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## Plenary Session

### To Members...And Beyond! Resources and Strategy for Effective Communications

Julie Defilippi Simpson

Julie Defilippi Simpson is the Data Team Leader for the Atlantic Coastal Cooperative Statistics Program. Julie's primary role is to provide guidance for all data related activities. This includes responsibility for the commercial and biological data, data collection and warehousing projects, user interface projects, and data dissemination activities. She also works closely with the IS Manager on database development and maintenance. For the past four years, Julie has chaired the Communications, Membership and Outreach Committee of the Organization of Fish and Wildlife Members. She has been an active member of AFS for over a decade and has served as Communications and Outreach Coordinator and President for the Fisheries Information and Technology Section. Julie is currently the Chair of the AFS Communications Committee.

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### Carp-ocalypse now! Your survival guide to invasive species communications

Dr. Katie Steiger-Meister

Aquatic invasive species are always on the move and tend to turn up at inopportune times in all the wrong places. From the moment of discovery to sustaining collaborative communication efforts with partners over the long haul, presenter Dr. Katie Steiger-Meister from the U.S. Fish and Wildlife Service will help you navigate your next big invasive species communications challenge by sharing lessons learned from regional Asian carp response efforts. Dr. Katie Steiger-Meister is a senior public affairs specialist for the U.S. Fish and Wildlife Service's Midwest Region. For the past eight years she has supported communications for the Service's Midwest Fish and Aquatic Conservation Program and led regional Asian carp communication efforts as co-chair of the Asian Carp Regional Coordinating Committee's Communication Work Group. Steiger-Meister received her Ph.D. in Natural Resources Science and Management from the University of Minnesota. A hurricane at heart, both her M.A. in Marine Affairs Policy and Management and her B.A. in Marine Science Affairs are from the University of Miami.



*Special thanks to the Chapter members who worked hard to make this meeting a success - Eric Altana, Mandy Erickson, Paul Glander, Jon Hansen, Craig Kelling, Michelle Krecklau, Kristan Maccaroni, Brian Nerbonne, Heidi Rantala, Keith Reeves, Ann Schneider, Patrick Schmalz and Calub Shavlik as well as the session moderators, student audio visual helpers and the Bemidji State University Student Chapter.*

## Concurrent Session 1 – Student Presentations University B

### Operation Bucket List: Tracking the Hitchhikers in Minnesota’s Bait Supply

Margaret McEachran, Nicholas Phelps

Presenter: Margaret McEachran, thom4412@umn.edu

Affiliation: University of Minnesota

In an increasingly connected world, human activities introduce the risk of moving invasive species and pathogens to naïve populations, and drive disease spillovers between farmed and wild populations. This reality is playing out in the use of baitfish for recreational angling, as billions of farm-raised and wild-caught fish (and their accompanying hitchhikers!) are moved long distances overland and intentionally introduced into new environments. As a result, baitfish movement has been considered a high-risk activity for the movement of aquatic invasive species (AIS) in Minnesota, with potentially major economic, ecological, and societal consequences. To obtain baseline data for potential hazards posed by baitfish use, a survey for invasive species and emerging diseases was performed at baitshops across Minnesota from 2014-2015. Golden shiners (n=30) were purchased at retail baitshops (n=34, 18 of which were sampled twice; 52 total) across the state by an ‘angler’ (participation in the research project was not disclosed). 33/52 cases included non-target species, such as fathead minnows, brook stickleback, and brown bullhead. Potentially significant pathogens were in many baitshops, such as *Aeromonas salmonicida* and *Ovipleistophora ovariae*. In addition, at least 9 novel viruses were identified from fish collected during the study. No regulated AIS or pathogens were found during the course of the survey; however, the presence of non-target species and important pathogens confirm that baitfish should remain a pathway of concern. Ongoing efforts to better define potential hazards, quantify the risk of introduction via bait movement, and risk mitigation strategies will also be discussed.

