries in the Great Lakes, yet many populations have declined. Conservation efforts focusing on re-establishing cisco in the Great Lakes are underway but increasing water temperatures may hinder these efforts. Therefore, we examined aerobic scope and thermal tolerance of allopatric cisco populations from different latitudes and habitats to determine if a southern latitude population (Crooked Lake, Indiana, USA) near the southern edge of cisco distribution was better adapted to withstand warmer water temperatures than a northern latitude population (Les Cheneaux Islands, Michigan, USA; Lake Huron). As expected, both stocks experienced increases in metabolic rates and absolute aerobic scope with increased temperature. Northern latitude cisco had significantly lower aerobic scope compared to southern latitude cisco at both treatment temperatures. Both cisco stocks had high thermal tolerances at 20 and 23 ℃ but low tolerances at 26 ℃. Cisco thermal tolerances increased with acclimation temperature, but we did not detect a difference in thermal tolerances between northern and southern latitude cisco. Although southern latitude cisco had higher capacity for aerobic metabolism, both stock sources had high thermal tolerances at the upper end of their thermal limits. Therefore, either population would be likely suitable for reintroduction into Great Lakes habitats, even with the lower Great Lakes expected to warm in the future.

Assessing the conditions and utilization of Lake Michigan reefs by Coregonid species and lake trout

Taylor Skiles[1], Lawrence Grennan[1], Andrew Tucker[2], William L. Chadderton[2], Ben Turschak[1], Matthew Herbert[2], Tracy Galarowicz[3], Eric Olsen[4], Chris Hessel[4], Dave Clapp[1], and Patrick Hanchin[1]

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Many fish species in Lake Michigan rely on open-water reef formations for spawning, though there is little known about the characteristics of these reefs, including but not limited to: substrate composition, predator assemblages, fish utilization, and the presence of invasive species. Lake Trout (*Salvelinus namaycush*), Lake Whitefish (*Coregonus clupeaformis*), and Cisco (*Coregonus artedi*) are three native fish species that rely on reefs for spawning habitat. These fish populations have experienced population declines, and we need to understand the biotic and abiotic factors on reefs that influence egg deposition, and ultimately egg and larval survival. To do this, we studied a variety of reefs in southern, central, and northern Lake Michigan. To estimate egg predators, we used baited camera quadrats to determine the relative abundance of Round Goby (*Neogobius melanostomus*) on each reef and on different habitats within each reef. Native and nonnative crayfish densities were estimated using dive

quadrats. The substrate composition of each reef was subsampled using drop cameras mounted to a frame. Photos were used to assign an index of interstitial habitat (based on dominant substrate type from the Coastal & Marine Ecological Classification Standard and interstitial depth of the substrate), and a qualitative index of Cladophora cover. Finally, egg deposition densities for Lake Trout, Lake Whitefish and Cisco were measured across different habitats on each reef complex using egg bags and egg mats. We have compared these metrics to one another on each of our reefs to evaluate relationships between reef characteristics and egg deposition across and within each region of our study. These analyses and other results of this study will ultimately be used to inform additional reef assessment efforts elsewhere in the Great Lakes, and to recommend future restoration, protection and monitoring efforts on Lake Michigan reefs.

Abiotic Characteristics of Boardman-Ottaway River

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FishPass is a riverine restoration project on the Boardman-Ottaway River seeking to selectively improve the migration of native fish to and from upstream habitats. The construction will replace the existing Union Street Dam in Traverse City, MI. To assess the restoration project efficacy, a large-scale cooperative research effort is underway to monitor changes in water quality, fish community composition, nutrient dynamics, and flow characteristics of the river. Larval fish drift samples were collected to assess community composition and quantify outmigration abundance of recently hatched fish. We measured several parameters (temperature, dissolved oxygen, conductivity, pH, and turbidity) that can impact the patterns in larval fish drift and production using a portable digital water quality meter. Data were collected at 7 sites within the Boardman-Ottaway River: three sites above the dam, two sites below, and one site in a tributary (Kids Creek) that connects below the dam. Sampling began on April 6, 2023, and ended on August 22, 2023. These data were then combined with provisional mean daily discharge data from the USGS flow gage on the river (Gage 04127200) for comparison with flow characteristics. We used Principal Component Analysis (PCA) to evaluate the relationships between different components of the dataset. The first principal component (PC) accounted for 57% of the variation in the data and was associated with seasonal change in river characteristics (declining discharge and dissolved oxygen, increasing temperature and pH between spring and summer). The second PC (24.6% of the variation) varied with turbidity and percent dissolved oxygen and varied more between sites. Conductivity was relatively constant within each site, and its variation was orthogonal to the other variables in the PCA. These results characterize patterns in abiotic conditions in the Boardman-Ottaway River during spring and summer in the area potentially affected by the FishPass installation.

