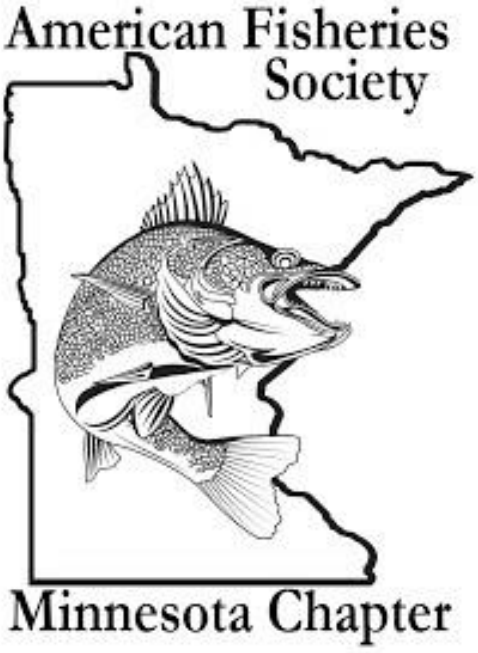
Minnesota Chapter of the American Fisheries Society Annual Meeting – Abstract Book



Leaving a Conservation Legacy

February 26-28, 2024

Brainerd, Minnesota

Concurrent Session 1

Lakeside 1 Tuesday 10:20am to 12:00pm

INABA: I Need A Better Acronym for these Big Fish Data

Mike Verhoeven, Holly Kundel Masui, Denver Link, Jenna Ruzich, Gretchen Hansen

Presenter: Mike Verhoeven verh0064@umn.edu
Affiliation: University of Minnesota

Many questions in fisheries management and ecology–especially those pertaining to climate change–are challenging to address at broad temporal and spatial scales and in ways that address the complexity of fisheries ecosystems. Model-based approaches that share data across broad environmental gradients can overcome some of these challenges, but the data requirements of those efforts pose challenges for implementation. For example, projecting fish growth or abundance in Minnesota under future climate scenarios requires an understanding of thermal performance of fisheries at temperatures never observed in Minnesota. To help address these challenges, we have assembled fisheries survey data from seven Midwestern states. We start with raw, variable, disparate agency datasets and shape them into a region-wide, interoperable, dynamic fish catch and effort database using a reproducible data handling workflow. Using these data our team has begun to address questions about drivers of fish growth and relative abundance in a changing climate. In this talk I'll introduce the database and workflow, as well as showcase some use cases of the various data types.

Walleye bright spots in the upper Midwestern USA

H.S. Embke, Z. Feiner, R. Henningsen, D. Isermann, Q. Smith, O. Jensen, M.J. Vander Zanden, B. Vasquez, G.JA. Hansen.

Presenter: Christopher Rounds round060@umn.edu
Affiliation: University of Minnesota-Twin Cites

Inland fisheries are affected by land use change, climate change, species introductions, and other anthropogenic stressors. In the upper Midwestern United States, walleye are an economically, culturally, and ecologically important cool water species sensitive to changing environmental conditions. Walleye stocks have declined in some locations in which they once thrived, while at the same time, other populations have thrived even when experiencing similar stressors. These heterogeneous responses have raised questions of the role of the environment vs management in shaping walleye populations and how to manage resilient populations under changing conditions. In this presentation, I will describe new research examining walleye using a "bright spots" approach, a method to understand why walleye populations are doing better than expected in some places. Using agency surveys, we describe walleye "hot spots" (i.e., better than average for a given metric) and "bright spots" (i.e., better than predicted based on environmental conditions) for multiple different metrics of walleye populations. Current metrics include recruitment to age-0 and adult relative abundance measured using gill net catch rates. We plan to investigate environmental correlates of these bright spots to predict where robust walleye populations are likely to persist given future climate change. Focusing on bright spots and examples of 'success' tends to highlight innovations, social context, and the possibility of more effective management in the face of large environmental change. We welcome discussion on our approach and the relevant metrics of success as a part of this presentation.

Juvenile Walleye (*Sander vitreus*) Foraging Success and Growth

Noland O. Michels, Allen F. Mensinger, Thomas R. Hrabik

Presenter: Noland Michels miche498@d.umn.edu
Affiliation: University of Minnesota – Duluth

Successful foraging of piscivores is often dependent on available light penetration. In areas like Northern Minnesota, high tannin concentrations limit the penetration of light into the water which may impact both foraging success and growth. We studied juvenile Walleye (*Sander vitreus*) reaction distance and foraging success at multiple light intensities (6.65 × 10^8, 1.58 × 10^11, 3.16 × 10^12, 3.16 × 10^13, 3.16 × 10^14, 1.58 × 10^15, 3.16 × 10^15, and 9.44 × 10^15 photons m^-2 s^-1 of 525 nm light) to observe their growth under varying conditions. Juvenile Walleye (109-156 mm total length; TL) were acclimated for one hour and then released to forage for 15 minutes on three Fathead Minnows (*Pimephales promelas*) in a 1900 L foraging arena. Recorded video was analyzed for the reaction distance to prey and whether the attack and capture were successful. Next, the Walleye (127-182 mm) were randomly assigned to a growth treatment at one of three light intensities (1.58 × 10^15, 3.16 × 10^15, and 9.44 × 10^15 photons m^-2 s^-1) and tannin concentrations (0 mg/L, 10 mg/L, and 20 mg/L) at 18°C for 16 days. TL (mm) and weight (g) were measured at days 0, 8, and 16 and consumption was measured each day for each replicate. Juvenile Walleye growth was always positive, ranging from a 1.76% to a 5.27% increase in total length. Growth was greatest in moderate light with the most tannins. However, capture success is greatest in very low light conditions (1.58 × 10^11 - 3.16 × 10^13 photons m^-2 s^-1) and declines as light intensity increases. Walleye reaction distance increases as light increases, but the probability of an attack decreases with increasing light intensity. This disconnect between prey detection, attack probability, and ideal growth conditions indicates a complex set of foraging cues that select for low light success.

Spatial ecology of reservoir Walleye during and after spawning

Claire L. Rude, John Kempe, Rick Bruesewitz, Michael J. Weber

Presenter: Claire Rude clrude@iastate.edu
Affiliation: Iowa State University

Understanding spatial distribution of fish can provide insights into their behavior, population structure, habitat importance, and even survival outcomes. For instance, fish spatial distribution and site fidelity during spawning can be indicators of quality spawning areas. After leaving spawning locations, spatial differences in spawning movements may persist throughout other seasons or fish may intermix and use similar habitats throughout the rest of the year. Yet, how intraspecific population differences in spawning movements translate into habitat use during other seasons and whether this is associated with differential survival is not well understood. Our objectives were to use acoustic telemetry to assess the spatial distribution and site fidelity of Walleye *Sander vitreus* in Big Sandy Lake, Minnesota between spring 2021 and spring 2022, and compare home ranges and survival of spatially segregated spawning groups outside the spawning season. We tagged and released 90 Walleye (303-615 mm TL) in 2020 and 2021, passively tracked them from October 2020–October 2022, assessed their presence during spring in two tributaries (Sandy and Prairie rivers) versus the main reservoir, and studied spatial use and mortality following the spawning period. Our results provide information on annual variation in Walleye preferences for reservoir tributaries versus lacustrine habitats during spawning and indicate Walleye spawning in different locations may use similar habitats during other seasons.

Investigating Movement Patterns and Behavioral States of Burbot, *Lota lota*, Using Hidden Markov Models

Abigail M. Fountain, Bemidji State University; Tyler J. Robinson, Utah Department of Natural Resources; Shannon J. Fisher, Minnesota Department of Natural Resources; Jon E. Anderson, University of Minnesota Morris; Andrew W. Hafs, Bemidji State University

Presenter: Abigail Fountain abigail.fountain@bemidjistate.edu
Affiliation: Bemidji State University

Burbot, *Lota lota*, are a relatively unmanaged rough fish historically overlooked and occasionally maltreated by commercial and recreational fishers. As such, relatively little research has been conducted on burbot, despite ecological significance as an indicator species. A recent increase in popularity as a target species, however, has prompted new research to inform management policies. The objectives of this study were to (1) summarize burbot movement by identifying patterns in swimming activity and identify possible predictors of movement, and (2) describe underlying, latent behaviors that may be influencing the observed movement activity and quantify the correlation of those behaviors with various cofactors. This study investigated 54 individuals implanted with acoustic transmitters in Bad Medicine Lake, Minnesota, a lentic system, over a period of 18 months. Movement rate and turning angle were calculated for each transmission interval and analyzed using mixed-effects modeling. Behaviors that drive movement, like feeding or resting, are often hard to observe and quantify, therefore further analysis was done using hidden-chain Markov modeling (HMM), a state space modeling technique commonly used in ecological studies to infer latent behavior from observable patterns in organism movement.

Lakeside 2-3 Tuesday 10:20am to 12:00pm

Goldfish removal and restoration of a pond in Eagan MN

Jessie Koehle, Jordan Wein, Jenna Olson

Presenter: Jessie Koehle jkoehle@cityofeagan.com

Affiliation: City of Eagan

A small, shallow lake in Eagan Minnesota has had poor water quality for many years. Over the last several years we have attempted to improve water quality by removing goldfish with rotenone, nets, and electroshocking; and we applied aluminum sulfate in 2023 to reduce internal loading of phosphorus. Goldfish have now been significantly reduced from the lake but not eradicated. Future work involves cleaning up incoming stormwater from the surrounding watershed, stocking bluegill as likely predators of goldfish eggs, and sending information to the community about aquatic invasive species prevention. We plan to monitor the fish population, plant community, and water quality data as part of our adaptive management process.

Aquatic Macrophyte Community Response to Carp Removal and Invasive Macrophyte Management in Staring Lake, Minnesota.

Maija E. Weaver, Raymond M Newman

Presenter: Maija Weaver weave530@umn.edu

Affiliation: University of Minnesota

Staring Lake is a shallow (4.9 m maximum depth) 66-hectare lake located in Eden Prairie, Minnesota. In 2011, the lake was turbid with poor water clarity and a high population of common carp (*Cyprinus carpio*; > 450 kg/ha). To improve water quality and the native aquatic macrophyte community, carp removal began in 2012 and concluded in 2015 with a reduction to approximately 100 kg/ha. Point intercept surveys were conducted 2-3 times a summer from 2011-present and biomass was assessed on a subset of points. Directly following carp removal there was an increase in plant diversity, frequency of occurrence, and biomass. Native plant frequency of occurrence increased from below 20% to 67% in 2016 and was up to 89% in 2022. Native biomass increased from <100 g/m2 in August 2015 to 615 g/m2 in August 2016 and remained above 250 g/m2 in 2022. These numbers were also influenced by the expansion and treatment of the invasive macrophytes curlyleaf pondweed *(Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Various herbicide teatments for both curlyleaf pondweed and Eurasian watermilfoil have been conducted from 2015-present. Staring Lake is an illustrative case study for improvement of native macrophyte communities and water quality post-carp removal. A combination of water quality improvements and herbicide treatments for invasives, may be needed to improve native plant communities of lakes with similar characteristics.