### Evidence of Recruitment Failure for 80 Years in Bigmouth Buffalo Fish (*Ictiobus cyprinellus* Valenciennes 1844) Populations of The Red River Of The North Basin: A Call for Further Study and Action

Alec R. Lackmann

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The bigmouth buffalo fish (*Ictiobus cyprinellus*) is the largest catostomid. The family Catostomidae is known for its high diversity in North America (NA), home to 77 of 78 total species. Bigmouth buffalo (BMB) were once broadly distributed from southern Canada to Louisiana. During the 19th Century they became economically important to commercial fisherman, with millions of kilograms harvested annually. By the late 19th Century BMB populations were overharvested, prompting an effort to supplement the native NA fish fauna with the Eurasian common carp (Cyprinidae: *Cyprinus carpio*), which became a notorious invasive species by 1900. Recently, BMB have been increasingly targeted by both commercial harvest and sport bowfishing. This native fish resource has remained understudied in spite of these increasing threats. We have found bigmouth buffalo to live to 104 years old, exactly four times longer than previously reported. Furthermore, 70 of 80 total fish collected in the Red River Basin of MN were greater than 75 years old. The paucity of younger fish suggests this population is in an extended period of reproductive failure. Reasoning from the case of the long-lived lake sturgeon (*Acipenser fulvescens*), further study and proper management will be essential to bringing these buffalo back from the road to extinction.

## Muskellunge Habitat Use and Movement Patterns in the St. Louis River Estuary

Erin Schaeffer, Jeramy Pinkerton, Loren Miller, Paul Venturelli

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Affiliation: University of Minnesota

The St. Louis River Estuary (SLRE) is a designated Area of Concern due to severe environmental degradation. Although recent restoration and remediation projects have benefited the estuary, the status of muskellunge, an indicator species, and their use of restored habitats is uncertain. Muskellunge were likely extirpated in the SLRE in the mid-19th century and subsequently restored through stocking by Wisconsin and Minnesota agencies. As part of a larger study to refine population estimates and determine which habitats are important for sustaining muskellunge, we quantified their habitat use and movement patterns and determined if these differed by genetic strain. Sixty adult muskellunge were trapped, acoustically tagged and passively and actively tracked. Acoustic tracking revealed that individuals have highly variable movement patterns. Some individuals were observed occupying only the upper or middle river and others spanned the length of the estuary and into Lake Superior. Despite this variability, our data reveal seasonal movement trends. In general, fish remained in the middle upper river section during spawning season before moving downstream and into Lake Superior throughout summer and into fall. Genetic analysis confirmed that roughly equal proportions of three genetic groups (Minnesota, Wisconsin and their hybrid) make up the muskellunge population and the tagged sample. Genetic analysis paired with acoustic telemetry revealed that a large proportion of our muskellunge visited Lake Superior, and remarkably, most of these were Minnesota strain. A better understanding of muskellunge ecology can guide future management and restoration efforts of muskellunge in the SLRE and other areas of the Great Lakes.

## Impacts of Anthropogenic Sound on Hearing Sensitivities of Bigheaded Carps

Andrew Nissen

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Affiliation: University of Minnesota Duluth

Silver (*Hypophthalmichthys molitrix*) and bighead (*H. nobilis*) carp, collectively bigheaded carps, are invasive fish that threaten aquatic ecosystems of the Upper Midwestern United States and Laurentian Great Lakes. Due to extensive ecological impacts associated with invasive bigheaded carps, prevention of further range expansion is the aim for fisheries management. Recent research has focused on evaluating acoustic deterrents to control the movement of bigheaded carps. Behavioral studies indicate that bigheaded carps will not cross acoustic barriers and exhibit negative phonotaxis in response to high intensity ( $\geq 150$  dB re 1  $\mu$ Pa) anthropogenic sound sources. However, the potential impact of long-term exposure to these sounds on the hearing sensitivities of bigheaded carps has not been well documented. In this study the auditory evoked potential (AEP) technique was used to evaluate hearing sensitivities among bigheaded carps after exposure to high intensity (170 dB re 1  $\mu$ Pa) broadband sound. Fish were exposed to sound for 30-minute or 24-hour durations and AEP measurements were taken immediately following. Results indicate that silver and bighead carp experience temporary threshold shifts (TTS) in hearing sensitivity following sound exposure. Among silver carp, significant TTS were measured following a 24-hour exposure period. However, TTS were seen at only two frequencies following a 30-minute exposure. Among bighead carp, significant TTS were measured for both sound exposure periods. Trials to determine whether the fish experience full or partial recovery of hearing sensitivity after sound exposure are currently ongoing. As acoustic deterrent measures will be directly aimed at the specific hearing sensitivities of bigheaded carps, it is important to understand how exposure to high intensity anthropogenic sounds impacts such sensitivities. These findings will be used to increase the long-term efficacy of acoustical deterrent measures aimed at preventing further range expansion of bigheaded carps.