Poster Presentations

Seasonal changes in coregonine diets in Lake Superior

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Lake Superior is the largest freshwater lake by surface area in the world, and is home to a diverse food web, including secondary consumers such as prey fish. Despite playing an important role in the ecosystem, few lake-wide food web studies have examined diets of prey fish, and how such diets change seasonally in Lake Superior. In particular, coregonine species are an important prey fish group for the Lake Superior food web, and many are part of a commercially important fishery. To better understand the role that coregonine species play in the Lake Superior food web, prey fish were collected in 2021 via gill net and bottom trawl surveys across the lake by state, federal, tribal and provincial agencies. The stomach contents of six coregonine species: Bloater, Cisco, Kiyi, Lake Whitefish, Round Whitefish, and Shortjaw Cisco were identified and biomass of the diet items were quantified. Seasonal changes in diet compositions were detected for the six prey fishes examined. Mysis, Diporeia, Bythotrephes, aquatic insect larvae, terrestrial insects, copepods and cladocerans, and other fish being the dominant prey items. Biomass of the prey consumed was highest in summer for Bloater, Kiyi, Cisco, and Lake Whitefish, whereas the biomass consumed by Round Whitefish was highest during winter. Shortjaw Cisco had the highest biomass in their diet in the fall; however, all specimens were collected in the summer and fall, and none were collected in the winter and spring to assess seasonal change. Understanding the diets of coregonine species is important because they are critical trophic linkages in the food web, and their diets can provide important insights on the seasonal and inter-annual dynamics and changes occurring in Lake Superior.

Population Dynamics of Eurasian Ruffe in Northern Green Bay, Lake Michigan

Erin Falk[1], Dalton Hendricks[1], Matthew Petasek[1], Cari-Ann Hayer[1], and Troy Zorn[2]

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Eurasian Ruffe (*Gymnocephalus cernuus*) have spread and become rapidly abundant in Lake Superior since their introduction to the Laurentian Great Lakes in the mid 1980's. Ruffe were first documented in Lake Michigan in 2004 and have established an isolated self-sustaining population in Little Bay de Noc, located in northern Green Bay. Long-term standardized sampling within Little Bay de Noc began in 2009. Catches were nominal until 2017, when catches began to increase exponentially. A study was implemented in 2022 to determine the most efficient gear to capture Ruffe. Several gears, including experimental gill nets, fyke nets, and Windermere traps, were used at known capture locations within Little Bay de Noc. In 2023, sampling was expanded to include southern Little Bay de Noc and Green Bay by the mouth of the Ford River. No detection outside of Little Bay de Noc was documented. Population dynamics (e.g., age, growth, size structure, condition) were quantified for all 2022 and 2023 captures. Age frequency was plotted for both years indicating a young Ruffe population. Using the relative weight index of 95 - 105 as a benchmark for fish in good condition, most fish collected were in good condition. Future surveillance will include documenting potential spread to areas adjacent to Little Bay de Noc, examining diet, and predation/competition with native fish species including Lake Whitefish (*Coregonus clupeaformis*).

Aquatic Invasive Species Early Detection and Monitoring Program - 2023 Season Overview

Erin Falk[1], Angela Grimm[1], Jacob Pantzlaff[1], Anjali Kumar[1], Sharon Rayford[1], and Cari-Ann Hayer[1]

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The Great Lakes are under continual pressure from aquatic invasive species (AIS) threatening native communities. Invasive species are known to cause cascading impacts on ecosystems that can be detrimental to native biological communities, recreation, commerce, and infrastructure. Given the importance of the Great Lakes basin and its resources, it is imperative that new nonnative species introductions are detected early so management agencies can assess and respond accordingly. The Green Bay Fish and Wildlife Conservation Office (FWCO) AIS Program conducts annual early detection and monitoring surveys throughout the near-shore zones and tributaries of Lake Michigan in locations with high invasion potential. Monitoring efforts focus on detecting known and novel invasive species. Early detection efforts are allocated between environmental DNA water samples, traditional fisheries gear surveys, and macroinvertebrate colonization rock bags. This poster provides an overview of the Green Bay FWCO AIS Program's effort and catch for the 2023 season.