Developing a Germline Chimera Between Common Carp and Fathead Minnow to Quicken Genetic Biocontrol Development

Colby Johnson, Nicholas Phelps, Michael Smanski

Presenter: Colby Johnson joh15243@umn.edu
Affiliation: University of Minnesota

The ability to spawn fish in a facility is key to several aspects of modern society. However, species may carry traits that make them logistically challenging to grow in a facility and spawn efficiently. This is the case for common carp (*C. carpio*), a harmful aquatic invasive in Minnesota that the Smanski lab is developing genetic biocontrol mechanisms to curtail. Due to long generation times and challenging aspects of their husbandry, there is sufficient incentive to develop methods of carp embryo production other than their natural reproduction. One such alternative is the creation of germline chimeras, with a faster-growing surrogate species hosting the germ cells of a donor species and producing the donor's gametes. We aim to establish a germline chimera with common carp as the donor and fathead minnows (*P. promelas*) acting as the surrogate host. This involves extracting common carp germ cells and implanting them into sterilized fathead minnow embryos. Sterilization of fathead minnows has been successfully achieved through dnd-morpholino treatment, and common carp germline transcript has been isolated from surrogate transplantees, which are currently growing to sexual maturity. Generating common carp gametes through the more facility-friendly fathead minnow would increase throughput significantly for the Smanski lab, and be a notable success in the developing field of fish surrogacy.

Sound Strategies for Common Carp: Enhancing management through acoustic conditioning

Rebecca M. Bullers, Przemyslaw G. Bajer, Alex W. Bajcz, and Allen F. Mensinger

Presenter: Rebecca Bullers rebecca.bullers@gmail.com
Affiliation: University of Minnesota

Acoustic conditioning has the potential to be a useful tool in common carp (*Cyprinus carpio*) management. Bait and removal strategies have proven to be effective, however, one limitation is that feeding aggregations vary in size and duration, and removals often eliminate only those fish present at a specific time. The efficiency of these strategies may be significantly increased through acoustic conditioning by synchronizing feeding aggregations. During the summer of 2023, we tested if common carp could be classically conditioned to associate an acoustic cue with a baited location in Harrisons Bay, Lake Minnetonka. Although evidence suggests that the acoustic cue alone did not attract carp to the baited sites, sites subjected to the cue on average recruited 12% more new carp after bait was administered than sites without the cue. Additionally, the average amount of time it took to attract 90% of the carp detected throughout the whole night was shorter when bait was paired with the cue than bait alone. These findings suggest that feeding aggregations become more synchronized when sites are subjected to both the acoustic cue and bait, leading to more efficient recruitment of fish in a shorter timeframe. The removal of these synchronized aggregations could expedite carp management efforts and potentially reduce associated costs.

Evaluating CO2 and Sound as an Invasive Bigheaded Carp Deterrent in a Model Lock and Dam

Amelia Berry, Michael Frett, Brooke Vetter, Allen Mensinger

Presenter: Michael Frett frett009@d.umn.edu
Affiliation: University of Minnesota Duluth

Invasive silver (*Hypophthalmichthys molitrix*) and bighead carp (*H. nobilis*), collectively referred to as bigheaded carp, are currently threatening to establish resident populations within Minnesota waterways and the Great Lakes. Existing dams, along with their adjoining lock chambers, are potential strategic bottlenecks for restricting the movement of bigheaded carp within the Mississippi River and its tributaries. The development of a multimodal system incorporating bioacoustics and carbon dioxide (CO2) has shown promise to act as an effective non-physical deterrent against the upstream movement of bigheaded carp through lock chambers.

The impact of CO2 injection paired with broadband sound was examined as a potential deterrent in a 10,000-liter model lock and dam system equipped with overhead cameras to analyze fish behavior. Schools of 10 bigheaded carp were initially acclimated in the lock and dam tank over a period of 96-hours. After acclimation, bigheaded carp were conditioned over two days to associate filtered broadband sound (2-4 kHz) with the simultaneous injection of CO2 (~38,000 uatm) within the lock chamber. Following conditioning trials, four broadband sound deterrent trials were conducted daily during a one-week period. Conditioned fish avoided the lock chamber whenever the broadband sound was active and the downstream gate was opened, effectively preventing upstream migration. Carp showed no evidence of habituating to the broadband sound deterrent during week-long trials. Thus far, eight total experimental trials have been completed. Successful implementation of this non-physical deterrent system in the field could impede the upstream movement of bigheaded carp, thus protecting aquatic ecosystems throughout Minnesota.

Lakeside 4 Tuesday 10:20am to 12:00pm

Zooplankton community trends in Minnesota's Large Lakes during a decade of change

Heidi M. Rantala, Kylie Cattoor, Jodie Hirsch, Gary Montz

Presenter: Heidi Rantala heidi.rantala@state.mn.us
Affiliation: MN Department of Natural Resources

Since 2012, zooplankton communities in the Minnesota's nine large Walleye lakes have been sampled during the summer. This effort was initiated to monitor the middle trophic levels as sentinels for ecosystem change related to invasion by zebra mussels and spiny water flea. Since the inception of the program, zebra mussels and/or spiny water flea have been confirmed in all nine lakes. These invasive invertebrates have significant, but different, impacts on the native zooplankton communities. In general, zebra mussels are associated with decreases in abundance, biomass, and production of native zooplankton populations. In addition to those impacts, spiny water flea are associated with a decrease in zooplankton species richness, as they may selectively feed on small-bodied cladocerans. There were decreases in native zooplankton biomass throughout the summer in the presence of either (or both) invasive species, as well as early summer before spiny water flea were detected in the water column. These results show that both invasive invertebrates impact zooplankton in these lakes, with the potential for cascading effects to both lower and higher trophic levels.

Anthropogenic Sound Increases Zooplankton Susceptibility to Fish Predation Beneath Lake Ice

Leah Glimsdal, Allen F. Mensinger

Presenter: Leah Glimsdal glims008@d.umn.edu
Affiliation: University of Minnesota Duluth

The effects of anthropogenic sound in marine environments has attracted considerable attention in the last decade, however little is known on how freshwater organisms may be affected, especially during the winter months. Ice cover on northern lakes blocks meteorological (i.e. wind, precipitation) contributions to the soundscape resulting in lower ambient sound intensities during the winter. However, recreational activities such as snowmobiling and ice fishing may negatively impact aquatic communities. This study examined the effects of motorized ice auger drilling on the behavior of fish and zooplankton on Pike Lake in northern Minnesota. Fish activity was monitored with underwater cameras that were deployed at the ice/water interface and at two and four meters depth. Videos were analyzed for fish presence before, during, and after two minutes of drilling. Zooplankton were collected from the ice/water interface and three meters below the ice five minutes before and after drilling.

Yellow perch (*Perca flavescens*) and golden shiner (*Notropis hudsonius*) increased presence significantly after drilling ($p = 0.04$). Significantly more ($p < 0.01$) zooplankton were captured after drilling at three meters depth. It is hypothesized that drilling initiated zooplankton migration away from the surface, which attracted fish from deeper waters to prey on the zooplankton. This is one of the first studies to demonstrate that zooplankton can be negatively affected by anthropogenic sound.

Seasonal Comparison of Diet Composition of Minnesota Fishes across Various Lake Types

Levi Feucht, Thomas Hrabik, Casey Schoenebeck, Alia Benedict, Tedy Ozersky

Presenter: Levi Feucht feuch017@umn.edu
Affiliation: University of Minnesota Duluth

Food web dynamics in aquatic ecosystems often fluctuate throughout the year due to changes in physicochemical conditions and resource availability. Resource availability under the ice is understudied, leaving opportunity for improved knowledge of under-ice energy exchange among trophic levels. The under-ice period, which can extend up to 6 months in Minnesota, can have both positive and negative lasting impacts on fish growth and overall bioenergetic budgets. To study the energy intake by fish at multiple trophic levels, we are using horizontal gill netting, minnow trapping, and angling under the ice of four Minnesota lakes. This is paired with open water electrofishing to determine if there are any seasonal dietary changes across species. Preliminary data indicates that fish may be more active in the winter than previously thought, with the proportion of empty diets lower than observed in previous studies. Fish at all trophic positions exhibit shifts in diet composition between winter and summer months. Capture and observation rates of fish at all trophic levels also change drastically across seasons. Understanding food web dynamics in the winter may be pivotal to sustainably managing the populations and understanding fish growth and bioenergetics. Our results represent baseline observations of winter/summer comparisons for future studies examining changing Midwest ice cover and winter conditions.

Sublethal Influences of Magnesium Chloride on Fathead Minnow (*Pimephales promelas*) Behavior

Joshua T. Schrope, Allen F. Mensinger

Presenter: Josh Schrope schr1266@d.umn.edu
Affiliation: University of Minnesota Duluth

It is estimated that 72 percent of the 317,000 tonnes of road salt applied annually to the Twin Cities Metropolitan Area is retained in the watershed, adversely affecting freshwater biota. Previous work has outlined the lethal thresholds of chloride-containing deicers to freshwater fish, but sublethal behavioral influences are far less understood. Here, we use the fathead minnow (*Pimephales promelas*) as a model organism to investigate the sublethal influences of magnesium chloride on freshwater fish behavior. Fish were exposed to three sublethal concentrations of magnesium chloride (low: 100 mg/L Cl-, medium: 230 mg/L Cl-, and high: 860 mg/L Cl-) for 72 hours and compared to control fish for differences in prey localization and locomotion. Divalent cations are known to interfere with the lateral line and therefore trials were run in complete darkness to eliminate visual cues and consider the effects of magnesium chloride on the lateral line system. Fathead minnow reaction distance to prey and average prey consumption significantly decreased in all three treatment groups compared to the control. Locomotion was also influenced as the total distance traveled, average velocity, and time spent moving decreased with increased salt concentrations. These sublethal influences could be attributed to the partial ablation of the lateral line system, resulting in reduced predator and prey detection and diminished foraging success. Thus, even relatively low road salt concentrations can interfere with fish sensory systems.

High school and university biologists reveal hidden historical mussel species: Is local park a refuge?

Hannah Grosser, Mark Hove, James Vande Glind, Ezekiel Hinton, Sophia Krueger

Presenter: Hannah Grosser 26evalorgrossha@availacademy.org
Affiliation: Avail Academy High School

Native mussels are important organisms in aquatic ecosystems of Minnesota. Until recently, little was known about the mussels living in Rice Creek, a third order Twin Cities metropolitan stream. To better describe the extant and historical mussel assemblage of Rice Creek, we used water scopes to search for live and dead mussels for periods of 10 to 90 minutes at eight locations between September–October 2023. We observed 12 of 21 mussel species known to live in medium-sized Minnesota streams, including two species listed as Special Concern by the State of Minnesota. Live mussels were collected at an average catch rate of 1.7 ± 1.5 (1 SD) mussels / person hour. It appears that 36% (5 of 14) of the historical mussel species assemblage has been extirpated from Rice Creek. In Rice Creek West Regional Trail Corridor, we observed shells of four mussel species that had not been previously reported from Rice Creek: Creek Heelsplitter, Pink Heelsplitter, Threeridge, and Wabash Pigtoe. Threeridge (*Amblema plicata*) was also found living at this site. Because of the additional species found in Rice Creek, we recommend additional and more intensive surveys be conducted in this stream and that efforts to protect the resources of Rice Creek be continued and expanded, especially those in the Rice Creek West Regional Trail Corridor and Locke Park.

Concurrent Session 2

Lakeside 1 Tuesday 1:00pm to 2:40pm

Male-dominated Bluegill harvest: Does it only occur during the spawn?

