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Walleye Spawning Movements and Temperature Cues in Tributary Rivers to Green Bay, Lake Michigan

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Walleye *Sander vitreus* use tributary rivers to Green Bay, Lake Michigan for all life stages including as vital spawning habitat. Spawning movements are cued by environmental factors (e.g., temperature, flow), but specifics and potential differences among Walleye and Green Bay tributaries are largely unknown. Therefore, our objectives were to determine if the arrival timing and temperature for Walleye entering tributary rivers from Green Bay differed among systems, sex, or total length. A subset of Walleye (n = 384) collected in the Green Bay system in fall 2017 and spring 2018 were implanted with an acoustic transmitter and archival temperature logger. Movements of tagged fish were monitored with an acoustic receiver array while temperature loggers required physical recaptures. Sampling and angling through fall 2019 recovered 40 of these individuals that were detected in the Menominee, Peshtigo, Fox, Cedar, and Escanaba tributaries, but some individuals were river residents or had short durations at large so were excluded from analyses. Preliminary analyses indicated no significant differences for mean arrival date or temperature between sexes, total length groups (i.e., medium, large), or systems; low sample sizes may have limited statistical comparisons. Telemetry detections indicated different behaviors among systems, and additional individuals will be included in analyses. Understanding spawning movements is necessary to guide management of temperature dependent species in changing environments, including for Walleye in Green Bay.

Poster Presentation, Student

Macrophyte Coverage Improves Largemouth Bass Abundance and Size Structure: A RAD Application for Aquatic Plant Management in Wisconsin Lakes

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Climate change is predicted to alter north-temperate ecosystems via lake warming, which could be followed by an increase in macrophyte production, forcing managers to decide whether to resist, accept, or direct these changes. Though warmer waters and more macrophytes are beneficial to some native species (e.g., Centrarchidae), this habitat change may negatively affect others (e.g., walleye *Sander vitreus*). Centrarchids (e.g., largemouth bass *Micropterus salmoides*; LMB) are known to win competitive and predatory interactions with walleye in warmer, more macrophyte dominant systems. Thus, in warming lakes unlikely to support walleye, macrophyte management could be a tool to accept ecosystem changes and provide robust centrarchid fisheries. Our objective was to explore potential relationships between LMB electrofishing catch-per-unit-effort (CPUE; fish/miles shocked), proportional size distribution (PSD), and the proportion of the littoral zone that is vegetated (PLV) across the Ceded Territory of Wisconsin. We found that LMB CPUE, PSD-Preferred (proportion of stock-length fish that are also preferred length), and PSD-Memorable were significantly positively related to PLV. We also found a significant inverse relationship between PSD-Quality and PLV while no relationship was found between PSD-Stock and PLV. Weighted binomial logistic regressions show that PLV was a significant predictor of PSD-Quality, -Preferred, and -Memorable. Results suggest increasing macrophyte coverage may promote an increase in LMB relative abundance and, on average, an increase in size structure. Given the negative (and cascading) effects of climate change on native coolwater species (e.g., walleye), some systems are likely to become dominated by LMB. Macrophyte management may therefore represent a strategy to accept these changes and improve expanding LMB fisheries, providing an example of how Resist-Accept-Direct (RAD) decision-making may be integrated into aquatic ecosystem management.

Poster Presentation, Student

Evaluating the Effects of a Protected 9-12 Inch Slot Regulation on Smallmouth Bass in Nebish Lake, Wisconsin