MiWaterNet: Enhancing Stewardship, Research, and Management through Remote Stream Monitoring

Drew Heckman[1] and Ashley Moerke[1]

[1]Lake Superior State University

The Center for Freshwater Research and Education (CFRE) at Lake Superior State University has been implementing a low-cost and remote monitoring network in small, wadeable streams across northern Michigan (MiWaterNet) since 2020. MiWaterNet has gathered years of sub-hourly data across seasons at over 30 monitoring sites. This initiative grants a diverse array of partners and stakeholders open access to real-time remote water quality and hydrology data. The continuous and long-term nature of these data presents a unique opportunity to enhance stewardship, research, and management throughout northern Michigan. Examples of data use by stakeholders will be presented, including novel place-based and data-driven watershed educational experiences for high schools throughout Michigan's eastern Upper Peninsula. Participating classes have worked directly with MiWaterNet data, helped to deploy MiWaterNet stations, and are developing stewardship projects to address community watershed concerns. Additionally, MiWaterNet data has enabled researchers and fisheries managers to gain valuable insights into the temperature trends of important fisheries, such as the Au Sable River. MiWaterNet is expected to lead to additional stewardship, research, and management outcomes, as CFRE continues to maintain and improve the initiative as a part of our continuing mission to inspire our community and sustain our Great Lakes.

Are Metabolic Rates Associated with Underlying Body Composition in Fish?*

Scott Jackson[1], Jim Breck[1], Kevin Wehrly[2], and Karen Alofs[1]

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In the ever-changing Anthropocene era, where human-induced alterations to the world are driving changes to ecosystems at unprecedented rates it is more important than ever to understand mechanistically how species are responding to the environment around them. One commonly used tool to measure fish's response to alterations in their environmental conditions is their metabolism. However, while presented as a fundamental physiological rate that follows strong allometric and temperature-

related responses, there are still high levels of inter and intraspecific variation that occur within metabolic rates in fishes. The underlying mechanisms behind this variation are still debated. One potential source for influencing metabolic rates may come from the fish's body's physical composition, where different body tissue types have different underlying energetic costs or needs. To investigate this hypothesized relationship, we measured metabolic rates using intermittent respirometry in age-0 walleye from Michigan Department of Natural Resources rearing ponds to determine their standard and maximum metabolic rates. We subsequently processed fish for their proximate body composition utilizing a series of analytical assays, providing the amount of water, ash, lipid, and protein present in a fish's body. In total 200 walleye ranging from ~2g-69g were measured for their metabolic rates and proximate composition. We then utilized partial redundancy analysis to determine the amount of variance in metabolic rate explained by proximate composition. We further investigated the relationship between metabolic rates and body composition using structural equation modeling, to better understand how these two sets of variables may influence or be related to each other. Overall, our results indicate that body composition is related to and helps explain some of the observed intraspecific variations in metabolic rates.

Curating a Digital Database to Examine Historical Fisheries Management Strategies in Michigan Inland Lakes*

Jaime Jacob[1] and Karen Alofs, Ph.D[2]

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Historically, various management methods were used to maintain the fish populations in inland Michigan lakes, where sportfishing was a main driver for the modification of the ecosystems. In the 1930s through the 1980s, some of the most popular management methods included stocking, eradication, habitat management, and fishing regulations. Instances of implementing management strategies were recorded on paper cards, however, the nature of the historical records has limited their usefulness for current research and management. Thus, our goal was to digitize the data from historical records, clean and organize the data, and look at patterns in historical management techniques across space and time. First, we transcribed the records into an accessible format, CSV files, using Optical Character Recognition and Amazon Web Services technologies. Then, using keywords that characterized the various management techniques, we built a Python program that iterated over the 5500 digitized cards and categorized each entry based on the management strategies. Finally, we examined trends in management strategies. There were not clear shifts in management strategies over time, but stocking was most frequently implemented and records of stocking appeared earlier in the data set. Looking forward, these data can be used by future researchers to examine the effectiveness of various management strategies and their long-term impacts on fish populations and Michigan lake ecosystems.

Development of a Water Quality Monitoring System on a USV

Zachary Kassuba, Xavier Vicent Navarro[1], and Edoardo I. Sarda[2]

[1]Florida Atlantic University
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"In the quest for sustainable water quality monitoring, this study introduces a cutting-edge approach that integrates sensor technology onto unmanned surface vehicles (USVs), specifically the Wave

Adaptive Modular Vessel (WAM-V) 16. This innovation is particularly beneficial for assessing freshwater quality, which is crucial for the health of aquatic life, such as freshwater fish.

The WAM-V 16 USV, a 16-foot catamaran equipped with electric motors and advanced motion controllers, is retrofitted with an array of sensors typically found on static water quality monitoring stations. This allows for efficient data collection across multiple sites without the need for numerous stationary units. The USV's autonomous capabilities enable it to navigate and maintain position for precise data gathering, essential for monitoring environments where freshwater fish reside.

By employing differential thrust for navigation and station-keeping, the USV can reach and analyse various locations that are prone to pollution, which could affect the habitat of freshwater species. The control architecture developed for the WAM-V 16 ensures accurate data collection while minimizing the carbon footprint associated with traditional manned operations.