Chris Uphoff, Mike McInerny, Chris Smith

Presenter: Chris Uphoff christopher.uphoff@state.mn.us
Affiliation: MN Department of Natural Resources

Bluegill *Lepomis macrochirus* are an important component of many recreational fisheries. In Minnesota, Bluegill make up almost all of the sunfish harvest and are the most commonly harvested fish species by number, with an estimated harvest exceeding 14 million fish annually. High annual harvest is likely affecting Bluegill populations across the state. Angling exploitation is inherently size selective and in fish species that exhibit sexually dimorphic growth or behavior, size-selective harvest can lead to sex-selective harvest. The effects of age, total length, week and lake on sex ratios of angler-harvested Bluegill were investigated in three west-central Minnesota lakes. Total length (mm) was measured, sex was determined, and ages were estimated for Bluegill collected on a weekly to bi-weekly basis from fish-cleaning stations located at Lake Carlos (2017 and 2018), Lake Minnewaska (2018 and 2021) and Lake Osakis (2018 and 2021). Totals of 305 to 1,455 Bluegill were examined from the six fish-cleaning station and year combinations. Sex ratios of angler-harvested Bluegill ranged from 22.6 to 42.6% female, and chi-square analyses found that sex ratios differed from 1:1 in all lakes and years. Male Bluegill made up a greater proportion of angler-harvested Bluegill in a majority of the sampled weeks during the open water season. Logistic general linear models indicated the percent female increased with increasing age of Bluegill, and was variable among lakes and weeks. The presence of large, male Bluegill is likely important in maintaining a high-quality Bluegill fishery, as large parental males may delay maturation of smaller males and help maintain faster growth rates. High proportions of male Bluegill being harvested throughout the year could affect sex ratios of the population and impact Bluegill population dynamics.

Sex ratios of angler-harvested Black Crappie, Largemouth Bass, and Pumpkinseed in several Minnesota lakes

Chris Smith, Mike McInerny, and Chris Uphoff

Presenter: Chris Smith christopher.d.smith@state.mn.us
Affiliation: MN Department of Natural Resources

Black Crappie *Pomoxis nigromaculatus*, Largemouth Bass *Micropterus salmoides*, and Pumpkinseed *Lepomis gibbosus* support popular, harvest-oriented fisheries throughout the Midwest. Due to their popularity and presence of sexual dimorphism among some species, angler harvest could disproportionately harvest one sex resulting in skewed sex ratios. We examined fish-cleaning stations adjacent to three Minnesota lakes to investigate sex ratios of harvested Centrachids. Sex ratios of angler harvested (expressed as % female) Black Crappie (31-57%), Largemouth Bass (32-62%) and Pumpkinseed (35-59%) varied around an assumed 1:1 ratio. In general, sex ratios of angler harvest were moderately male-skewed for most species and fish-cleaning stations. Despite a perceived increase in vulnerability of nesting males, sex ratios of angler harvest do not appear to be affected by spawning. Rather, harvest rates of males appear elevated throughout the entire survey period (May-September). Binary logistic regression models indicated species and age were the best predictors of sex ratios. While angler harvest does not appear to be the primary mechanism driving sex-ratios of these populations, a positive relationship between female harvest and age indicates male panfish may have higher total annual mortality rates than females. An improved understanding of sex-ratio dynamics in relation to angler harvest could improve management of these fisheries.

Optimal Spring Panfish Trap Net Sampling

Tanner Stevens

Presenter: Tanner Stevens tanner.stevens@state.mn.us
Affiliation: MN Department of Natural Resources

Spring trap net sampling targeting mature adult panfish has increased in Minnesota as panfish management becomes more frequent. With differences in panfish spawning phenology, timing of spring sampling is critical and objective dependent. The objective of this project was to examine catch rates and size structure among panfish species over the spring 2023 period to develop recommendations for spring trap net sampling. Sampling took place from May 1st to June 6th with five nets set weekly and ran for two nights each week. A Hobo temperature logger was also placed in 1 meter of water to record hourly water temperature data throughout the project. Bluegill catch was generally consistent over the six weeks. Size structure for Bluegill was lowest the first week but increased quickly and peaked during the 4th week along with catch. Black Crappie catch was the highest the first week, maintained for three weeks and then declined. Black Crappie size structure was variable throughout the sampling period with random peaks in the 2nd and 5th week. The timing of spring panfish trap netting is highly dependent on the target species. Black Crappie catch and size structure was optimized during the 2nd week which corresponded to a water temperature of 13.9 C°. Bluegill however, were optimized during the 4th week which corresponded to a water temperature of 19.8 C°. While it is possible to sample both species during a survey, managers will need to decide the most important target species when scheduling spring trap net survey and closely monitor water temperature.

The Effects of Forward-Facing Sonar on Angler Catch and Harvest Rates

Nick Rydell

Presenter: Nick Rydell nicholas.rydell@state.mn.us
Affiliation: MN Department of Natural Resources

Forward-facing sonar (FFS) has been available to recreational anglers for nearly a decade. With a recent increase in popularity, Minnesota anglers and fisheries managers have raised concerns about how the use of such technology may affect exploitation. However, little information is available regarding the effects of FFS on fish populations. The objectives of this study were to determine: 1) the percent of anglers using FFS, other forms of sonar (e.g., 2D sonar, down imaging, side imaging), and no sonar; 2) what species are FFS users targeting, and 3) if angler catch and harvest rates differ between anglers using FFS and other forms of sonar for Black Crappie (*Pomoxis nigromaculatus*), Bluegill (*Lepomis macrochirus*), Yellow Perch (*Perca flavescens*), and Walleye (*Sander vitreus*). Creel survey data conducted on seven Minnesota lakes between 2021 and 2023 was used. Information presented will aid managers in determining how the use of forward-facing sonar may affect fish populations.

Barotrauma prevalence and post release recovery of Black Crappie angled from a range of depths under the ice.

Will French, Jeff Reed, Brandon Eder, Chris Smith, Jon Hansen, Dave Weitzel

Presenter: Will French will.french@state.mn.us
Affiliation: MN Department of Natural Resources

Black Crappie are a popular game species in most midwestern states and are a frequent target of ice anglers. In many fisheries, ice angling for Black Crappie occurs in areas of deep water (30+ ft.), as crappie often congregate in these habitats under the ice. Angling fish from deep water can induce barotrauma, negatively influencing survival of released fish, and with high angling catch rates (even with catch-and-release efforts) could increase mortality rates. Increased mortality of released fish from barotrauma could mitigate the effectiveness of management actions such as reduced bag limits and size restrictions. Therefore, it is important to understand how barotrauma may impact mortality of angled and released Black Crappie. The goal of this study was to quantify the prevalence of external barotrauma symptoms in ice angled Black Crappie from a range of catch depths and quantify overnight post-release recovery. Black Crappie were angled, assessed for barotrauma symptoms, then held under ice in a net pen for overnight observation. Barotrauma symptoms were less frequent and overnight recovery was high (96%) at capture depths less than 25ft, with increasing barotrauma prevalence, severity, and reduced overnight recovery (44%) up to the maximum capture depth of 35ft.

Changing Use and Selection of Stream Habitats for Redd Placement by Brown Trout Along a 4.8-km Stream Reach

Neal Mundahl, Avery Schnaser

Presenter: Neal Mundahl nmundahl@winona.edu
Affiliation: Winona State University

As stream habitats change from upstream to downstream, choice of spawning redd sites by Brown Trout may shift as habitat availability changes. In a previous study, we examined the importance of overhead cover in redd site selection. Here, we examined spawning site habitat use and selection by Brown Trout by assessing physical characteristics at redd sites in a 4.8-km reach of Garvin Brook during each of five spawning seasons, 2016–2020. We measured redd dimensions, water depths, and current velocities, and compared these among four separate sections (900–1900 m in length) of the stream. We also assessed available habitats within each section to examine possible selection of habitats by spawning trout, plus quantified the size distribution of gravel substrate at redd sites within two stream sections. Habitat availability varied dramatically among stream sections. After analyzing 1844 redds from the five spawning seasons, Brown Trout displayed strong selection for water depths between 10 and 29 cm and current velocities between 10 and 49 cm/sec when choosing redd locations. Preferred/selected water depths and current velocities increased by 7 cm and 10 cm/sec, respectively, between upstream and downstream sections. All redds were placed in gravel/cobble substrates, with variations in size distributions of gravels not correlated to redd dimensions or any measured habitat variable. Spawning site preferences of Brown Trout can change along a stream reach of moderate length, likely in relation to changing availability of various combinations of water depth, velocity, substrate, available cover, and trout abundance.

Hatchery propagation did not reduce natural steelhead productivity relative to habitat conditions and predation in a mid-Columbia River subbasin

Sean Gibbs, Ian Courter, Mark Roes, Tom Chance, Ryan Gerstenberger, Adrian Spidle

Presenter: Sean Gibbs sean.gibbs@mthoodenvironmental.com
Affiliation: Mount Hood Environmental

For over 150 years, hatchery-origin anadromous salmon and steelhead have been reared and released throughout the Pacific Northwest to mitigate for lost habitat and sustain harvest opportunity. Similarly, hatchery programs have been used to introduce and sustain salmon and steelhead fisheries throughout the Great Lakes. Some studies demonstrate that introgression of hatchery and naturally produced fish may constrain conservation efforts through maladaptive genetic processes. However, empirical demonstrations of the influence of these genetic interactions on population productivity are lacking, making it difficult to assess their importance relative to other drivers of productivity. Using a Bayesian state-space stock-recruitment model, we estimated the effect of the proportion of hatchery-origin spawners (pHOS), proportionate natural influence (PNI), and hatchery fish releases on natural adult winter steelhead recruitment in the Hood River, Oregon, over a 27-year period of record. Adult winter steelhead productivity was not associated with pHOS and PNI. However, natural winter steelhead productivity was positively associated with ocean conditions, stream flow, and hatchery fish release numbers, while negatively associated with pinniped abundance. Our analysis highlights the importance of quantifying the influence of hatchery programs on fish production relative to environmental factors known to affect natural-origin anadromous fish recruitment.

Evaluation of Walleye hatch rates at the Park Rapids hatchery

Calub Shavlik, Scott Muhm, Jody Derks

Presenter: Calub Shavlik calub.shavlik@state.mn.us
Affiliation: MN Department of Natural Resources

Park Rapids State Fish Hatchery has been receiving fertilized Walleye eggs from the Boy River spawning trap located just outside of Walker, MN since 1969. Throughout the years egg mortality has occurred at various stages of the process such as: fertilization, water hardening, and incubation. Daily hatch rates have varied greatly, therefore the purpose of this project is to determine if modifications to current standard practices and procedures at either the spawn take site or hatchery could help stabilize and increase overall annual hatch rates. Results from this ongoing project could yield information leading to a larger potential research project benefiting the State of Minnesota walleye stocking program.

Minnesota Record Fish

Mandy Erickson

Presenter: Mandy Erickson mandy.erickson@state.mn.us
Affiliation: MN Department of Natural Resources

Updates on the Minnesota Record Fish program, including expanding the catch and release option and classification of historical records within the harvest program.

Bait Supply Legislative Report

Sean Sisler and Neil Vanderbosch

Presenter: Sean Sisler sean.sisler@state.mn.us
Affiliation: MN Department of Natural Resources

Minnesota bait is mostly wild caught, bait supplies vary annually. Historic causes of supply variability include winterkill, drought, floods, and access to minnow production areas. These factors have been exacerbated by land-use practices and bait harvest restrictions aimed at preventing spread of fish disease and invasive species. Increasing bait demand, especially due to an increase in winter angling, has caused some seasonal bait shortages. The DNR supports the private bait industry so that a Minnesota-grown bait supply can be secured to meet angler demands. The DNR held three meetings with bait producers, harvesters, and retailers, and other fishing interest groups. Discussions resulted in the recommendations to improve bait supply including some that would require changes in rule and/or permitting procedure by the DNR. Such as: Explore the use of artificial ponds and other rearing techniques to supplement wild harvest, VHS free zones, consider expanding minnow harvest gear, increase communication between DNR and minnow dealers, etc. The DNR believes that the recommendations listed in the report have the greatest potential to improve bait availability.