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Joseph Mrnak, Greg Sass

Understanding how fish populations respond to various regulations is critical for informing management decisions. Indeed, similar regulations (e.g., bag limits, length limits, season closures) may elicit different population-level responses depending on the species and ecosystem. Nebish Lake, a 94-acre oligotrophic lake in northern Wisconsin with a simple fish community (Yellow Perch, Smallmouth Bass) is part of the Northern Highland Fisheries Research Area (NHFRA) compulsory creel census where fishing pressure, angling data, and harvest is recorded. A protected no harvest slot length limit on Smallmouth Bass from 9-12in and a daily bag limit of 5 fish was in place from 1989-2015. This regulation was enacted to protect fish reaching sexual maturation. We used all available creel and fyke netting data collected during 2010-2015 to test for changes in: 1) population size structure, 2) growth rates; and 3) catch rates in response to the regulation. Population size structure did not change, and the number of fish caught >12in declined over this time frame. This was likely a result of angler harvest of >12in fish. Sustained successful natural recruitment led to a high density of small, slow-growing individuals. Angler effort and catch rates were highest in May-June corresponding with the spring spawning period. Our results suggest that a protected no harvest slot limit of 9-12in for Smallmouth Bass may increase overall abundance and induce density dependent growth effects. Our results also suggest that bed fishing or fishing during the spawning did not negatively influence recruitment success or population abundance.

Poster Presentation, Professional

Occurrence Patterns and Population Structure of Slimy Sculpin, Western Blacknose Dace, and White Sucker in the Coon Valley Watershed, Wisconsin

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Tracy Joe, David Schumann

The Coon Valley watershed supports numerous coldwater streams with well-known trout populations in the Driftless Area of southwestern Wisconsin. Numerous research efforts have documented the occurrence and habitat requirements of sport fish in the region, but less is known about the non-game fishes. To provide a new understanding of the ecology of these lesser-known fishes and inform potential management efforts, we conducted backpack electrofishing at four streams to: (1) identify the occurrence patterns of Slimy Sculpin (*Cottus cognatus*), Western Blacknose Dace (*Rhinichthys obtusus*), and White Sucker (*Catastomus commersonii)*; (2) compared the catch-rates and size structures of each species amongst four sampled streams; and (3) quantified the relationship between relative abundances and common stream characteristics. Electrofishing occurred at six 100-m sampling sites in four separate streams ($N = 24$): berge, hohlfeld, rullands, and spring coulees. All captured fish were identified, counted, and measured to total length (mm) before release. Water chemistry, instream characteristics, and riparian conditions were measured at 11 transects at each site. A Kruskal-Wallis test was used to compare the relative abundances of each species among streams. Although mean catch-rates of Slimy Sculpin (range: 0 - 168 fish per hour) and White Sucker (range: 0 - 260 fish per hour) varied among the streams, there was no statistical difference among streams for either species (Slimy Sculpin: $F = 2.9$, $df = 3$, $p = 0.06$; White Sucker: $F = 4.9$, $df = 3$, $p = 0.18$). Western Blacknose Dace were only caught in Hohlfeld Coulee (mean = 5.10 ± 3.57 fish per hour). Further analyses will describe the relationships between fish catch-rates and environmental covariates. This research provides additional ecological insight into these lesser-known species.

Poster Presentation, Student

Paving a Way for Northern Pike (*Esox lucius*) in Brown County, Wisconsin

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The Northern pike, *Esox lucius*, was once regarded as one of the most prolific esocids residing within Green Bay and its joining tributaries. Native to the region, this top predator has offered abundant economic benefits to communities through recreational, commercial, and sport fishing opportunities. Anglers can harvest up to five fish a day with no minimum size limit. This provides citizens with an excellent self-sustaining protein source that can be caught in many of their local waterways. The Wisconsin Department of Natural Resources has been inventorying these toothy giants in lower Green Bay since the early 1980s. Although WDNR creel data suggests that catch and harvest rates have naturally fluctuated over the last three decades, Northern pike are now facing reproductive challenges due to decreasing water quality and increasing habitat degradation. Pike require adequate vegetation throughout ditches, tributaries, and ephemeral wetlands to increase the adhesion probability of their mucilaginous young. Unfortunately, pike spawning activity has been drastically influenced by wetland loss, fragmentation, and the intrusion of invasive florae. Private, state, and federal organizations continue to work together to combat changing environmental conditions and urban developments. The reestablishment and monitoring of ephemeral waterways will continue to remain a significant contributor to Northern pike spawning success as aquatic environments continue to face variable change. Due to the wide variety of agricultural practices and the rapidly increasing population within Brown County, the Brown County Land and Water Conservation Department has prioritized the advancement of Northern pike and their habitats through landowner partnerships and cost-sharing initiatives.