This method not only offers a cost-effective solution to water quality monitoring but also serves as a proactive measure to protect freshwater ecosystems. The mobility and autonomy of the WAM-V 16 USV make it an invaluable tool for environmental scientists and conservationists aiming to preserve aquatic biodiversity and ensure the safety of freshwater resources for fish populations. The study demonstrates the potential of USVs in revolutionizing water quality assessment, paving the way for more informed and timely conservation efforts.

Investigating the Impact of New Zealand Mud Snails (*Potamopyrgus antipodarum*) on Macroinvertebrate communities and Algal growth in the Manistee River*

James Laperriere[1] and Dr. Ashley Moerke[1]

[1]Lake Superior State University

The New Zealand Mudsnail (*Potamopyrgus antipodarum*) is an invasive species that was introduced to Michigan waters in 2015 and since then has spread to numerous high quality trout streams in the Lower Peninsula of Michigan, including the Manistee River. In invaded sites, mudsnails can reach densities up to 500,000 per square meter and as grazers, they could alter important ecological processes in these high quality streams. Given the New Zealand mudsnail's proficiency as a grazer, its presence could potentially disrupt primary productivity in areas where it reproduces. The disruption of primary productivity could cause unwanted problems up the food chain. This project aims to assess the potential impacts of the New Zealand mudsnail on macroinvertebrate communities and algal growth in the Manistee River. In the summer of 2023, 15 paired 10x10 cm tiles (one elevated and one on the stream bottom) were deployed in stream reaches that had varying densities of mudsnails. After 30 days, tiles were picked for macroinvertebrates and scraped for algal biomass. Chlorophyll a and Ash-free-dry-mass (AFDM) were analyzed in the laboratory this winter and preliminary findings suggest that algal biomass differs across a gradient of mudsnail densities, with the highest measurements of chlorophyll and AFDM found at sites with low densities of mudsnails. However, there was no difference in algal biomass on paired platforms, which suggests that mudsnails may not affect algal biomass more so than native grazers. The results of this research will provide valuable insights into the long-term impacts of New Zealand mudsnails on the ecology of northern Michigan streams.

Littoral Dissolved Oxygen Trends in Muskegon Lake*

John Lawrence[1] and Carl Ruetz III[2]

[1]Grand Valley State University
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We assessed spatial and temporal dissolved oxygen trends within littoral habitats of Muskegon Lake. Littoral habitats are highly productive and support diverse ecological communities, and coincidentally are often the focal point of human interaction. We quantified the magnitude of diel oxygen fluxes during May, July, and September at four littoral sites in Muskegon during 2022-2023. Dissolved oxygen and temperature loggers collected time-series data for one day-night cycle. Additional readings of dissolved oxygen and temperature were taken with a sonde on the set and pull day of each logger. Percentage of SAV cover was visually estimated at each sampling site. Diel oxygen fluxes were the least extreme at sites with the lowest SAV cover. Dissolved oxygen never reached concentrations below 4 mg/L (i.e., threshold for mild hypoxia). However, oxygen supersaturation in excess of 20 mg/L was noticed during summer, which may be a proxy for eutrophication. This is likely due to external nutrient loading from the greater watershed, and the complex interactions between plant respiration and microbial decomposition of detritus. In Muskegon Lake SAV likely influences diel fluxes in dissolved oxygen and hypoxia was not present at littoral sites, though we suspect littoral hypoxia is more likely under different conditions.

Potential overlap of Asian carp with important game fish and migratory species habitat implications for future invasive species management in Michigan streams*

Cori Martorana[1], Jared Ross[1], Arthur Cooper[1], and Hao Yu[1]

[1]Michigan State University

There are many important fish species in Michigan waters. Among these are five species, Walleye, Brook Trout, Lake Sturgeon, White Sucker, and Rainbow Trout, identified by the Great Lakes Fishery Commission as priority species for management. These fishes carry high importance as game species as well as being considered migratory, requiring movement between distinct habitats to complete their life cycles. Anthropogenic stressors and climatic changes in the region have led to changes in stream habitats and the fish species they support. For example, Lake Sturgeon, recently listed as endangered by the International Union for the Conservation of Nature (IUCN), were historically abundant in the Great Lakes region. However, overfishing, habitat fragmentation, loss of connectivity by dams and roads, and an ever-changing climate have all contributed to their vulnerable status. Non-native and invasive species additionally threaten the survival of high priority species in Michigan. For example, Bighead and Silver Carp are highly invasive in areas of the Mississippi River Basin and cause major problems for both humans and the ecosystems in areas where they have invaded. Although these Asian carp species have not yet invaded streams in the Great Lakes Basin, this work quantifies the potential spatial overlap in suitable stream habitats in Michigan for these carp and high priority species by evaluating predicted species distributions. These results can be used to help managers prioritize where to conduct surveillance efforts in order to respond to potential invasion, or where protection and enhancement of suitable habitats for high priority species may be warranted. Our approach can be used as a proof of concept and adjusted to be applied in other areas and for additional combinations of species that are of high management interest in those regions.