Lakeside 4 Tuesday 1:00pm to 2:40pm

BWCA Survey Sampling and Techniques

Brent Flatten

Presenter: Brent Flatten brent.flatten@state.mn.us
Affiliation: MN Department of Natural Resources

Ever wonder how a MNDNR fisheries lake survey is done in the BWCAW? This is an overview of some of the common sampling methods and techniques. As well as how we get all that gear into some of the most remote work locations in the state.

10 years of MN DNR Lake Index of Biological Integrity Program

Jessica Massure, Derek Bahr, Lucas Borgstrom, Aaron Sundmark, Stephanie Simon, Josh Knopik, and Jacquelyn Bacigalupi

Presenter: Jessica Massure jessica.massure@state.mn.us
Affiliation: MN Department of Natural Resources

The DNR developed fish-based IBIs by sampling a wide range of lakes, from high-quality lakes to those with significantly degraded water quality or shoreline habitat. A statistical analysis found a relationship between the fish communities and water quality and physical habitat characteristics. Four fish-based IBIs were developed to accurately evaluate different types of lakes and expectations for their associated fish communities. The fish-based IBI is one important component that is considered during the MPCA watershed assessment process. Specifically, it is the primary tool used to assess whether a lake fully supports aquatic life. The first assessments using the FIBI tools began in 2015, we will discuss the growth of the program over the past decade, an overview of the fish communities assessed in 38 watersheds, and provide a roadmap for the Programs future.

Identification of stressors impacting Minnesota's lake fish communities

Derek Bahr, Jacquelyn Bacigalupi, Lucas Borgstrom, Josh Knopik, Jessica Massure, Stephanie Simon, and Aaron Sundmark

Presenter: Derek Bahr Derek.Bahr@state.mn.us
Affiliation: MN Department of Natural Resources

Fish communities in Minnesota's lakes have been impacted by various anthropogenic stressors, and to varying degrees. The lake fish index of biological integrity (FIBI) is a tool that has been used to identify impaired or vulnerable fish communities. Once identified, those lakes are included in a rigorous stressor identification process. While lakes within forested watersheds that are surrounded predominantly by natural shorelines often support healthy fish communities, those within agricultural or developed watersheds with extensive shoreline development are more likely to contain fish communities that are impaired or vulnerable to impairment. Measures of these and other stressors such as altered interspecific competition, temperature regime changes, and decreased dissolved oxygen are evaluated and summarized in watershed-specific stressor identification reports. Information from those reports is integrated into watershed restoration and protection strategies and comprehensive watershed management plans, to guide future implementation efforts and ultimately improve fish community health. We will provide an overview of findings, products, and future direction related to stressors impacting Minnesota's lake fish communities.

Fish community-based diagnostic tools for identifying potential stressors and tracking changes in environmental conditions

John Sandberg

Presenter: John Sandberg john.sandberg@state.mn.us
Affiliation: Minnesota Pollution Control Agency

Fish communities reflect environmental conditions and can serve as diagnostic indicators for stressors that are otherwise difficult or expensive to monitor. This diagnostic function is related to different levels of tolerance among species to various stressors; the presence/absence and abundance of individual fish species (and how species comprise a community) can be used to infer the presence or absence of specific stressors in waterbodies, and subsequently inform potential restoration and protection efforts.

Using concurrently collected fish community and water quality data from Minnesota streams and rivers, species-level Tolerance Indicator Values (TIVs) were developed for individual water quality and habitat parameters. Species-level TIVs were then aggregated to derive community-level Stressor Index Values (CTIVs). CTIVs were used to predict the probability of meeting Minnesota water quality standards for dissolved oxygen and total suspended solids. CTIVs have also been developed for potential stressors for which water quality standards do not currently exist (e.g., water temperature). This approach demonstrates potential uses in a) identifying locations of potential (but undocumented) water quality impairments, b) causal diagnosis of biological impairments, and c) inferring changes in stressor exposure over time and space.

Can mechanical removal of invasive cattail benefit lake fish communities?

Amy Schrank, Brendan Nee, Daniel Larkin, Mike Tuma

Presenter: Amy Schrank aschrank@umn.edu
Affiliation: Minnesota Sea Grant

Over the last century, invasive narrow-leaf and hybrid cattails (*Typha angustifolia* and *Typha* x *glauca*, hereafter cattail) have moved into lake littoral zones across the Great Lakes region and displaced native vegetation. Expansion of cattail has altered littoral zone ecosystems by forming dense, homogenous stands of cattail that change environmental conditions, displace native vegetation, and may have detrimental effects on fishes. The goal of our work is to determine if localized mechanical control of cattail in lake littoral zones can improve water quality and increase plant and fish diversity. Phase I of our project showed that dissolved oxygen increases, plant diversity increases, and fish community tends to change in cattail removed relative to cattail retained locations. We are beginning phase II of this work to 1) understand if cattail removal can restore ecological function over multiple years, 2) compare cattail retained and removed areas to uninvaded nearshore zones to determine if cattail removal approximates uninvaded conditions, and 3) to understand how cattail management affects fish use of littoral zones. Our results will inform researchers, policy makers, and managers about the effectiveness of mechanical cattail removal as a restoration method in cattail invaded nearshore lake zones.

Concurrent Session 3

Lakeside 1 Wednesday 8:20am to 10:20 pm

Factors Driving Isotopic Niche Size and Niche Overlap in Yellow Perch *(Perca flavescens)*

Kyle Zimmer, Dylan McNulty, David Gallagher, Sara Kangas, Payton Johnson, David Staples, and Brian Herwig

Presenter: Kyle Zimmer kdzimmer@stthomas.edu
Affiliation: University of St. Thomas

Patterns of trophic niche overlap in fish communities is important because trophic redundancy stabilizes food webs. δ13C and δ15N in fish can be converted into percent littoral carbon and trophic position, respectively, and used to estimate isotopic niche size of fish species A and niche overlap of other species on species A. Our previous work in 17 lakes showed Yellow Perch (*Perca flavescens*) had the largest niche overlap and largest niche size of 21 species tested. However, perch niche size varied ten-fold and niche overlap varied sevenfold among lakes. We hypothesized perch niche size and overlap is driven by population size structure where populations with greater body-size variability exhibit largest niche size and overlap. Alternatively, perch niche size and overlap could be driven by food web variables such as mean perch trophic position. Results showed little evidence population size structure influences niche ecology of perch, as perch size range, size standard deviation (SD), and mean size were unrelated to niche size and overlap, and unrelated to perch trophic position SD and littoral C SD (the two determinants of niche size). Instead, perch mean trophic position was negatively related to perch trophic position SD, niche overlap, and had a marginal negative effect on perch niche size. Perch mean trophic position, in turn, was positively related to depth of hypoxic water. Yellow Perch niche size and overlap is thus impacted by lake effects on perch trophic position, indicating lake physical environments can influence patterns of fish trophic overlap and food web stability.

A Comprehensive Investigation of Reduced Catch Rates of Yellow Perch in Leech Lake

Carl Pedersen, Erin Haws

Presenter: Erin Haws and Carl Pedersen
erin.haws@state.mn.us carl.pedersen@state.mn.us
Affiliation: MN Department of Natural Resources

In the last decade standard survey catch rates of Yellow Perch have sustained at low numbers in Leech Lake, with the 2023 survey observing a historical low of 8.1 perch per net. CPUE in standard survey gill nets have surpassed the lakes historical average only once since 2012. What do we tell stakeholders when they ask, “why are the perch numbers so low?” We decided to dive into the available datasets to take a comprehensive look at potential factors explaining the observed reduced catch rates, possible management implications, and some elements of the fishery to watch moving forward.

Understanding Minnesota's changing Yellow Perch populations

Beth Holbrook, Bethany Bethke

Presenter: Beth Holbrook beth.holbrook@state.mn.us
Affiliation: MN Department of Natural Resources

Yellow Perch is a species of management interest both as a primary prey resource for predators and as a targeted species for harvest by anglers. Declining statewide catch rates of Yellow Perch in MNDNR standardized gill net sampling gears has been identified as a concern. However, causes for this decline could not be identified due to a lack of information on sex and maturity, and from individuals less than the minimum gear capture size of 130 mm. To address these information needs, a collaborative study was undertaken to collect a broader size distribution of Yellow Perch and to establish population metrics that could be used to characterize populations. Yellow Perch were sampled from 28 lakes during 37 events in autumn 2019-2021 using supplemental sampling gears including small-mesh multi-mesh gill nets and boat electrofishing. Data were collected on length, sex, and maturity, and ages were estimated from a subset of fish. There was evidence of early maturation at small sizes; in the fall preceding spawning, the female median length at 50% maturity was 102 mm and the female median age at 50% maturity was 1.3 years. Population metrics responded in predictable, ecologically understandable patterns and were correlated with environmental variables including summer surface temperature and Secchi depth.

Comparing consumption patterns of Muskellunge, Northern Pike, Walleye, and Largemouth Bass populations

Tyler Ahrenstorff, Brian Herwig, Andy Hafs, Kamden Glade, and Kyle Zimmer

Presenter: Tyler Ahrenstroff tyler.ahrenstorff@state.mn.us
Affiliation: MN Department of Natural Resources

Muskellunge, Northern Pike, Walleye, and Largemouth Bass are popular sport fish that often co-occur in aquatic ecosystems, yet little is known about what, and how much, food these populations consume. We combined lake-specific population estimates and bioenergetic models (that used fish diets, growth, and water temperatures) to examine consumption patterns of these top predators in three lakes. Population estimates between lakes were remarkably consistent where Largemouth Bass were the most abundant (47-50% of the total predator population), followed by Northern Pike (31-34%), Walleye (17-18%), and Muskellunge (1-4%). Of all the food eaten by these top predators in each lake, Northern Pike populations consumed the most (38-50%), followed by Largemouth Bass (23-29%), Walleye (15-23%) and Muskellunge (6-16%). The higher consumption by Northern Pike and Muskellunge populations relative to their population size was driven by the fact that larger fish eat more food on an individual basis. Notably, Muskellunge consumed many different prey resources, such as White Sucker, Northern Pike, and bullheads, compared to the other predators. Walleye and Northern Pike consumed primarily Yellow Perch and Bluegill while Largemouth Bass ate mostly crayfish. These results will directly benefit MN DNR managers, policy makers, and the public by clarifying the ecological role of top-level predators and providing integral information that helps form the basis for management decisions.

Short and long-term effects of winterkill on the fish community of a shallow, glacial lake

Hrabik, T.R., M. Ellman, B. Holbrook, J. Hoffman, T. Ozersky

Presenter: Thomas Hrabik thrabik@d.umn.edu
Affiliation: University of Minnesota, Duluth Campus

Hypoxia is a source of winter mortality for fish in north-temperate lakes and alters fish communities. A multi-year dataset on Buckskin Lake, which has a history of winterkill, allowed the investigation of the effects of periodic winter hypoxia on fish communities. An aeration system installed in 1984 raised winter oxygen levels to levels promoting higher fish survival. In the winter of 2007-2008, the aerator failed, causing an extensive winterkill. The lake was sampled from 2002-2005, before the aerator failure, and in 2008-2009, after the winterkill event. In addition, 16 similar lakes in the area with no winterkill history were sampled using similar methods. We hypothesized that (1): after 18 years of aeration, the Buckskin Lake fish community from 2002-2005 would be similar to the non-winterkill lakes due to the recolonization of species from connected lakes, and (2): the fish community changed significantly in the lake due to the 2007-2008 winterkill event. The first hypothesis was not supported, as NMDS and PERMANOVA analyses showed that Buckskin Lake retained a fish community distinct from the non-winterkill lakes. Our findings were consistent with the second hypothesis: an incomplete winterkill occurred in 2007-2008 due to lack of aeration, causing changes in fish abundances, the reduction of game fish species, with no notable extinctions. Together, our findings indicate that winter aeration may improve gamefish survival and allow lakes with winterkill tendency to support sport fish communities with healthy piscivore populations such as Walleye and Largemouth Bass, which would be otherwise greatly reduced.