# Concurrent Session 1 – Student Presentations State

## Effect of Beaver on Brook Trout Habitat in North Shore, Lake Superior Streams

Kathryn Renik, Dr. Andrew Hafis

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Brook Trout (*Salvelinus fontinalis*) are a native species to Minnesota and provide a valued and productive sport fishery to the North Shore streams of Lake Superior. Beaver (*Castor Canadensis*) dramatically alter the ecosystem they inhabit and are often referred to as a keystone species. Beaver were nearly extirpated from Northeastern Minnesota due to trapping and timber harvest but have since rebounded. Suitable Brook Trout habitat is characterized by cold, spring-fed water with silt-free rocky substrate and abundant cover, all of which Beaver may directly, or indirectly, affect. Data collection occurred on 31 (200 m) stream sections and 10 beaver ponds spanning the North Shore during the summer 2017, with anticipation of data collection occurring in summer 2018 on an additional 30 (200 m) stream sections and 20 beaver ponds. Both habitat suitability index (HSI) and bioenergetics models were employed, and through interpolation in geographic information systems (GIS), maps depicting Brook Trout habitat of sampled stream sections were produced. The average HSI and suitable area ( $\text{m}^2/100 \text{ m}^2$ ) of each sampled reach were compared to Beaver related activity, including reach slope, distance to nearest Beaver pond, and number of dams upstream of sampled sites. Classification regression trees were used to identify significant thresholds in which Beaver activity influenced the amount or quality of Brook Trout habitat. Preliminary results indicated that a greater area of suitable Brook Trout habitat in North Shore streams was achieved when the maximum tree line width of the nearest upstream Beaver pond was  $\leq 71.23 \text{ m}$ . Since the effect of Beaver on Brook Trout varies regionally, this study will provide a simple decision-making flow chart to aid in the development of management strategies pertaining to these two species in North Shore, Lake Superior streams.

## Variability in Spatial Distribution of Larval Yellow Perch in a Northern Lake Ecosystem

Steve Hauschildt, Dr. Andrew Hafis

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The success of many game-fish species can depend on larval Yellow Perch (*Perca flavescens*) for forage in northern lake systems. Year class strength estimation using larval tows, is often unreliable, or has the potential to include large amounts of variation. To better understand larval Yellow Perch densities, the objectives of this study were to measure the variation in the spatial distribution of larval Yellow Perch on Blackduck Lake in northern Minnesota, and then determine if wind is a significant source of variation. Tows were performed with a neuston net in a random pattern across the towable area of Blackduck Lake, Minnesota. Sixty tows were taken every two days over a two-week period. All fish were counted, and total length was measured for up to 30 fish from each tow. The number of fish at each location was used to create GIS maps through interpolation techniques to demonstrate larval Yellow Perch spatial distribution. Relationships between the variability depicted in our spatial distribution maps and wind characteristics should help managers increase confidence in estimates of year class strength done via neuston tows.

## **The Effect of Self-generated Movement on Lateral Line Sensitivity in the Toadfish, *Opsanus tau***

Loranzie S. Rogers, Jacey C. VanWert, Allen F. Mensinger

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The mechanosensory lateral line in fishes detects movement, vibration, and pressure gradients in water. However, the effect of self-generated movement on the sensitivity of the lateral line remains largely unknown. Microwire electrodes were inserted into the anterior lateral line nerve of toadfish using an implantable micromanipulator which allowed neural activity to be monitored for up to two weeks post-implant. Experiments measured neural response to external stimulus during forward movement. Freely swimming fish remained sensitive to stimuli produced by a vibrating sphere indicating that the lateral line can detect external stimuli during movement. Additionally, moving fish were able to detect the stimuli generated by the tail motions of a robotic fish. There was no evidence of efferent modulation during forward movement and efferent nerves did not show increased firing during swimming. While efferent modulation or central filtering of self-generated movements had previously been postulated as mechanisms to allow free swimming fish to continue to detect outside stimuli, the current experiments show that at the swim speeds observed, the mechanosensory lateral line can sense external stimuli without modulation or filtering.