Poster Presentation, Professional

Density-Dependent Growth Effects and Muskellunge Management: A Case Study in Escanaba Lake

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Camille Mosley, Stephanie Shaw, Brett van Poorten, Greg Sass, Stuart Jones

Voluntary catch-and-release (CR) by anglers and stocking have emerged as a recreational fisheries management panacea in many regions. Anglers and managers often assume that CR practices and stocking will allow more individuals to survive to older ages and larger lengths. Taken together, the increasing prevalence of CR fishing and long history of stocking creates questions about the long-term effects of these practices on population size structure are in meeting diverse angler desires. Muskellunge are a key species that has undergone a transition in angler behavior from harvest to CR fishing in addition to widespread stocking. Muskellunge growth rates vary widely among populations in different waterbodies, and previous work has provided contrasting evidence for trade-offs between fish abundance and individual growth rates. Given the cultural, recreational, and economic importance of muskellunge fisheries, and the observed growth variability among populations, understanding whether increases in density due to CR and stocking compromises trophy potential is critically needed for managing muskellunge. Using 60 years of harvest, age, length, and abundance data from Escanaba Lake, the relationship between abundance and length-at-age was modeled to estimate what effect, if any, abundance increases had on fish length. Our findings, while mostly relevant to Escanaba Lake muskellunge, provide general insight into the length-abundance tradeoff in this species and suggests stocking and regulatory practices currently in place may need to be recalibrated to meet angler desires for trophy fishing opportunities.

Poster Presentation, Professional

Muskellunge Epigenetic Clock: Non-Lethal DNA-Based Aging

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Current fish aging methods are largely based on counting annuli on otoliths, fin rays, scales, and other hard structures. Otoliths, which are often the most reliable aging structure, can only be read if they are extracted from the fish. For most species and aging structures, annuli group closely together as the fish approaches its full-grown size, which can lead to inaccuracies in older fish. Methylation-based aging has been demonstrated to be an accurate alternative means for non-lethally aging fish. As fish age, there are methyl groups added to their DNA at a predictable rate, which can then be detected using a bisulfate treatment followed by DNA sequencing. This technique has been developed and validated for several fish species, including zebrafish, lungfish, and red snapper; however, the approach has not yet been applied to a North American freshwater fish species. Our current research aims to develop and validate a methylation-based aging model for muskellunge, Esox masquinongy. We have identified regions in the muskellunge genome that are synonymous with age-associated methylation sites in zebrafish and have begun optimizing a technique for genotyping those targets. We will calibrate our model using known-age hatchery-reared muskellunge samples that were PIT tagged upon release and later collected by the Wisconsin Department of Natural Resources from Lake of the Pines, Middle Eau Claire Lake, and Sand Lake. Known age samples, and therefore aging model applicability, currently span ages from one to twelve years old. Once further optimized, this technique may provide fishery biologists with an alternative means for accurate non-lethal aging of muskellunge and serve as a proof-of-concept for development of methylation-based aging models for other Wisconsin fishes.

Poster Presentation, Student

Using known cisco population sizes to evaluate catchability coefficient (q)

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As population size increases, catch rates are assumed to increase proportionally. This assumption that the catchability coefficient (q; proportion of the available fish stock captured with a single unit of effort) scales proportionally with stock size may not always be true due to gear biases and limitations, fish behavior and movement, and(or) interactions between other biotic or abiotic factors. Two ongoing whole-lake experiments provide a unique opportunity to examine this assumption of q whereby known numbers of cisco *Coregonus artedi* have been stocked into Crystal and Sparkling lakes (Vilas Co., Wisconsin). We conducted monthly vertical gillnet sampling on both lakes from June – August of 2021 and 2022. These data (known population size of cisco and the number of cisco sampled in the gill nets) were then used to estimate q for each sampling event. We then used a linear regression analysis to test if q was consistent through time. Our results show that q did not significantly change from June – August in either study lake during 2021. However, during 2022, we found a significant positive relationship and a significant negative relationship between q and month for Crystal and Sparkling lake, respectively. Thus, we found the assumption that q scales proportionally with stock size may not always be accurate, which has critical management implications. For example, the Invisible Collapse of a few Canadian Shield lakes was proposed to be partially driven by stable catch rates concurrent with declining stock sizes. Misguided management directives following insufficient/poor stock assessments may lead to devastating or irreversible negative impacts on the native ecosystem. We encourage managers and researchers to consider that species-specific behavioral and ecological differences, gear biases and limitations, and the fact that fish move through space and time may independently or jointly interact to influence the relationship between q and stock size.