Lakeside 2-3 Wednesday 8:20am to 10:20 pm

A reconstruction analysis of Minnesota's fisheries catches from 1950 to 2021 describes substantial change

Vicky Lee, Maria LD Palomares, Peter Sorensen, Daniel Pauly

Presenter: Peter Sorensen soren003@umn.edu
Affiliation: University of Minnesota

Understanding trends in fisheries catch rates across time can be useful to assess their overall health and potential for improvement. Although Minnesota has been collecting records on fisheries since 1950, these data have never been systematically examined. Comprehensive annual records exist for both commercial and indigenous fisheries while good records exist for recreational fisheries in the form of creel censuses. In this study, recreational fisheries were estimated ("reconstructed') using creel data that were regressed against lake surface area and extrapolated to the state at 5-year intervals and then summed with commercial and indigenous data. We found large changes in Minnesota's fisheries over time, with an overall decrease since 1950 when over ~14,000 metric tonnes (MT) of fish were caught to approximately ~8,000MT today. In 1950 commercial catch was seemingly a third of the total catch while today it is only about a tenth (~1MT), and then mostly attributable to buffalos whereas Common Carp was the major catch initially. Recreational fisheries catch has also declined by about a quarter since peaking in the early 1980s at ~10,000MT when Walleye catch also peaked. Indigenous fisheries have always been just a few hundred MT and fluctuated greatly. Bowfishing (including for native fish) may be the only sector for which catch is not decreasing but the data are poor. With the possible exception of bowfishing, CPUE also appears to be declining in spite of increasingly sophisticated gear. Similarities exist with partial datasets from Wisconsin. Hopefully, this information can be used to reverse these trends.

Migratory Behaviors of Bigmouth Buffalo (*Ictiobus cyprinellus*) in the Red River

Stuart, W.M., Gutowsky, L.F.G., Watkinson, D.A., Caskenette, A., Jarvis, L., Kovackik, C., Leroux, D.R., Pegg, M.A., Kludt, N.B. Enders, E.C.

Presenter: Nick Kludt nicholas.kludt@state.mn.us
Affiliation: MN Department of Natural Resources

Improvements in fish tracking technology have facilitated research that covers broad geographic and temporal scales. The acoustic telemetry array in the basin of the Red River of the North has monitored movements of fish for over seven years and spans geopolitical boundaries. Telemetry tracking of 80 Bigmouth Buffalo (*Ictiobus cyprinellus*) revealed facultative migratory behavior in the longest unimpeded section of the river between St. Andrews Lock and Dam and Drayton Dam. Bigmouth Buffalo moved regularly from Canada, where they are considered a species of concern, to the United States where no harvest restrictions are in place. Of fish that were detected after tagging, 65% (n = 51) crossed the border at least once, while others (n = 5) crossed the border every year. Bigmouth Buffalo migrated upstream in the fall, regularly moving over 200 river kilometers, to overwintering locations near the Drayton Dam. Individuals either made non-migratory movements for a short period in the spring after ice-out, eventually returning to summer ranges in Canada, or made directed migratory movements into Canada. In other sections of the river there was not a clear distinction between summer and winter home ranges. Telemetry projects continue to reveal that fish travel great distances, highlighting needs for improved aquatic connectivity, interjurisdictional management, and consideration of appropriate spatial scale when evaluating migratory species.

Demographics of Flathead Catfish in Pools 2 -9 of the Upper Mississippi River

Neil Rude, Devon Oliver, Nicholas Schlesser, Charmayne Anderson, Joel Stiras

Presenter: Devon Oliver devon.oliver@state.mn.us
Affiliation: MN Department of Natural Resources

Flathead fisheries in Minnesota generally require less intensive management than other fisheries because of consistent recruitment and lower harvest rates. However, catfishing may be increasing in popularity with Minnesota anglers based on increased social media attention and recent surveys. Protecting and enhancing important fisheries is one of the four primary objectives guiding the management of Minnesota catfish. The Mississippi River is one of Minnesota's most popular Flathead fisheries. In turn, MNDNR has a closed season for Flathead Catfish during the overwintering period of December 1st through March 31st and has enacted a possession limit of 10 catfish combined with one over 30". Estimation of demographic parameters has not occurred since their enactment. We aim to bridge current gaps in demographic information from pool 2 to pool 9. Annual electrofishing has been conducted since 2007, and pectoral spines were aged (N = 610) from fish from 2020 to the present. A Bayesian hierarchical formulation of the Galluci-Quinn, von Bertalanffy growth curve was used to estimate growth parameters by pool, reach (above and below Lock and Dam 5), and across all pools (i.e., pools 2 – 9). A Bayesian weighted catch-curve regression was used to estimate instantaneous and, by proxy, annual mortality across all pools. Estimates of growth (omega; omega= Linf X k) were similar across all pools of the Minnesota portion of the Upper Mississippi River. However, estimates of L-infinity and survival to 30" were highly variable. These data provide a much-needed baseline for future evaluations of the fishery.

Gaining a Lota insight from a little SNP - a pilot project

Kristen Patterson, Beth Holbrook, Loren Miller, Chris Smith, Derek Bahr

Presenter: Kristen Patterson kristen.patterson@state.mn.us
Affiliation: MN Department of Natural Resources

Burbot (*Lota lota*) are a unique fish in Minnesota as the only freshwater member of the cod family Gadidae and the only under ice spawner. There has been a variable history of appreciation across the state from a productive commercial fishery to some generalized opinion as "trash fish". Although relatively little is known about populations in Minnesota, Burbot was recently designated a game fish and will have a bag limit set as early as 2025. Minnesota DNR staff have noted increased Burbot angling interest and have expressed concerns about current exploitation and future potential impacts on area lakes if angling pressure continues to build. Burbot are not well represented with methods employed in current fisheries assessments, and generally targeted with methods outside of standard protocols, e.g. hoop or trammel netting, set or long lining. Without employing intensive sampling efforts, we aim to use single nucleotide polymorphisms (SNPs) to determine whether Burbot are currently showing signs of genetic depression in popular fisheries and if this could be a useful method to gain population level information moving forward. We will share our current plans for winter 2024 and 2025 seasons, and welcome input and discussion for future management of this unique cold-water fish in Minnesota.

The Effects of Road Crossings and Impervious Surface on Stream Habitat and Karst Headwater Fish & Crayfish Species in Northwest Arkansas

Susan Colvin, Anthony Zenga, Tyler Fox

Presenter: Susan Colvin susan.colvin@mnsu.edu
Affiliation: Minnesota State University - Mankato

The karst region of NW Arkansas is home to many freshwater endemic Species of Greatest Conservation Need (SGCN). We evaluated the effects of road crossings on aquatic SGCN's including spring headwater endemics Arkansas Darter (*Etheostoma cragini*) and Least Darter (*E. microperca*) and their habitat. The results of our work showed stream sites with road crossings had significantly higher water temperature and conductivity, more embedded substrates, and increased levels of bank incision. Additionally, the composition of fine sediment and aquatic vegetation, the preferred habitat for these SGCN fishes, was significantly lower at sites with road crossings. Our results indicate road crossings can affect both stream habitat and SGCN taxa in urbanizing environments, suggesting potential benefits of site-specific stream barrier removal or remediation.

Towards a Sustainable Future for Minnesota's Native Rough Fish

Shannon J. Fisher

Presenter: Shannon Fisher shannon.fisher@state.mn.us
Affiliation: MN Department of Natural Resources

Attitudes have shifted and creating a sustainable future for Minnesota's native rough fish has become a higher priority. In a public questionnaire (N=592), 91% of respondents indicated that they believe native rough fish are critically important to lake and stream ecology. In that same questionnaire, 79% of respondents believe that regulations are needed to protect native rough fish species. The Minnesota legislature agrees and has also weighed in – indicating that it is time to take a hard look at how we manage native rough fish species. As a result of legislation, the Minnesota Department of Natural Resources was charged with developing a set of recommendations for statutory/rule changes, research needs, and outreach efforts to create a sustainable future for native rough fish. To develop these recommendations, we brought together an internal technical team, established an external work group, provided a public input opportunity, mined available data, and considered peer-reviewed literature. Based on the available input and data, the internal technical team developed recommendations that were ultimately approved by DNR leadership and passed along to the legislature for consideration. This presentation will highlight the process we used and the recommendations that were ultimately identified.

Lakeside 4 Wednesday 8:20am to 10:20 pm

Incorporating Technology to Measure Angler Effort

Jeff Reed

Presenter: Jeff Reed jeffrey.reed@state.mn.us
Affiliation: MN Department of Natural Resources

Estimating angler effort via creel surveys is a foundational practice in fisheries management. Combined, cameras and various types of creel surveys can provide fishery managers with tools to monitor harvest and assess angler responses to management activities such as stocking and alterations of fishing regulations. In this presentation I'll discuss the use of cameras to estimate effort, compare camera derived estimates with those from an access-based creel survey, and how to incorporate cameras creel surveys to identify angling patterns to increase the precision and accuracy of non-uniform probability surveys. Additionally, I'll discuss the development of a data-entry portal application for use in assessing angling within a remote, wilderness setting.

Strategizing an eDNA sampling design for fish bioassessment in northern Minnesota lakes

Courtney E Larson, Chelsea Hatzenbuhler, Aubree Szczepanski, Greg Peterson, Erik Pilgrim, Joel Hoffman, Anett Trebitz

Presenter: Courtney Larson larson.courtney@epa.gov
Affiliation: US Environmental Protection Agency

Fish community assessment is an important component of evaluating ecosystem health and invasive species risk. Environmental DNA (eDNA) methods may supplement conventional methods to enhance community assessments. However, eDNA community assessments are not typically paired with physical catch surveys because molecular methods remain under studied in management contexts and may not fit well with existing protocols. We aim to develop practical, scalable methods for eDNA based fish community surveys in freshwater lentic systems with varying complexity and diversity. We conducted eDNA fish surveys of 9 lakes in the Northern Lakes and Forest ecoregion of Minnesota to determine the number and allocation of samples required to detect maximal species richness using different lake zone (littoral vs. open-water) and gear type (eDNA vs. physical catch) approaches. Our 2021 survey (1093 samples from 318 sites) indicate that certain species were missed with either conventional or eDNA methods, although there was considerable overlap. Large lake (255-296 ha) results are still pending, but in small (26-40 ha) and medium (92-124 ha) lakes eDNA methods detected as many or more fish species than conventional survey methods, with eDNA detecting 88-100% of species from historical observations and physical methods detecting 50-100%. We expect results to provide insight on how to efficiently incorporate eDNA sampling into existing broad scale lentic surveys to increase the probability of detecting new invaders and native fish species that may be missed by conventional methods.

Anglers Technology used for Fisheries Science (Round 2)

Michelle Krecklau, Josh Knopik

Presenter: Michelle Krecklau michelle.krecklau@state.mn.us
Affiliation: MN Department of Natural Resources

This is an update of the MN DNR's lake habitat mapping project using Lowrance depth finders. This year we tested out software ReefMaster, and field methods to determine how to collect the best data possible over this last year. In addition, they are working with the Division of Forestry's Resource Assessment Unit to help develop tools to automate side scan substrate classification data.