## **Adult Walleye Abundance and Subsequent Fry Output in The Tamarac River**

Phillip Oswald, Dr. Andrew Hafs, Tony Kennedy

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Affiliation: Bemidji State University

Understanding Walleye reproductive success in the Red Lakes is of critical interest as this system supports robust commercial and recreational fisheries, and is maintained entirely by natural reproduction. The Tamarac River, a major tributary to the Red Lakes hosts a substantial Walleye spawning migration, however data regarding the magnitude of the migration have not been available since the late 1970s. The Walleye population collapsed in the 1990s, and after closing the fishery and short-term recovery stocking efforts, the Red Lakes has successfully recovered and once again supports healthy fisheries. The Minnesota Department of Natural Resources has been estimating relative abundance of Walleye in the Tamarac River by electrofishing during spawning migrations since recovery efforts began, and Bemidji State University has been conducting an annual Fyke netting assessment since 2014. In 2017, a Jolly-Seber abundance estimator was used to estimate the absolute abundance of Walleye spawning in the Tamarac River. A total of 13 capture-recapture sampling events resulted in the capture of 9,648 spawning Walleye. Sampling occurred throughout the spawning migration with peak abundance estimated at 268,877 (76,952-460,802 95% CI) Walleye. It is estimated that 86,040, or 32% of the population in the river were females at peak migration. Drift nets to collect larval walleye were later set to gauge reproductive success because the Tamarac River drains the largest peat bog in the lower 48 states, and it is largely unknown how the potential anoxic bog water affects walleye reproductive success. Gauging the magnitude of the annual Walleye run and determining fry output from the Tamarac River will help managers better understand the importance of the Tamarac River to overall Walleye production in the Red Lakes.

## Concurrent Session 1 – Student Presentations Senate/Congress

### A Pulsed Sound Paired with an Air Curtain is Over 98% Effective at Detering Carp Passages in the Laboratory.

Clark Dennis, Peter Sorensen

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Affiliation: University of Minnesota

If bigheaded (Asian) carp (*Hypophthalmichthys spp*) are to invade Minnesota it will be through Lock and Dam #8 which is located near our southern border on the Mississippi River. Fish could conceivably pass through either the spillway gates or through the lock. Computational modeling conducted by our team has already shown that passage through these spillway gates is minimal and can be cut in half by adjusting gates to balance flow – a process which is already underway by the U.S. Army Corps of Engineers. This leaves the lock which might be protected using deterrent systems utilizing sensory stimuli (i.e., sound, light, chemicals). Three types of sound stimuli have shown promise: a continuous boat motor sound (although see Riesgraf et al. poster for field effectiveness), a pulsed sweeping sound and an air curtain. In this laboratory study, we tested the response of bighead carp (*H. nobilis*), common carp (*Cyprinus carpio*) and largemouth bass (*Micropterus salmoides*) to both types of sound with or without an air curtain. Our results show that this new pulsed sound when coupled with an air curtain is over 98% effective at blocking common and bighead carp passages, even after 8 exposures, with lower blockage rates (90%) for native largemouth bass. By comparison, the boat motor sound only displayed a 50-85% blockage rate for common and bighead carp in the lab, and has been shown in some circumstances to lose effectiveness with repeated exposure (Zielinski and Sorensen 2017). A version of this deterrent system using this pulsed sound is proposed for testing at Lock and Dam 8 this year while we continue to modify this pulsed sound to have even less impact on native fishes. (Funded by the Minnesota Environmental and Natural Resources Trust Fund).

### Koi Herpes Virus Reaches Minnesota Lakes: Implications for Management and Biocontrol

Isaiah Tolo, Margaret Thompson, Craig Soupir, Soumesh Padhi, Alexander Primus, Sunil Kumar, Nicholas Phelps

Presenter: Isaiah Tolo, tolo0007@umn.edu

Affiliation: University of Minnesota

Koi herpes virus (KHV), also called Cyprinid herpes virus 3 (CyHV-3), is a highly specific and virulent pathogen of common and koi carp (*Cyprinus carpio*) in wild and farmed populations around the world. Between June and October 2017, mass mortalities of common carp were reported in six nearby lakes in Le Sueur and Waseca counties in Minnesota. Clinical signs of dead and moribund fish included severe gill necrosis, dermal hemorrhaging, sloughing and discoloration, as well as sunken eyes and facial tissue. KHV was detected by polymerase chain reaction (PCR) analysis of common carp tissues sampled from these events which represents the first detection of KHV in wild fish in Minnesota. Additionally, KHV was associated with a mortality event in a distant lake but an additional mortality event in Carver County and five other lakes without mortality events tested negative for KHV within the same time frame. These results are suggestive of a recent and discrete introduction of KHV to wild common carp in this region of Minnesota. Here we will discuss potential management and biocontrol implications of these outbreaks.