Poster Presentation, Student

Evaluating Brook Trout Connectivity and Spring Pond Use Within the Plover River System, Wisconsin

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Protecting refugia that provide favorable thermal habitat will be crucial for the persistence of sensitive salmonid species amid changing climates. Wisconsin has thousands of miles of thermally suitable habitat for brook trout *Salvelinus fontinalis*, but climate change threatens to drastically reduce cold-water habitat. Spring ponds may serve as refugia during droughts and periods of extreme weather events because of consistent groundwater input and depth that maintain cold water. However, the limited knowledge of brook trout movement and genetic connectivity between spring ponds and river systems limits the efficiency of spring pond management, protection, and rehabilitation efforts. The Plover River system in central Wisconsin contains a naturally reproducing brook trout population in upstream reaches and connected spring ponds. Passive integrated transponder (PIT) tags and antennas and genetic analyses will be used to determine if brook trout use of spring ponds varies by season, abiotic factors, and pond characteristics, and if population connectivity exists between spring ponds and river reaches from late fall 2022 to spring 2024. The relationship between brook trout demographics and spring pond characteristics, and whether brook trout are locally adapted to the contrasting river and spring pond habitats will also be evaluated. This study will inform managers of spring ponds to protect and rehabilitate to provide thermal refuge and provide greatest benefit to brook trout populations and allow appropriate management of these populations based on population connectivity between systems.

Poster Presentation, Student

Tracking Genetic Diversity of Wild, F1, and Interpopulation F2 Brook Trout Crosses

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Population genetic diversity is broadly accepted as an important variable of population viability. However, genetic diversity can be lost in the hatchery breeding and rearing processes. The Wisconsin DNR propagates Brook Trout *Salvelinus fontinalis* that have been raised in a hatchery for only one (F1) or two (F2) generations to reduce the effects of genetic diversity loss and domestication. Moreover, while domestic Brook Trout are often cheaper and logistically easier to produce, F1 and F2 wild Brook Trout tend to have higher survival rates than their domesticated counterparts. Our objectives were to track changes in genetic diversity from wild to F1 Brook Trout and to determine if genetic diversity of F2 Brook Trout can be increased by crossing F1 individuals from different populations. We genotyped wild, F1, and F2 Brook Trout from five populations at 91 microsatellite loci. Preliminary analyses indicate that allele richness (AR) and effective population size (Ne) decline from the wild to F1 generations, following theoretical expectations given a bottleneck from the total wild population size to the smaller number of Brook Trout spawned for hatchery production.AR and Ne then increased from the F1 to the interpopulation crossed F2 generations, again following theoretical expectations of outcrossing. Preliminary results also indicate that the inbreeding coefficient (Fis) increased in the F2 individuals, possibly due to the incidental production of some F2 crosses generated from the same F1 population source. Although genetic diversity of interpopulation crossed F2 Brook Trout increased from the F1 generation, concurrent research will evaluate whether fitness and survival in the wild have a concordant increase. Collectively, this research may help inform Brook Trout propagation practices to better achieve goals of conserving native genetic variation while maximizing fitness of stocked fish.