Determining Threshold Levels and Sensitivity Using Environmental DNA Approaches to Detect a Nuisance Freshwater Diatom, *Didymosphenia geminate*

Shawnee McMillian[1], Ashley Moerke[1], Britton Ranson Olson[2], and Raven Mckechnie

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Didymosphenia geminata is a stalk forming freshwater diatom that produces nuisance blooms and has recently emerged in many streams and rivers throughout the state of Michigan. The didymo cell forms long polysaccharide stocks that extend into the water column forming thick slimy mats that attach to river substrate. The slimy mats are known to alter native species, ecosystems functions, and adversely affect fisheries and tourism. *D. geminata* cells have successfully been identified using microscopic methods and more recently through environmental DNA (eDNA). Although these methods have been successful for detection, an evaluation of sample collection of didymo has been understudied. In this study we wanted to see if distribution, distance, and volume played a key role in quantifying the detection threshold levels and sensitivity of eDNA to improve early detection of Didymo. We hypothesize that the closer to the didymo source and the more volume filtered will yield higher didymo concentrations. Water samples were collected by deploying a drift net at different increments from a didymo infested area, the Main Rapids of the Saint Marys River in October 2022 and May 2023. At each increment, a target volume of 10,000L was filtered followed by 30,000L to compare the didymo abundance between the two volumes. All water samples were extracted and eDNA analysis was performed using species specific *D. geminata* primers and probe. We found that there was no significant difference in didymo concentrations between the two filter volumes. In 2022 the didymo concentration did not change between the three distances from the didymo source, but in 2023, the concentration was significantly different and the highest concentration was found furthest away from the source counter to expectations. Further work is needed to refine techniques, but initial findings will help to improve sampling guidelines for eDNA analysis of *D. geminata* and provide better monitoring tools for didymo in river systems.

Grass Carp Monitoring in Lake Michigan

Jacob Pantzlaff[1], Nathan Barton[1], and Cari-Ann Hayer[1]

[1]U.S. Fish and Wildlife Service

In 2022, the Green Bay Fish and Wildlife conservation Office started the current dedicated Grass Carp (*Ctenopharyngodon idella*) surveillance efforts in the Lake Michigan basin. Sampling methods were adopted from Lake Erie removal efforts which primarily used daytime electrofishing with grass carp specific electrofishing settings. The predominant removal locations were sites with historic documentation of Grass Carp encounters (pre-2020) which included the St. Joseph River (MI), Burns Harbor (IN), and Milwaukee River confluence (WI). Other survey locations which have not yielded Grass Carp include the Fox River (WI), Galien River (MI), Paw Paw River (MI), upper St. Joseph River (MI), and lower Grand River (MI). Twelve Grass Carp in 2022 and twelve Grass Carp in 2023 were removed from the Lake Michigan basin. A variety of biological data were collected from each Grass Carp to further understand the Grass Carp population in the Lake Michigan basin. These data will be used to assess diet, natal origin, ploidy status, genetics, age, and growth rates. In the 2024 field season, continued monitoring of primary sampling locations and additional exploratory locations will be sampled. Experimental use of passive gears, including hoop and/or fyke nets, may also be used.

The occurrence, abundance, and type of microplastics in larval Lake Whitefish (*Coregonus clupeaformis*) diets in relation to water depth and watershed land use*

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[8]Michigan Department of Natural Resources
[9]Minnesota Department of Natural Resources
[10]Little Traverse Bay Bands of Odawa Indians
[11]Bay Mills Indian Community
[12]Sault Ste. Marie Tribe of Chippewa Indians
[13]Little River Band of Ottawa Indians

Lake Whitefish *Coregonus clupeaformis* abundances have been decreasing since the 1990s in Lake Huron and Lake Michigan. Several theories exist as to why Lake Whitefish abundances have been decreasing, including a decline in suitable spawning habitat, adverse interactions with invasive species, and poor recruitment. Further, microplastics can be easily mistaken by biota as a food resource or may inadvertently end up in the diet of an organism. Microplastics are small pieces of plastic that are found in soil and water, and are commonly grouped as either fibers/lines, pellets/beads, foams, films, and fragments. Very little data exists on whether and to what extent larval fish such as Lake Whitefish consume microplastics, which may affect their growth and survival. Our objectives are to (1) determine microplastic occurrence, type, and concentrations in larval coregonines, (2) test if microplastic concentrations in larval coregonine diets are related to anthropogenic watershed land use types, and (3) identify potential microplastic hotspots within Lake Huron. Through an ongoing collaboration, sites have and will be sampled up to three times each during the day for larval Lake Whitefish and other Coregonus spp. on the beach (≤ 1 m water depth) and nearshore (1-10 m water depth) throughout Lakes Michigan, Huron, and Superior in spring 2023 and 2024. This study will initially focus on samples collected in Lake Huron from areas that span a gradient of land use types (e.g., urban, forested, and wetland) in the surrounding watershed. Sites from Lakes Michigan and Superior may be included in the future. Preliminary observations indicate that microplastics are in diets of larval Coregonus spp., and sometimes at higher densities than zooplankton and other diet items. Potential implications to the ecology and management of Lake Whitefish will be discussed.