## Using Geospatial Analysis and Host Studies to Determine the Importance of Fish Distribution to the State Threatened Pondmussel (*Ligumia subrostrata*)

Cameron Swanson, Mark Hove, Alex Franzen, John Waters, Daniel Hornbach, Bernard Sietman, and Mike Davis

Presenter: Cameron Swanson, swan2229@umn.edu  
Affiliation: University of Minnesota

Conservation efforts to protect the pondmussel, *Ligumia subrostrata*, are limited by a lack of knowledge regarding factors affecting the distribution and abundance of this species. In Minnesota this species is scattered among the dendritic reaches of the highly agricultural landscape of the Rock River watershed in the far southwest corner of the state; a tiny portion of the Missouri River drainage. State conservation research on this mussel has focused primarily on its distribution and identifying fishes that host its larvae, or glochidia. The purpose of our study was to increase our knowledge of glochidial hosts for the pondmussel and their distributions. Secondly, we sought to find geospatial relationships between these distributions and land use in the Rock River watershed. We followed standard methods to identify natural fish hosts and conduct laboratory trials on a variety of fishes to identify suitable glochidial hosts. Field studies confirmed previous findings that *Lepomis* spp. are natural hosts. Similarly, laboratory host suitability trials with pondmussel confirmed several known suitable hosts, extended our understanding of unsuitable hosts, and found two new marginal suitable hosts, brook trout and walleye. Preliminary geospatial analyses indicate that while the distribution of *Lepomis* spp. has an influence on the distribution of the pondmussel, land use, slope, and buffer strip compliance do not appear to be associated with mussel abundance.

### Assessing Dispersal and Condition of Stocked Walleye Fry in a Northern Minnesota Chain of Lakes

Heather M. Marjamaa, Anthony J. Kennedy, Dr. Andrew W. Hafs

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Affiliation: Bemidji State University

Walleye (*Sander vitreus*) is the most sought-after sportfish in Minnesota. Minnesota is the third most popular inland fishing destination in the country and fishing contributes a significant amount of revenue to the state. Cass Lake is one of the ten largest Walleye lakes in Minnesota and the largest in a chain of lakes that is a popular destination for anglers. The Minnesota Department of Natural Resources (MNDNR) collects Walleye eggs each spring from a tributary to Lake Andrusia. Lake Andrusia lies immediately upstream of Cass Lake and is connected by the Mississippi River. As a matter of policy, 10% of collected eggs are returned to the donor lake as fry, which in Lake Andrusia results in elevated fry densities (range: 1,000 to 17,000 fry/littoral acre, mean: ~7,000) that may create negative density-dependent effects. However, if these fry distribute throughout the chain, fry densities would be much lower (500 to 1,000 fry/littoral acre). In 2016 and 2017, approximately three million Walleye fry were marked with an oxytetracycline (OTC) solution and stocked into Lake Andrusia (~7,000 fry/littoral acre) to allow differentiation of stocked and wild fish. Walleye fingerlings were collected in the fall from each lake within the chain. Fish were measured for total length and weight and otoliths were examined for the presence of an OTC mark. The primary objectives of this project were to: 1) document dispersal of Walleye from Lake Andrusia to other lakes within the chain at ages 0 and 1 using relative abundance and OTC marking rates, and 2) compare growth and condition of marked and unmarked fish within and among lakes to detect possible density-dependent effects. These results will help determine the effect Walleye fry stocking in Lake Andrusia has on the Cass Lake chain and ensure stocking efforts are as efficient and effective as possible.