Poster Presentation, Student

Temporal Trends in Gill Lice *Samincola edwardsii* Infection Intensity in Individual Brook Trout

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Nick Hoffman, Matthew Mitro, Spencer VanderBloemen

Gill lice *Salmincola edwardsii* are ectoparasitic copepods that have been observed infecting Brook Trout *Salvelinus fontinalis* in Wisconsin streams since the late 19th century. Recent research identified gill lice as a proximate cause of Brook Trout loss in Ash Creek; quantified the distribution, prevalence, and maximum intensity of infection of adult female gill lice in streams across Wisconsin; documented short-term dynamics of gill lice infection in caged Brook Trout; and described temporal trends in infection and variation in attachment location on Brook Trout in four streams. Here, we build upon this research by investigating temporal trends in infection intensity in individually tagged Brook Trout in three streams: Ash Creek (Richland Co.), Lawrence Creek (Adams Co.), and Upper Middle Inlet (Marinette Co.). Specifically, we were interested in understanding the conditions in which gill lice infection intensity in a fish can decrease over time. We observed that on streams where Brook Trout generally have a low intensity of infection (1-5 adult female gill lice), infection intensity generally remained low, varying over time, and sometimes went to zero. However, when infection intensity increased and became high (15 or more adult female gill lice), it generally remained high.

Poster Presentation, Professional

Use of Aerial Imagery to Document Stream Habitat Change: Beaver Dam Removal on Armstrong Creek (Lincoln Co.)

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Ryan Bemowski, Nick Hoffman, Mirjana Mataya, Spencer VanderBloemen

Beaver *Castor canadensis* colonization of trout streams can create complex channel structures that can be difficult to quantify and represent by field measurements. Aerial imaging using unmanned aircraft systems provides an approach that can complement ground-based habitat measurements with visual representations of streams, which convey the scale of beaver dam effects on streams and recovery following their removal. We proposed restoring free-flowing conditions to improve thermal habitat for trout and other coldwater fishes by removing all beaver dams from a headwaters section of Armstrong Creek, a Class 2 trout stream in Lincoln County, Wisconsin. Here we show how aerial images capture the scale of habitat changes from pre- to post-restoration of the stream following beaver and beaver dam removal in spring 2022.

Poster Presentation, Professional

Use of Aerial Imagery to Document Habitat Change: Beaver Colonization on Big Spring Branch (Iowa Co.)

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Ryan Bemowski, Nick Hoffman, Mirjana Mataya, Spencer VanderBloemen

We used aerial imaging to document habitat changes in Big Spring Branch, a Class 1 trout stream in Iowa County, Wisconsin, as beaver *Castor canadensis* continued to recolonize the stream. Sequential images showed the transience of some beaver dams breached or blown out by a March 2022 flood and the persistence of others. The unmanned aircraft system also employs forward-looking infrared (FLIR) technology to capture infrared images alongside visible light images. The color gradient in FLIR images represents relative temperature, with an image near a beaver dam on Big Spring Branch showing colder water temperatures largely maintained in the thalweg as water flowed downstream through the beaver dam. Used in combination with water temperature data loggers, FLIR images can provide stream-wide context for temporal monitoring of thermal conditions at fixed point locations in streams.

Poster Presentation, Professional

Applying Panarchy Theory to Invasive Species Management: Is Top-Down Control a Requirement for Food Web Restoration?

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Invasive species are a global concern. After an invasive species establishes, they often disrupt ecosystems leading to new dynamics and species interactions, making management efforts difficult. Panarchy theory is a conceptual framework to account for the dual and seemingly contradictory characteristics (stability and change) of all complex systems across distinct spatial and temporal scales. Panarchy theory has the potential to be applied to gain better insight into invaded system dynamics by creating a framework to characterize complex natural systems. This framework allows for management actions (e.g., whole-lake biomanipulations, invasive species control, native species restoration) to be leveraged against natural and induced ecosystem processes, providing a greater probability of desired outcomes. Following this framework, we are conducting two whole-lake experiments aimed at invasive rainbow smelt (*Osmerus mordax*) control and native cisco (*Coregonus artedi*) restoration. We will be testing whether food web structure (i.e., presence or absence of apex predators) influences the interactions among invasive and native forage fishes. The application of panarchy theory should be viewed as a conceptual extension of efforts to restore ecosystems and(or) manage fisheries using a food web and ecosystem context (i.e., "food web thinking", ecosystem-based fisheries management).