Alpha gal syndrome – a Minnesota case study to encourage proper tick prevention

Carl Pedersen

Presenter: Carl Pederson carl.pedersen@state.mn.us
Affiliation: MN Department of Natural Resources

Alpha-gal is a sugar found in a wide variety of mammals except for humans and primates. Ticks can transmit alpha-gal to humans through a bite which can trigger an allergic reaction due to the body producing antibodies to combat alpha-gal. These antibodies, once present, can then create an allergic reaction when any mammalian meat is consumed resulting in alpha-gal syndrome (AGS). Symptoms can range from simple gastrointestinal issues to anaphylaxis if not treated immediately. The Lone Star tick, prevalent in the south and southeastern United States is the common cause but there have been incidence of other ticks causing the allergy worldwide. A case study will be provided from Minnesota to inform and encourage proper tick prevention. There is no cure for AGS, treatment involves epinephrine, allergy medication, avoidance of additional tick bites and a red meat free diet.

Minnesota fish health: overview and selected topics

Dr. Isaiah Tolo, Tim Monahan, Sophie Halvorson, John Olson

Presenter: Isaiah Tolo isaiah.tolo@state.mn.us
Affiliation: MN Department of Natural Resources

Minnesota's fish health program addresses fish disease certification for pathogens of regulatory concern in state and public hatcheries, wild fish surveillance for emergency and emerging fish pathogens, and special projects for emerging fish health issues such as fish contaminants, non-pathogenic diseases, and diagnostic development projects to address the ever-changing needs of fish health management. This presentation will review Minnesota's fish health program and cover selected topics of interest such as development of diagnostic assays for invasive fish pathogens including, a statewide fish kill report, and more.

Fish health through space and time: The more you look, the more you find

Nick Phelps, Isaiah Tolo, Soumesh Kumar Padhi, Jan Lovy, Margaret McEachran, Alexander Primus, Barry Thole

Presenter: Nick Phelps phelp083@umn.edu
Affiliation: University of Minnesota

Golden shiner are an ecologically and economically important fish in many North American lakes. Their widespread distribution has been furthered by decades of human-mediated movement for use as bait and forage. One critical bottleneck for aquaculture production and potential risk to wild populations is the microsporidian parasite, *Ovipleistophora ovariae*, which is widespread in production systems. Investigating this parasite in Minnesota USA presents an interesting case study for three reasons 1) legal baitfish importation has been banned in Minnesota for ~five decades, 2) records suggest golden shiner were exported from Minnesota to Arkansas shortly before the parasite was first discovered, and 3) wild and farmed populations of Minnesota golden shiner have never been surveyed. We used an innovative approach, whereby we combined a survey of golden shiner collected present-day (2020) as well as fish archived in a museum collection (1893-2014). The results were surprising and have implications for fish health management in Minnesota and beyond.

Poster Session

Long Term Trends in Mortality Rates of a Smallmouth Bass Population

Caleb Anderson

Presenter: Caleb Anderson calebanderson3421@gmail.com
Affiliation: Bemidji State University

Smallmouth bass *Micropterus dolomieu* are known as a popular sport fish for anglers. When a known smallmouth bass fishery appears to have a dwindling population, it raises questions about the population health. A common indicator of the health of the population is the mortality rate. By comparing mortality, conclusions can be made on whether smallmouth bass are dying at a different rate in the system over time. Therefore, the objective of this study was to see if there had been a significant change in smallmouth bass mortality over a span of thirty years in Round Lake (DOW:010204), Aitkin County, Minnesota. Smallmouth were sampled using Minnesota Department of Natural Resources standard gillnets, trap nets, and electrofishing gear following their procedures for a standard lake survey. Once data was collected, annual mortality was calculated. Catch curves were analyzed using regression analysis and graphed with 95% confidence intervals. There was not a significant trend in mortality rates through time ($P = 0.37$), and there was overlap of confidence intervals among years. Mortality ranged from 0.05 to 0.61 with a mean of 0.29 over the years sampled. It appears the mortality rates reported in this study are similar to those previously published for smallmouth bass in similar systems (0.16 to 0.40).

Examining the effect of anthropogenic sound on feeding behavior in bluegill sunfish in a non-motorized lake

Devanshi Arora, John Hermann, Trevor Keyler, Brooke Vetter

Presenter: Devanshi Arora
Affiliation: University of St. Thomas

Anthropogenic sound, such as boat motor noise, can impact local fish populations. High-amplitude anthropogenic sound can cause hearing damage and disrupt feeding, migratory, and reproductive behaviors. Research suggests that fish populations regularly exposed to boat noise respond to boat noise differently compared with populations of the same species in protected areas. We collected bluegill sunfish (*Lepomis macrochirus*) from a lake with no motorized boat traffic (Lake Sagatagan on St. John's University campus in Collegeville, MN) and examined feeding behavior in response to playback of an outboard motor recording (0.06-10 kHz; 150 dB re 1 uPa). Bluegills (N= 5 individuals; N=4 groups) exposed to 72-hours of simulated boat traffic demonstrated reduced feeding activity compared with control groups (N= 5 individuals; N=4 groups). To examine feeding responses in the wild, we used a baited underwater video (BUV) system in Lake Sagatagan. The BUV was outfitted with a bait jar, speaker, and an overhead GoPro camera. The BUV worked effectively at bringing bluegills into the camera's field of view. Preliminary data suggests that bluegills were less likely to remain in the area around the bait jar during playback of the outboard motor recording. With this research, we aim to identify potential impacts of anthropogenic sound on bluegills, a species that supports ecosystem health.

Winter kills extend past fish: impact of severe winter on lake zooplankton community

Alia Benedict, Kylie Cattoor, Casey Schoenebeck, Ted Ozersky

Presenter: Alia Benedict bened109@umn.edu
Affiliation: University of Minnesota Duluth

In shallow eutrophic lakes, severe winter conditions can deplete oxygen and cause winter fish kills. Although zooplankton are important for winter fish survival, particularly age-0 fish, no study on winter anoxia has examined the response of zooplankton to under-ice oxygen stress. A severe winter in 2022-2023 led to a partial fish kill in a shallow, eutrophic lake in northern Minnesota. Zooplankton community structure was monitored before, during, and after the fish kill and compared to historical zooplankton records from this lake. Pre-kill zooplankton were composed of cyclopoids, small cladocerans, copepodites, and nauplii (~60 Ind/L) before all groups decreased to 0 Ind/L by late winter. Post-kill summer zooplankton were less diverse and dominated by nauplii, which peaked in late spring (~100 Ind/L). Although there is a lack of winter data to contextualize zooplankton communities under ice, historical data shows that summer zooplankton communities following mild winters are more diverse and three to eight times more abundant than summer communities following severe winters. Winters are becoming warmer and shorter, potentially leading to fewer winter kills but enhancing the risk of summer anoxia in productive lakes. Monitoring zooplankton responses to oxygen stress will be crucial to better predict the effects of changing climate on fish survival and whole lake food webs.

Response of Invasive Silver and Bighead Carp to Broadband Sound and Carbon Dioxide in a Model Lock and Dam System

Amelia Berry, Michael Frett

Presenter: Amelia Berry berr8662@stthomas.edu
Affiliation: University of St. Thomas

Silver (*Hypophthalmichthys molitrix*) and bighead carp (*H. nobilis*), collectively known as bigheaded carp, are invasive fish species that are currently threatening to establish resident populations within Minnesota and the Great Lakes. While most dams in the Upper Mississippi River are effective physical deterrents, adjoining lock chambers provide a conduit for invasive species to migrate upstream. The development of a multimodal system incorporating bioacoustics and carbon dioxide (CO2) has shown promise to act as an effective non-physical deterrent against the upstream movement of bigheaded carp through lock chambers. The effects of CO2 injection paired with broadband sound (recorded from an outboard motor) were examined as a potential deterrent in a 10,000-liter model lock and dam system. During experimental trials (N=8), schools of 10 bigheaded carp were allowed to acclimate in the lock and dam tank for 96 hours. Schools were then conditioned over two days to associate broadband sound (2-4 kHz; 145-150 dB re 1 uPa) with the simultaneous injection of CO2 (~38,00 uatm) into the lock chamber. Following conditioning trials, four broadband sound deterrent trials were conducted daily throughout a one-week period. During the acclimation, conditioning, and deterrent trials, fish behavior was evaluated using overhead video. Conditioned fish avoided the lock chamber during the broadband sound playback, effectively preventing upstream migration. Successful implementation of this non-physical deterrent system in the field could impede the upstream movement of bigheaded carp, thus protecting native fish populations and preserving aquatic ecosystems throughout Minnesota.

Sculpin Reintroductions in Southeast Minnesota

Doug Dieterman, Brian Beyerl, Loren Miller

Presenter: Loren Miller on behalf of Brian Beyerl brian.beyerl@state.mn.us
Affiliation: MN Department of Natural Resources

Sculpin (*Cottus spp.*) are obligate cold-water fishes native to several Minnesota drainages, serve as important indicator taxa and may be important prey for larger recreationally important salmonids. Two species inhabit the Driftless Area in southeast Minnesota, Slimy Sculpin *Cottus cognatus* and Mottled Sculpin *Cottus bairdii* and both were assumed widespread before land use changes resulted in habitat degradation and subsequent extirpation from many streams. Current distribution and status of both species is not well known in part because of difficulty identifying the two species and because recent collections have been sporadic. In 2003, Slimy Sculpin were reintroduced into 10 streams based on mixing sculpin from three donor streams. Initial genetic studies found sculpin from some donor streams were more successful than from others and that mixing donor streams may have resulted in outbreeding depression and reduced genetic viability. However, longer term genetic effects were not evaluated. Also, sculpin-trout interactions have long been of interest as juvenile trout and sculpin were thought to compete for food resources, whereas sculpin may be important prey for larger adult trout. Several studies are being implemented to assess these factors to guide future reintroduction efforts and include assessing (I) current status, distribution and genetic structure, (II) long-term patterns in genetic ancestry of original 2003 reintroductions and (III) effects of reintroduced sculpin on stream food webs.

Impact of road salt on mussel algae clearance study offers suggestions for future research

Hannah Grosser, James Vande Glind, Daniel Hornbach, Mark Hove

Presenter: Hannah Grosser 26evalorgrossha@availacademy.org
Affiliation: Avail Academy High School

Freshwater mussels contribute to aquatic ecosystems in Minnesota in many ways, including filtering algae and other organic material from water. Because water from winter roads and streets is washed into rivers and lakes, there is concern, and some evidence, that mussels are affected by the road salt. We conducted a study to determine if the clearance rates of male Fatmuckets (*Lampsilis siliquoidea*) were influenced by increased salt concentrations in their tank environments. In this study, 12 male Fatmuckets were held in separate aquaria with varying salt concentrations: 0 mg/L, 500 mg/L, 1000 mg/L, and 2000 mg/L. They were fed algae, and water turbidity was measured routinely during each 48 hour sampling period. A control without mussels was used to account for algal settling. The average algae clearance rates (difference between aquaria with and without mussels) for each group of aquaria were 53 mg/mussel/hr for the tanks with 0 mg/L, 50 mg/mussel/hr for 500 mg/L, 53 mg/mussel/hr for 1000 mg/L, and 20 mg/mussel/hr for 2000 mg/L. While a large amount of salt appears to have a threshold effect on the Fatmucket clearance rates, more research is needed in order to draw strong conclusions. Additionally, there were several mussel deaths, especially at the end of our experiment, and so important factors when conducting future experiments include maintaining water quality, monitoring mussel health, and maintaining algae suspension.