Zooplankton beach and nearshore densities and their relation to larval coregonines at day versus night in the Upper Great Lakes*

Elliana Prow[1], Jose Bonilla-Gomez[2], Ben Breaker[2], Kennan Bruening[2], Ethan DePauw[1], Brett Diffin[3], Silas Dunn[1], Simon Freeman[1], Ian Harding[4], Chris Hessell[5], Andrew Honsey[6], Joshua Hug[2], Samuel Johnston[7], Jory Jonas[8], Kevin Kapuscinski[1], Kevin McDonnell[9], Gary Michaud[10], Erik Olsen[5], Paul Ripple[11], Katherine Skubik[10], Jason Smith[11], Mason Spiess[1], Jacob Synnott[1], Jack Tuomikoski[12], Christina VanDoornik[13], Sarah Woody[2], and Jonathan Doubek[1]

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[9] Minnesota Department of Natural Resources
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[12]Sault Ste. Marie Tribe of Chippewa Indians
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Zooplankton play a vital role in aquatic ecosystems as they feed on phytoplankton and transfer energy up the food chain. However, most of our understanding of zooplankton dynamics is based on data collected during the daytime from relatively deep, pelagic environments. In Lakes Michigan and Huron, Zebra (*Dreissena polymorpha*) and Quagga Mussels (*Dreissena bugensis*) have decreased phytoplankton and subsequently zooplankton abundances, but these plankton data are primarily from deeper habitats. Further, zooplankton density and biomass can vary between day and night among different habitats because of diel vertical and horizontal migrations. More information is needed to better understand zooplankton populations at various shallow water locations and times (i.e., day versus night) at large scales and how those population estimates may affect larval fish. Our objectives are to determine (1) how zooplankton density and biomass vary between day and night on the beach and nearshore, and (2) zooplankton relations to larval fish across different habitats and time of day. We have and will sample zooplankton, larval fish, and other environmental variables during the day and at night at numerous beach (≤1 m water depth) and nearshore (1-10 m depth) sites seasonally (each site sampled up to three times) in spring and summer of 2023 and 2024 across Lakes Michigan, Huron, and Superior. Samples are paired day and night for each site, and a subset of beach sites are paired with nearshore sampling for the same variables. This study provides insight into Great Lakes zooplankton ecology and potential implications for fisheries management.

Use of St. Marys River Coastal Wetlands by Black Bass*

Clayton Robertson[1] and Ashley Moerke[1]

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Great Lakes coastal wetlands provide essential ecosystem services and sustain sport and commercial fisheries. The St. Marys River, the connecting channel between Lake Superior and Lake Huron, has one of the highest densities of wetlands remaining within the Great Lakes region. Throughout the St. Marys River, black bass (Smallmouth and Largemouth Bass) are known to be present, however their use of coastal wetlands is less well known. Due to these gaps in knowledge, the objectives of this study are to: 1) determine the extent of wetland use by black bass species, 2) better understand the potential of sympatry in St. Marys River wetlands, and 3) evaluate any temporal changes in black bass populations over the past decade. To test these objectives, data collected from the Great Lakes Coastal Wetland Monitoring Program from the years 2011-2021 was obtained for the SMR and summarized. Out of all 41 coastal wetlands along the St. Marys River used in this study, 22 (55%) of the wetlands contained bass, and their distribution ranged throughout the entire SMR channel. However, out of the 22 coastal

wetlands, Smallmouth Bass were found alone 23% of the time while Largemouth Bass were always collected with Smallmouth Bass. Smallmouth Bass and Largemouth Bass were found to coexist in wetlands, but there was no common vegetation type used by bass. Trends over time will also be discussed in relation to changes in water levels. Findings from this study will help highlight the importance of coastal wetlands for black bass populations and determine if management or habitat protection is required to provide key habitat for these species.