Poster Presentation, Student

Aquatic Invasive Species Early Detection and Monitoring Program – 2022 Season Overview

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Lake Michigan is under constant pressure of new invasive species threatening native aquatic communities. Previous invasions of species such as round goby (*Neogobius melanostomus*), zebra mussels (*Dreissena polymorpha*), and quagga mussels (*Dreissena bugensis*) continue to severely impact the ecosystems of the Great Lakes. New invasive species have unknown cascading impacts on established ecosystems, therefore it is critical that early detection efforts guide future management applications preventing the establishment of invasive viable populations. The Green Bay Fish and Wildlife Conservation Office Aquatic Invasive Species Team monitors the Lake Michigan basin for these future invaders. Each year, effort is allocated between water samples and traditional fisheries gear surveys. Environmental DNA (eDNA) water samples are collected to detect potential presence of invasive carp. Early detection methods, including gill nets, boat electrofishing, ichthyoplankton trawls, and colonization rock bags, are used to optimally sample nearshore fish and aquatic macroinvertebrate communities. In 2022, the AIS program grew to include Eurasian ruffe (*Gymnocephalus cernuus*) and grass carp (*Ctenopharyngodon idella*) monitoring surveys. Biological data and structures are collected from these species to expand current knowledge of life history and diet composition. This poster provides an overview of our effort and catch for the entire 2022 season.

Poster Presentation, Professional

Investigating Relationships Among Walleye (Sander vitreus) Egg Quality, Maternal Traits, and Interactions with Environmental Factors

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Stephanie Shaw, Zachary Feiner, Greg Sass

Walleye (*Sander vitreus*) survival to the fall recruitment stage has notably declined over time within the Ceded Territories of northern Wisconsin with many hypothesized and potentially interactive causes. Failure to recruit can have cascading effects within lake ecosystems, which can be exacerbated by other sources of walleye decline such as production overharvest, poor habitat, and inter-specific competition. Maternal traits, like length and body condition, can influence successful walleye recruitment, but the relative contribution of these traits can be inconsistent, indicating that other environmental or population-level factors may become more important under certain conditions. The walleye fishery of Escanaba Lake, Wisconsin, presents unique opportunities to study the reproductive characteristics of a formerly unexploited, naturally recruiting population to better understand walleye recruitment and thus, future population dynamics. Our goals were to: 1) test for a relationship between egg size and phenotypic traits of female walleye; and 2) test whether any identified relationships were affected by environmental and population factors. We collected egg samples during spring fyke netting surveys annually during 2018, 2019, 2021, and 2022. Egg and oil droplet diameter were measured on ten eggs per female and the mean diameters and standard deviations were calculated. We related egg and oil droplet diameter to maternal age, length, weight, and body condition (corrected for gonad weight), and tested for interactions with winter severity, angling effort, water temperature, walleye and yellow perch (*Perca flavescens*) population density, and spawning phenology, using the Akaike information criterion model selection approach. Our research findings could help inform managers of the mechanisms driving low walleye recruitment and be better equipped to respond efficiently to management concerns.

Poster Presentation, Professional

2022 USFWS Lake Michigan Grass Carp Strike Team

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Cari-Ann Hayer, Nathan Barton, Sharon Rayford, Matthew Petasek

Grass carp are a non-native invasive species which threaten the health of the Great Lakes Ecosystem. When present in high densities, grass carp may act as ecosystem engineers by impacting the establishment and growth of aquatic plants. In 2022 the Green Bay Fish and Wildlife Conservation Office formed a dedicated Grass Carp Strike Team which operates within the Lake Michigan Basin. The purpose of the Grass Carp Strike team is to identify and remove populations of grass carp from the Lake Michigan Basin. During the first year of work twelve grass carp were removed from Wisconsin, Michigan, and Indiana. Briefly we plan to identify why grass carp are a problem, share our results from the 2022 field season, and offer lessons learned along the way. Additionally, we will share our contact information within the poster, inviting biologists to share their grass carp observations with us.