The Effects of Habitat Characteristics and Location on Brook Trout Size Distribution

Bryce Groves

Presenter: Bryce Groves brycegroves5@gmail.com
Affiliation: Bemidji State University

Adfluvial Brook Trout *Salvelinus fontinalis* are known to typically grow larger than riverine Brook Trout. The Kabekona River in Hubbard County, Minnesota exhibits suitable habitat for both fluvial and adfluvial Brook Trout populations. The objective of this study was to analyze the relationships between depth, stream width, canopy cover, water temperature, sediment size, and distance from Kabekona Lake on Brook Trout size distribution in the Kabekona River. Brook Trout (n=33) were angled from the Kabekona River from August 24 to September 26. Each fish was measured and released, with habitat metrics being recorded at time of release. ArcGIS was used to determine distance from Kabekona Lake for each Brook Trout, and linear regression analysis was used to determine if any of the habitat metrics showed correlation to Brook Trout size. Distance from Kabekona Lake had a significant effect on Brook Trout size ($P = 0.03$), with larger trout being captured closer to the lake. Trout size also increased as depth increased ($P = 0.02$). The information from this study could be useful to those seeking to improve stream habitat to enhance the size of Brook Trout.

The Effects of Mercury Concentrations on Burbot *Lota lota* in North-Central Minnesota Lakes

Liam Hanley, Dr. Andrew Hafs, Tyler Orgon.

Presenter: Liam Hanley liam.hanley57@gmail.com
Affiliation: Bemidji State University

Burbot *Lota lota* in north-central Minnesota lakes have the potential to reach large sizes and consume large volumes of prey. This caveat may make burbot susceptible to higher rates of biocontamination, bioaccumulation and biomagnification. The objective of this study was to determine how changes in age, length, gender, weight, and lake affect total mercury concentrations in burbot. In this experiment 28 burbot were angled from three lakes: Cass (n = 17), Winnibigoshish (n = 4), and Bad Medicine (n = 7). Then tissue samples were taken from each fish and were lyophilized and homogenized. Homogenized tissue samples were analyzed by a Milestone TriCell Dual Beam Direct Mercury Analyzer (DMA-80evo) while following EPA protocol 7473. Average total mercury concentration was 0.1248 mg/kg (SD = 0.0717) in Cass Lake; 0.1022 mg/kg (SD = 0.0352) in Lake Winnibigoshish; and 0.0435 mg/kg (SD = 0.0176) in Bad Medicine Lake. Linear regression analysis using AIC scores was used to determine the effects of each variable on total mercury. Models attributed changes in total mercury with changes in length, weight, and lake. It was found that as fish weight and length increase total mercury concentration increased. Furthermore, consumption advisory guidelines place burbot in 1-2 servings a week for safe consumption.

The Influence of Ecoregions and Land Use and Land Cover on Fish Assemblages in Southern Minnesota

Masaki Hara, Dr. Susan Colvin, and Dr. Donald Friend

Presenter: Masaki Hara masaki.hara@mnsu.edu
Affiliation: Minnesota State University, Mankato

Level III ecoregions of the conterminous United States provide an ecosystem framework for facilitating environmental understanding and aiding management practices. In southern Minnesota near Mankato, there are two level III ecoregions: to the west are the Western Corn Belt Plains, and to the east the North Central Hardwoods. Formerly, Tall Grass Prairie prior to settlement, the Western Corn Belt is predominately used for agriculture due to its fertile mesic prairie soils, temperate climate, and adequate precipitation during the growing season. Pockets of prairie habitat still occur along with wetlands specific to this ecoregion, specifically prairie potholes. The North Central Hardwoods contain a mosaic of deciduous forests, wetlands and lakes, with predominant land uses of cropland agriculture, pasture, and dairy operations. Land use impacts can cause reduced water quality, impaired ecosystem functioning, and loss of fish habitat which will negatively influence fish diversity, ecosystem functions, natural resource-based economies, and recreational opportunities. Understanding fish diversity and population dynamics, land use, land cover, and water quality helps us to understand the relationship between fish species and their habitat, and how environmental factors affect fish distributions in these ecoregions. This research project investigates how land use and land cover may impact fish assemblage diversity in lakes in these ecoregions. Specifically, we will examine how land use and land cover may affect fish diversity and distributions, and water quality similarly or disparately between ecoregions.

A Summary of Floating and Emergent Macrophytes in Leech Lake

Jack Hasty, Carl Pedersen, Dr. Andy Hafs

Presenter: Jack Hasty iy2162ao@go.minnstate.edu
Affiliation: Bemidji State University

Monitoring aquatic macrophyte density and diversity can play a key role in lake management. The presence and density of certain species can indicate current habitat quality and can provide the basis for future management planning. The objective of this study was to compare floating and emergent (FLEM) vegetation diversity and distribution on Leech Lake using surveys from 2009 and 2016. Plant beds were delineated within 14 lake sections using ArcPro GIS to demonstrate potential bed shift and community changes. Percent composition for dominant species, Shannon's diversity index, and total macrophyte coverage were compared between the two surveys, using standard t-test procedures. To test for differences in percent change among dominant species groups an ANOVA was used. The results from this study should determine if large-scale changes are occurring within the Leech Lake FLEM macrophyte community. This data will inform area managers and establish baselines for future habitat surveys.

Utilization of Genetic Tools in Determining Valid Morphometrics for Identification and Assessing Hybridization in Moxostoma Carinatum

Cristian Hernandez, Loren Miller, Devon Oliver, Anthony Sindt

Presenter: Cristian Hernandez hern0459@umn.edu
Affiliation: University of Minnesota

Redhorse species face a diverse array of impacts and conservation issues but often remain overlooked relative to their sportfish counterparts. The River Redhorse is a member of the Catostomidae family that has experienced reductions in abundance and range over the last century and is listed as critically imperiled in Kansas, New York, Louisiana, and Florida, imperiled in Wisconsin, Michigan, Virginia, and North Carolina, and vulnerable in Illinois, Indiana, West Virginia, Mississippi, and Georgia; additionally, they are listed as a species of special concern in Canada. Furthermore, like many potentially imperiled or vulnerable catostomid species, the River Redhorse suffers from a paucity of demographic and life history information. For River Redhorse, there is some ambiguity as to which morphological characters should be used to identify them relative to Shorthead and Greater Redhorse, which must be addressed first. To address this knowledge gap due to ambiguity in the identification of this species and unknown hybridization rates, this study utilized 1) DNA barcoding to evaluate and determine useful morphometrics for the identification of the two redhorse species (*M. macrolepidotum* & *M. carinatum*) based on genetically confirmed specimens, and 2) fragment analysis of microsatellite sequences to determine the potential rate of hybridization between the species of redhorse.

New chemical and toxicological tools to characterize water quality stressors

Will Jacobsen, David Fairbairn, Will Backe and Dalma Martinović-Weigelt

Presenter: Will Jacobsen wmjacobsen@stthomas.edu
Affiliation: University of St. Thomas

Minnesota has a robust statewide water quality assessment and reporting program, but condition monitoring and Total Maximum Daily Loads (TMDLs) cannot always sufficiently identify or explain causes of biological impairments. The project was conducted in Spring Valley Creek, MN, where routine monitoring and assessments could not identify stressors associated with observed fish and invertebrate impairments. To determine whether chemicals were contributing to the impairments we collected water samples during low and high flow runoff events at eight locations throughout the watershed including wastewater treatment effluent (WWTP) and stormwater. Samples were analyzed for 90+ chemicals including industrial, wastewater and pesticide derived chemicals. Exposure activity ratios (EAR) were calculated to identify exceedances of the aquatic-life benchmarks. Aquatic-life Benchmarks codeveloped by U.S. EPA and USGS are estimates of concentrations below which pesticides are not expected to represent a risk of concern for aquatic life. Fish, invertebrates, vascular and non-vascular plant benchmarks were used. Assessments of 24-hour exposure to solid-phase extracts of stream waters on larval mortality and behavior were completed. Three toxicity evaluation methods, EAR-based toxicity predictions, direct in vitro (data not shown), and direct in vivo assessments showed WWTP, and stormwater were important contributors of CECs in this system, and they could initiate adverse biological responses. EAR-based assessment indicated copper and clothianidin occur at most sites at concentrations exceeding benchmarks, and their quantity varies with hydrological conditions. Additional sampling is underway to develop additional benchmarks relevant to this site and to advance understanding of seasonal variations in chemistry and associated hazard.

Patterns of fish traits for species of special concern in Minnesota.

Carter Johnson, Masaki Hara, and Dr. Susan Colvin

Presenter: Carter Johnson
Affiliation: Minnesota State University – Mankato

This project examines patterns in traits across fish species of concern in Minnesota. We seek to identify if shared traits or habitats indicate specific conservation needs to protect Minnesota fish assemblage diversity.

Don’t judge a nongame fish by its cover-age: An assessment of Minnesota's native fishes' coverage and user engagement on a social media platform

Faith Kelly, Solomon David

Presenter: Faith Kelly kelly880@d.umn.edu
Affiliation: University of Minnesota-- Twin Cities

In the last decade, there has been a slow but palpable shift towards conserving a wider diversity of native freshwater fishes. While researchers lead the way in filling knowledge gaps for more effective conservation, science communicators and public relations teams provide a bridge from research to the public through educational outreach initiatives. Social media platforms such as Instagram, Facebook, and X (formerly Twitter) provide a flexible space for government and regulatory agencies to communicate press releases, updates to policy, and reinforce agency values through photo sharing or special features. In this study, I examine how fish species/groups of different regulatory status differ on social media with respect to the coverage (frequency of features) and user engagement (amount of interaction by viewers). Using data gathered from the Minnesota Department of Natural Resources “X” account, I compare coverage and engagement of fishes who maintain a “game” or otherwise managed status, and those with “nongame” status or are not managed by current policies. Kruskal Wallis nonparametric tests provide clear evidence that “game” fishes appear in media posts at considerably higher rates than their “nongame” counterparts. However, a fish’s regulatory grouping has a markedly smaller influence on the degree to which users engage with the post, demonstrating the willingness of followers’ to engage with a wider diversity of species-related content than is most often featured. The findings from this study provide further support in favor of the recent shift towards more species-inclusive outreach and conservation policy efforts and highlight opportunities for future strategic outreach.

Interannual and Inter seasonal Differences in Diets of Largemouth Bass (*Micropterus Salmoides*), Muskellunge (*Esox Masquinongy*), Northern Pike (*Esox Lucius*), and Walleye (*Sander Vitreus*) in Bald Eagle Lake Minnesota

Nathan Martin, Kamden Glade, Brian Herwig, Tyler Ahrenstorff, Kyle Zimmer

Presenter: Nathan Martin mart3541@stthomas.edu
Affiliation: University of St. Thomas

Largemouth Bass (*Micropterus nigricans*), Muskellunge (*Esox masquinongy*), Northern Pike (*Esox lucius*), and Walleye (*Sander vitreus*) co-exist in many lakes. Understanding diet overlap and potential for resource competition among these species can inform management and stocking decisions. Previous studies have examined diets in these species but seasonal and interannual variability in diets are less known. We assessed diets in all four species (n = 457 diets) in spring, summer, and fall in both 2019 and 2023 in Bald Eagle Lake, MN, to address this data need. Prey in diets were expressed as percent of total mass in diets, and we used PERMANOVA to test for significant differences among species, seasons, and years. Tests for time effects showed diets of Walleye, Northern Pike and Largemouth Bass changed significantly between years, Largemouth Bass was the only species to differ among seasons, while Muskellunge showed no year or season effects. Tests for species effects showed all pairwise-tests were significant in spring and fall (excluding Northern Pike-Walleye in spring), while no summer pairwise tests were significant. Interannual differences were driven by offsetting changes in consumption of Yellow Perch and Black Crappie between years. Seasonal differences between species showed Muskellunge had the most generalized diet, Largemouth Bass consumed more invertebrates in spring and more sunfish in fall, while Walleye consumed more Yellow Perch in fall relative to Northern Pike. Similar work is needed on additional lakes, but our results indicate that temporal variability should be accounted for in diet studies of these fish.