Assessing Physical Effects of Entrainment on Larval Fish Passing Through Union Street Dam, Traverse City, MI

Anna Schwarzkopf[1], Stacey Ireland[1], Robin DeBruyne[1], Edward Roseman[1], Heather Hettinger[2], Dan Zielinski[3], and Reid Swanson[3]

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Adult and juvenile fish have been shown to sustain injury and experience mortality after entrainment through dam and hydropower infrastructure, but the impact on larval fish is largely unknown. Habitat restoration efforts on the Boardman (Ottaway) River system near Traverse City have resulted in the removal of three dams, with a fourth on Union Street to be replaced by a bi-directional selective fish pass system (FishPass). Characterization of the larval fish community and potential damage caused by the dam structure prior to dam removal is ongoing to facilitate current and future assessment. Larval fish were sampled passively using D-frame nets downstream and upstream of the Union Street Dam to identify if and what types of damage are incurred while entrained in the dam's primary spillway, as well as document any infrastructure related mortality. To quantify corresponding strain rate and turbulence length scales of the dam flow field, field measurements and model estimates were utilized for future evaluation of the driving factors behind observed injury and mortality. A framework for categorizing and rating injury severity was established for entrainment injury characterization. In-field processing of live larvae produced a mortality rate of 50.3% (n=38 of 73 larvae collected). Out of the 73 larvae preserved (Percidae, Catostomidae, 5-25 mm TL), 280 injuries were noted, the most prevalent being fin fold damage (68.9%), followed by other injuries (26.1%) including eyeball luxation and rupture, head indentation, and full eye detachment. Impacts of these injuries on long term larval fish development and survival were not assessed in this study but could be considered in future river infrastructure assessments. As the FishPass is designed to minimize strain rate, we expect a reduced frequency in observed injury and mortality. These findings support larval and juvenile fish conservation regarding dam entry mitigation and downstream habitat restoration.

Crustacean zooplankton exhibit higher diel density and species richness in murky versus clear lakes in southern Michigan*

Dakota Smith[1] and Jonathan Doubek[1]

[1]Lake Superior State University

Inland lakes across the United States, including lakes in Michigan, are becoming more murky in color in recent decades, which is also known as "brownification" of lakes. Changes in water color can greatly affect lake ecosystem processes and the demographic population estimates and behavior of organisms residing in those systems. Once such group of organisms that can be affected by changing water color

are zooplankton. Zooplankton link the bottom of the food chain (phytoplankton), to the top (fish), and changes to their population estimates and community composition can greatly affect those trophic linkages. Little information exists on how differing lake color affects zooplankton community dynamics and resulting consequences for lake ecosystem processes. To address some of these knowledge gaps, two murky and two clear lakes of different sizes were sampled in summer 2023 at day and at night at multiple depth locations to test overall and day versus night differences in zooplankton density and species richness. Secchi disk depth was higher in clearer versus murky systems. Murky lakes had higher zooplankton density and species richness than clearer lakes, especially of Cladocera taxa. Shallower systems had higher zooplankton density at night versus day, especially so of the murkier shallow water system. The murkier systems may have had lower dissolved oxygen concentrations in their hypolimnion versus clearer lakes, which could result in greater diel horizontal migration of zooplankton in those systems, and subsequently higher nighttime estimates of zooplankton. Perhaps murky systems also have more diverse habitats, or a reduction in the ability of visual predators such as fish to find and consume zooplankton, which results in a higher zooplankton density and species richness. Results of this study are important to the ecology of zooplankton, with links to fisheries ecology and management.

Stream connectivity analysis for priority fish species in Michigan: Applications for barrier management*

Jack Taylor[1], Arthur Cooper[1], Jared Ross[1], Maggie Haite[1], and Hao Yu[1]

[1]Michigan State University

Several priority fish species inhabiting tributaries of the Great Lake Basin, including Walleye, Lake Sturgeon, White Sucker, Brook Trout, and Rainbow Trout, have been identified by the Great Lakes Fishery Commission. These species, in addition to being migratory, are among some of the most important game fish in Michigan. The migratory behavior of these species stems from habitat requirements for their life histories such that they spend various life cycle phases in different freshwater ecosystems, including streams. However, a loss of connectivity along the stream networks that they are required to navigate in order reach vital spawning areas can prevent them from fully completing their life cycles. Additionally, species such as Lake Sturgeon are currently threatened due to a multitude of stressors, including the inability to access important stream habitats for spawning, increasing risks to populations of this long-lived species. We combine information on the role of dams in fragmenting stream networks with information on the distributions of these fishes in Michigan to understand the impact of dams in fluvial habitat connectivity losses. We provide spatially explicit maps showing species-specific river connectivity loss in a framework that could be applied in other regions and for additional migratory species. Ultimately, this data can assist managers and decision-makers in determining where efforts to increase stream connectivity might most effectively be focused.