Poster Presentation, Professional

Walleye Fisheries of the Upper Great Lakes Region: Bright Spots in a Changing Climate

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Holly Embke, Zach Feiner, Gretchen Hansen, Dan Isermann, Olaf Jensen, Jake Vander Zanden

Multiple anthropogenic stressors have influenced inland fisheries in the past and continue to do so today. Habitat loss, pollution, species introductions, and overfishing have influenced inland fisheries for decades, and the effect of climate change threatens to compound these anthropogenic stressors. This project focuses on inland lake walleye fisheries of the Upper Great Lakes region, which have been declining in the past two decades. Instead of focusing on factors that influence population decline in these walleye fisheries, this research emphasizes 'bright spots' – walleye fisheries success stories. The bright spots project seeks to understand the factors associated with fisheries that perform far better than expectations given climate change effects. This project combines different approaches to provide new insights into walleye fishery bright spots, which include: a whole-lake experimental removal of centrarchids, observational studies of walleye thermal-optical habitat use through acoustic tagging across several lakes, a synthesis of how walleye fisheries have responded to previous management restoration efforts, and a statistical analysis aimed at detecting walleye fishery bright spots across a large spatial scale. The bright spots project is currently in the beginning phases and anticipates that combining the results of these multiple approaches will yield new insights into what helps contribute to a successful walleye fishery. These results will also generate knowledge that will aim to inform climate-smart fisheries management in the future.

Poster Presentation, Student

Brook Trout Population Characteristics in McGee Lake, Langlade County, WI

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Dave Seibel, Joshua Raabe

Spring ponds are unique, fertile aquatic systems important for native cold-water organisms such as Brook Trout *Salvelinus fontinalis*. Langlade County has the highest density of spring ponds in Wisconsin, many are surrounded by Wisconsin Department of Natural Resources (WDNR) property. Trophy Brook Trout (I.e., >14 in) are infrequent across Wisconsin due to non-native fishes, harvest, and habitat alterations. McGee Lake, a 23-ac spring pond in Langlade County, has produced trophy Brook Trout approaching 20 in for decades. McGee Lake has been managed for various purposes and received two chemical treatments for removal of non-native fishes. Our objectives were to determine absolute growth, compare PSD values to other spring ponds, and observe tends in length frequency histograms in relation to estimated abundance. Brook Trout were sampled during annual double run boom electrofishing surveys conducted mid-October from 2017-2022. Individuals were measured for total length, examined for sex, spawning stage, and the presence of a Passive Integrated Transponder (PIT) tag, with new individuals being tagged. Size structure was evaluated with length- frequency histograms and proportional size distributions, while growth was examined with recaptured individuals. Analyses revealed an abundance of trophy fish with high growth rates. Average length across all years was 12.64 in with a growth co-efficient of 0.40. The average proportional size distribution was 77 using a stock size of six in with quality fish greater than 11 in. Studying the unique Brook Trout population characteristics in McGee Lake is critical for its conservation and the conservation of northern Wisconsin spring ponds.

Poster Presentation, Student

Evaluation of Natural and Artificial Habitat on Brook and Brown Trout in Central Wisconsin Streams

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Patrick Catalano, Darian Woller, Isaac Cavanaugh, Colton Sime, Joshua Raabe