Miller Valley Creek Brook Trout Population Analysis

Colby Menden, Ian Wildeman

Presenter: Colby Menden cjmenden@hotmail.com
Affiliation: Winona State University

The main objective of this project is to assess the fish community in Miller Valley Creek (MVC) and in particular to understand the structure of the brook trout population, a prized native species. Using a backpack electrofisher, fish were collected at five one-hundred-meter-long stations and at the end of each section the collected fish were identified by species and sorted. Measurements of brook trout, including weight (g) and length (mm), were taken using a balance and bump board. These field measurements were used to determine the average size (length and weight) of trout in MVC. Using these size measurements length range, weight range, condition factor, and annual mortality rates were determined and by plotting the length against the weight, age distribution was determined. The findings revealed four distinct age classes, suggesting a healthy, reproductive population of brook trout in MVC.

Fillet weight and comparison for Bluegill, Crappie, and Yellow Perch

Mikenna A. Pattrin, Dr. Andrew W. Hafs

Presenter: Mikenna Pattrin px2246vo@go.minnstate.edu
Affiliation: Bemidji State University

Panfish, including bluegill *Lepomis macrochirus*, black crappie *Pomoxis negromaculatus*, and yellow perch *Perca flavescens* are three sought-after species. Anglers often perceive a change in regulations as an attempt at limiting the amount of harvest. However, the goal of many regulation proposals is to increase the size structure of panfish, allowing anglers to achieve their ideal harvest with less fish. The primary objective of this study was to assess the relationship between panfish fillet weight and total length to estimate how many fillets would be needed to reach a harvest weight of 0.5 lbs. A secondary objective was to compare this relationship from ten West Central Minnesota lakes to previous estimates generated from past research from seven Wisconsin lakes. Minnesota fillet weights and yields were calculated from 360 bluegill, 167 crappie, and 108 yellow perch. Total fillet yield was 36.5%, 42.3%, and 44.5% for bluegill, black crappie, and yellow perch, respectively. On average the fillet yield from Minnesota lakes were 5% greater than fillet yields from the previous research done in Wisconsin. In conclusion, fillet weight and fillet yield can be useful metrics for managers to generate harvest limits that allow anglers to reach the 0.5 lbs fillet goal.

A guide to the otoliths of Minnesota fishes

Baylor Short, Kamden Glade, Andy Hafs

Presenter: Baylor Short baylor.short@live.bemidjistate.edu
Affiliation: Bemidji State University

Investigations into the diet patterns of piscivores can provide crucial information on predator-prey relationships, population dynamics, and responses to changing ecosystems. However, digestive processes often remove or alter physical characteristics that are traditionally used to identify consumed fish. This problem has been addressed to some degree with advances in molecular technologies, although these methods can be costly and require specific training and equipment to do so. In contrast, bony structures such as otoliths, vertebrae, cleithra, and others frequently have morphologies that are unique among families, genera, and species. Because these structures are resistant to digestion, they can be used to identify prey fishes effectively and efficiently in varying states of digestion, if the investigator has access to reference specimens or photos from identified taxa. Although some reference materials for identifying bony structures are available, many are specific to a small number of species. This is especially true for otoliths, which are often more difficult to differentiate among species. To address this issue, we have compiled a photographic atlas of sagittal otoliths for fishes of Minnesota that have been identified in previous diet studies and during summer sampling within the state. In addition to photographs, this guide will provide insights on distinct morphological characteristics and key differences among similar species, making this a useful resource for investigations of piscivore diets in Minnesota and the surrounding area.

A fish tracking study shows that few fish pass Lock and Dam 5 even in years with flooding except via its lock, and then rarely, suggesting that it is a suitable location to stop invasive carp

Peter Sorensen, Jay Hatch, Gabe Berken

Presenter: Peter Sorensen soren003@umn.edu
Affiliation: University of Minnesota

Silver (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) from Asia escaped into the Mississippi River in the 1970s and now pose a significant threat to ecosystems and fisheries. Mature Silver Carp are now found in Iowa and are making their way into Pool 8 (MN). A way to stop this invasion would be reduce passage at Lock and Dam 5 (LD5) whose dam spillway gates rarely open, meaning that few fish can pass. Indeed, a numeric simulation suggests that 95% of all carp would be blocked if a 50% effective deterrent system were added to LD5's lock. While two years of studying fish movement support this hypothesis, these years had relatively low flows so were a best-case scenario. However, last year experienced springtime flooding. Accordingly, we once again captured ~100 fish (common carp, bowfin) upstream of LD5, tagged and released them below LD5, and tracked their movements. We also tracked ~50 Silver Carp released by agencies. Once again, no fish were observed to pass LD5 by any route other than its lock including 3 bypass culverts although 2 Silver Carp did pass in April prior to receiver placement. Further, while many fish of all 3 species entered the lock (disproportionally with barges), only a few Common Carp passed (no Silver Carp), strongly suggesting that fish find locks unattractive and a deterrent would work well. We conclude that LD5 is well suited to serving as a site to block carp, especially if combined with carp removal and spillway gate adjustments.

Effects of Dam Removal on Trout Abundance in a Northern Michigan Stream

Owen Stephenson, Amy Schrank

Presenter: Owen Stephenson steph868@umn.edu
Affiliation: University of Minnesota - Twin Cities

In recent years, dam removal has become an increasingly common method for environmental restoration, as structures age, become unstable, and outlive their utility. However, removal projects and their ecological impacts are often poorly understood due to a lack of both pre- and post-dam removal monitoring. To better understand the impacts of dam removal on fish abundance, we conducted 2-pass electrofishing to monitor fish populations before and after a dam removal project on the Maple River near Pellston, Michigan. Bayesian analysis was then used to estimate abundance of Brook Trout *Salvenlinus fontinalis* and Brown Trout *Salmo trutta* at sites above and below the former dam. Further analysis by linear regression indicated that Brook and Brown trout abundance tended to increase both up and downstream of the damsite following removal, with Brown Trout abundance at upstream sites increasing significantly. These findings provide further support for the growing body of evidence that indicates dam removal positively affects fish abundance by restoring natural stream conditions. Our results also suggest that Brown Trout abundance may increase more rapidly than Brook Trout abundance on either side of the former dam. This has important implications for the native Brook Trout population in the Maple River and other Midwestern streams, as Brown Trout have been shown to outcompete Brook Trout when the two species are sympatric. This study expands our current understanding of the ecological impacts of dam removal, which may help managers weigh costs when assessing future removal projects.

Variability in growth and diet of yellow perch in Pike Lake, MN

Abigail Stott, Levi Feucht, Alia Benedict, Thomas Hrabik, Tedy Ozersky, Casey Schoenebeck

Presenter: Abigail Stott stott077@d.umn.edu
Affiliation: University of Minnesota Duluth

Variations in season and habitat influence prey availability for yellow perch in north-temperate lakes. Seasonal differences can lead to changes in their bioenergetic budget from winter to summer and may differ among ecosystems. If an individual fish has a sub-optimal diet for an extended amount of time, they may experience negative effects on their growth and health. Pike Lake near Duluth has a yellow perch population that exhibits extremely slow growth, and we hypothesize that this may be caused by a non-optimal diet year-round. To test this hypothesis, we sampled both Pike Lake and Portage Lake, which is near Park Rapids, for yellow perch during summer and winter. Yellow perch were processed for length, weight, diets, and age structures. We used this data to create two lake-specific Von Bertalanffy growth curves that formalize the relationship between size and age. Temperature data was used to make a year-long temperature profile for each lake, which was used alongside the yellow perch diets to estimate temperature-corrected feeding success using the Fish Bioenergetics Model (v.4). From there we analyzed the proportion of maximum consumption (P) that the yellow perch were consuming both seasonally and year-round in each lake. If our hypothesis is supported, the yellow perch from Pike Lake will have a smaller P value than those from Portage Lake, indicating that they have less optimal consumption. These results will help to determine if an energetic deficit is a key determining factor of stunted growth, or if other factors play a larger role.

Surveillance and a Case Study of Largemouth Bass Virus in Minnesota.

Tim Monahan & Dr. Isaiah Tolo

Presenter: Isaiah Tolo isaiah.tolo@state.mn.us
Affiliation: MN Department of Natural Resources

Largemouth bass virus (LMBV), a member of the *ranavirus* genus (family Iridoviridae) is a pathogen of largemouth bass *Micropterus salmoides*. Infections have been reported in other fishes of the Centrarchidae family, however clinical disease symptoms associated with mortalities in species other than largemouth bass in Minnesota have not been reported. Limited surveillance of largemouth bass (from 2002-2016) in Minnesota has identified six lakes and two Mississippi River pools with detections of LMBV. In August of 2021, a mortality event of wild smallmouth bass *Micropterus dolomieu* began in Green Lake located in Spicer, Minnesota over a three-week period. One permitted walleye tournament on August 23rd occurred during this event and initial notifications of the morality event implicated illegal culling of smallmouth bass. Clinical signs of the smallmouth bass exhibited diffuse subdermal hemorrhaging of the head and surrounding ocular region, minor dermal lesions to progressed circular ulcerations on the head, operculum and lateral midbody. Largemouth Bass Virus (LMBV) was isolated from EPC and FHM cells at 25oC from pooled kidney and spleen of the fish and confirmed by qPCR. qPCR ct values of viral load in kidney tissues ranged between 29-36. Histopathology reported myositis and splenitis associated with isolation of LMBV. *Aeromonas hydrophila* was isolated from lesions likely advancing the atypical clinical symptoms of the immunocompromised fish. Whole genome sequencing of the LMBV isolate was also performed.

Maintaining freedom from Viral Hemorrhagic Septicemia in Minnesota Waters

Sophie Halvorson, Dr. Isaiah Tolo, Tim Monahan

Presenter: Isaiah Tolo isaiah.tolo@state.mn.us
Affiliation: MN Department of Natural Resources

Viral hemorrhagic septicemia virus (VHSV) is a highly infectious virus that has significant impacts on fish health management globally. The virus has been detected in all five of the Great Lakes, though it hasn't yet been detected in Minnesota inland waters. Over 18 years of VHSV surveillance with no detections in inland waters has been used to establish VHSV-free zones in Minnesota, and annual surveillance is conducted to maintain a zone's freedom of disease status. Supplemental sampling along the Lake Superior shoreline has also expanded screening in the Lake Superior drainage basin. Pooled kidney and spleen samples are screened for the presence of VHS via cell culture, RT-qPCR, or iiPCR analysis. Of the 199,861 fish sampled from January 2013 to December 2023, the majority represented families Percidae and Centrarchidae, which includes common MN fish species such as walleye, perch, and sunfish. MN still has not detected VHSV in inland waters as of December 2023, though several priority areas for future sampling efforts have been identified following this review. Future surveillance efforts will continue for both statewide inland waters and Lake Superior, and additional testing will continue as-needed for any proposed movement of VHSV-susceptible fish species from the Lake Superior VSZ.

The Clean Water Act: The Importance of Comprehensive & Uniform Federal Regulations

Matthew Trenne, Dr. Susan Colvin

Presenter: Matthew Trenne Matthew.trenne@mnsu.edu
Affiliation: Minnesota State University, Mankato

This work reviews states that do and do not have state-level protections for water bodies beyond federal "Clean Water Act" protections. We additionally examine state-listed 303 (d) waters to establish a baseline for whether states are adequately tackling the growing issue of gaps left by shrinking federal protections.