Comparison between Lake Superior State University Fish Hatchery and Platte River State Fish Hatchery in Atlantic Salmon rearing

Megan Thompson[1] and Paul Stowe[2]

[1]Lake Superior State University
[2]Michigan Department of Natural Resources Platte River State Fish Hatchery

Lake Superior State University (LSSU), in collaboration with the Michigan Department of Natural Resources (MI DNR) and Cloverland Electric Cooperative, has been rearing and stocking Atlantic Salmon

since 1987, with >1 million fish stocked to date. This program has been successful at achieving its goal of training students in fish culture methods, and also created a world-class fishery for Atlantic Salmon in the St. Marys River. During the past decade, the MI DNR expanded efforts to rear Atlantic Salmon at the Platte River and Harrietta State Fish Hatcheries, and substantially increased stocking numbers in Lake Huron to provide fishing opportunities as the Chinook Salmon fishery declined. We will provide an overview of the rearing processes at the LSSU and MI DNR hatcheries, and compare growth, size at stock out, survival to stock out, and rates of return among the three hatcheries. We will also discuss disease treatments, research needs, and future directions.

Preliminary Assessment of Larval Fish Distribution in the Boardman-Ottaway River

Kaylea Tipper[1]; Chris Bucher[1], Nakiah Dague[1], Riley Ralph[1], Anna Schwarzkopf[1], Robin Debruyne[1], Reid Swanson[2]; Edward Roseman[1], and Dan Zielinski

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The Boardman-Ottaway River is a 45.4-km tributary with a 743 km2 watershed area that makes up ~30% of the surface water input to Grand Traverse Bay. Long-term conservation efforts to restore the natural ecological connectivity of the Boardman-Ottaway River ecosystem have resulted in the removal of three dams, with Union Street Dam remaining as the last major impediment to full watershed accessibility for Great Lakes fishes. The installation and development of a bi-directional selective fish passageway (FishPass), intended to identify, sort, and selectively pass desirable fishes, is scheduled to replace the Union Street Dam. Despite benefits to native fishes from enhanced connectivity, barrier removal can also benefit undesirable species by allowing access to spawning habitat in tributaries. A baseline understanding of the existing fish assemblage, spawning phenology, and abiotic conditions within the Boardman-Ottaway River is needed to accurately measure ecological changes subsequent to FishPass installation and operation. One objective of this preconstruction assessment is an evaluation of spatial and temporal patterns of larval abundance across collection sites upstream and downstream of the Union Street Dam, the future site of FishPass, from April – August, 2023. Sampling was primarily conducted using passive D-frame (500-µm and 1600-µm mesh) drift-nets during weekly day and night paired sampling events at seven sites. Samples were isolated and enumerated in the lab prior to individual taxonomic identification and measurement of larval fishes. A total of 830 samples with 34,829 larval fish were collected in 2023. Species groups identified include Percids, Gobiids, Cyprinids, Salmonids, Centrarchids, and Catostomids. The sampling site, located between Boardman Lake and Union Street Dam, had the highest yield among sampling sites at ~44% (15,455 fish) of the total fish catch. Preliminary results provide an initial assessment of the abundance, diversity, and phenology of larval fish drift in the Boardman-Ottaway River during spring and summer.

Density of invasive dreissenid mussels in the Upper Great Lakes in relation to chlorophyll a, zooplankton density, and larval coregonine abundance*

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The Lake Whitefish *Coregonus clupeaformis* is culturally, ecologically, and economically important to the Great Lakes region, but many populations throughout the Upper Great Lakes have declined since the late 1990s. This decline can be attributed, in part, to the establishment and increased populations of invasive dreissenid mussels: Zebra *Dreissena polymorpha* and Quagga *D. bugensis*. These invasive mussels reproduce and colonize at a high rate, and have altered the food web of several Great Lakes. For example, the invasive dreissenids have decreased phytoplankton, and subsequently, zooplankton abundances in Lakes Michigan and Huron, which can affect the diets of larval Lake Whitefish and other coregonine species (e.g, *Coregonus artedi*) because their early stage diet depends mainly on zooplankton. Few studies have compared the effects of invasive mussels across multiple trophic levels, and how they may be related to larval coregonine abundances. To address some of this knowledge gap, we conducted a collaborative study throughout the Upper Great Lakes basin where we collected chlorophyll a, zooplankton, and larval coregonine samples from beach habitats (≤1 m water depth) shortly after ice-off in 2023 (will sample again this spring 2024), and compared these data to previously published literature on invasive mussel densities from similarly sampled areas. We found that regions with lower mussel densities had higher larval coregonine abundances, and that the concentration of chlorophyll a was positively related to coregonine abundance. The highest overall mussel densities were observed in Lake Huron. Zooplankton data are being processed from 2023 and we will report on relations between mussels, zooplankton, and larval coregonines. More work is needed to sample for and connect multiple trophic levels together to obtain a more holistic understanding of how ecosystem changes can affect food web dynamics in our ever-changing Great Lakes.