Trout stream habitat restoration and enhancements receive considerable efforts in the United States (>$1 billion annually), but the effects of these projects are rarely evaluated. Therefore, our objectives were to determine if Brook Trout *Salvelinus fontinalis* and Brown Trout *Salmo trutta* demographics (e.g., body condition, length, abundance) differed between natural and artificial habitat sites in three central Wisconsin streams. Each stream had a natural (i.e., no restoration/enhancement) and an artificial (i.e., brush bundles, overhead structures) habitat site that were approximately one mile apart. Sites (200 meters in length) were sampled using barge electrofishing in October 2022, with length and weight measured for all trout. Preliminary analyses indicate Relative body condition was significantly different between artificial and natural habitat types for both Brook (p=0.02) and Brown (p=0.0001) Trout, with trout growing plumper in artificial habitats. For artificial habitat, Brook Trout had a significantly (p=0.0003) higher relative condition in overhead structure sites compared to brush bundle sites, but Brown Trout condition did not have a significant (p=0.75) difference. Total length for Brook Trout was significantly higher (p=0.003) in natural sites compared to the artificial sites, but Brown Trout did not have a significant (p=0.49) difference in total length between the artificial and natural habitat sites. Trout had higher or similar catch rates in the artificial sites compared to the natural sites. Trout stream restoration appears to improve length for Brook Trout, and body condition of both Brook and Brown Trout in central Wisconsin streams, but additional research such as other seasons, systems, and other habitat types is necessary. This study provides valuable information to managers on how stream restoration techniques affect Brook and Brown Trout in central Wisconsin streams.

Poster Presentation, Student

Effects of Riparian Habitat Type on Macroinvertebrate Drift in the Little Plover River, Wisconsin

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Rachael Valeria

Many benthic macroinvertebrates are indicators of factors affecting stream health; therefore, composition and abundance of aquatic and terrestrial macroinvertebrates may reflect the impact of riparian habitats. Research into riparian habitats and corresponding terrestrial macroinvertebrate availability is important because many stream fishes, such as the economically and ecologically important Brook Trout (*Salvelinus fontinalis*), rely on macroinvertebrates that fall from riparian areas, drift downstream, or are aquatic for part of their life cycle to promote a healthy diet and growth. The study objective was to determine if the composition and abundance of aquatic and terrestrial macroinvertebrate drift varied among differing riparian areas; forested, wetland restoration, and agriculture in the Little Plover River in Central Wisconsin. In the fall of 2021, two drift nets were deployed in previously selected sites at all three locations for 24 hours to collect and preserve aquatic and terrestrial macroinvertebrates. Macroinvertebrates were sorted and identified to family in the Aquatic Biomonitoring Laboratory. Macroinvertebrate drift composition and abundance was compared among each of the riparian habitats and analyzed. Results from the drift samples showed the highest number of total macroinvertebrates in the restored wetland, and lowest in the agriculture/grassland; all three locations exhibited a higher proportion of aquatic invertebrates than terrestrial. This research provides insight into how riparian land use may affect stream macroinvertebrate populations and Brook Trout prey availability.

Poster Presentation, Student

Environmental Influences on Adaptive Genomic Variation of Lake Michigan's Lake Whitefish

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Local adaptation is an evolutionary process where natural selection leads populations to become better suited to survive and reproduce in their proximate environment. Through time, local adaptation can generate a spatial patchwork of adaptive genetic variation, leading to a variety of ecological and evolutionary outcomes pertinent to population persistence. For instance, evolutionary diversification across interconnected subpopulations can boost resiliency of both the individual subpopulations as well as the population at large, making them more robust to future challenges such as climate change and habitat alterations. Our objective was to determine whether lake whitefish (*Coregonus clupeaformis*) adaptive genomic variation that occurs across Lake Michigan is associated with specific environmental characteristics that vary throughout the lake. To identify potential environmental features correlated with genomic signals of selection, we used genotype-environment association (GEA) analysis, which quantifies relationships between local allele frequencies and abiotic metrics. We used zonal statistics in ArcGIS Pro to quantify variation of nine environmental attributes in relation to 17 lake whitefish spawning locations— both at local (5km) and regional scales (50km). Redundancy analysis was used to compare allele frequencies at nearly 200,000 single nucleotide polymorphism genetic loci with our collected environmental variables. Preliminary analyses identified 788 loci that were significantly associated with environmental characteristics. Of those, most putatively adaptive genetic variation was linked to local mean depth, local spring rate of warming, and local surface temperature. In general, local factors had more significant relationships than regional ones, which may indicate that selection pressure is occurring more widely at early life history stages for lake whitefish rather than later stages.

Poster Presentation, Student