## Concurrent Session 2 – Professional/Student Presentations University B

### Understanding Largemouth Bass Expansion in Northeastern Minnesota

Bethany Bethke, Patrick Schmalz

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Affiliation: MN Department of Natural Resources

Largemouth Bass (*Micropterus dolomieu*) in many northeastern Minnesota lakes are being sampled by the MN DNR and caught by anglers with increasing frequency. Local fisheries managers need to determine factors associated with Largemouth Bass abundance, and they need to know if increasing abundance of Largemouth Bass is affecting other local sport fishes. Therefore, we measured Largemouth Bass relative abundance (electrofishing catch per hour (CPH)), aquatic plant biovolume, lake temperature, water clarity, and trophic position of adult sport fish in nine small lakes (less than 1,000 acres surface area) in northeastern Minnesota (St. Louis, Carlton, Lake, and Cook Counties) in 2015 and 2016. Three of the lakes had no previous record of Largemouth Bass being sampled, three had recently detected (sampled for the first time after 1999) populations, and three had historical populations (known presence since 1970 or earlier). Electrofishing CPH increased with increasing aquatic plant biovolume ( $R^2 = 0.66$ ) among lakes, but our model comparison approach did not identify any other variables predicting Largemouth Bass CPH. Trophic position of Largemouth Bass differed from Northern Pike, Walleye, Bluegill, and Yellow Perch indicating Largemouth Bass diets did not overlap with diets of these other species in lakes where they co-occur. Our results indicate that Largemouth Bass are more likely to become established and abundant in lakes with larger amounts of aquatic vegetation, however they may not directly compete for prey resources with other common sport fish species at the adult life stage.

### Muskellunge Spawning Habitat in Big Mantrap Lake

Calub E Shavlik

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Affiliation: MN Department of Natural Resources

Ten unique female Muskellunge were implanted with a miniature radio transmitter each spring from 2015 - 2017 in Big Mantrap Lake to identify spawning habitat. Of the thirty fish, fifteen (50%) expelled their radio transmitter, suggesting potential spawning habitat. These areas were assessed using different methods to see if Muskellunge sought out a unique habitat. Some of these potential spawning habitats had *Chara* as the dominant plant taxa while others did not. Two to three times a week, tracking was done to document movement and determine the date of expulsion. Some Muskellunge traveled considerably (i.e., 2 - 3 km) while other exhibited more typical “home range” (i.e., 700 m). The timing of expelled miniature radio transmitter corresponds to two different spawning periods with a Muskellunge swim up fry collected correlating with a successful early spawning period.

## Genetic Connectivity of Seven Fish Species Sampled Above and Below The Prairie Du Sac Dam on The Lower Wisconsin River

Jenna Ruzich, Keith Turnquist, Nathan Nye, David Rowe, Wesley Larson

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Affiliation: University of Wisconsin Stevens Point

The Prairie du Sac dam is the first upstream barrier on the Wisconsin River above confluence with the Mississippi River. Some downstream fish movement at Prairie du Sac is possible, however, reductions in connectivity caused by this artificial barrier could influence the genetic diversity of isolated subpopulations and reduce their ability to adapt to selective pressures. The objectives of our project were to determine if (1) genetic structure existed among populations and (2) if differences in diversity measures existed between populations of fish found above and below the Prairie du Sac dam. We analyzed seven fish species with varying life history traits and generation times: Lake Sturgeon, Walleye, Sauger, Smallmouth Bass, Flathead Catfish, Shorthead Redhorse, and Quillback Carpsucker. Sampling occurred over two years, and fifty samples above and below the dam were collected for each species in each year (1,400 samples total). Genetic analyses including diversity (heterozygosity and number of alleles), population structure, effective population size, allelic richness, FIS, source of variation (AMOVA), and power analysis, were conducted and evaluated for each species using a minimum of eight microsatellites. Our results revealed very low values of population structure ( $F_{ST} = 0 - 0.007$ ) between subpopulations for all species. Our results also indicated very small differences in genetic diversity between populations found above and below the Prairie du Sac dam. Most of the genetic variation was found among sampling years within individual populations. Simulations were also run to determine how many generations it could take for subpopulations of species to become more differentiated based on various levels of gene flow. The results of this project will provide resource managers with baseline genetic information that can be used to develop management strategies, such as fish passage, that will preserve the genetic integrity of populations within the Wisconsin River.

## Impacts of Emerging Ecological and Fishery Stressors on The Lake Superior Ecosystem

Bryan Matthias, Thomas Hrabik, Joel Hoffman, Dan Yule, Michael Seider, Mark Vinson

Presenter: Bryan Matthias, bmatthia@d.umn.edu  
Affiliation: University of Minnesota Duluth

Lake Superior is unique among the Laurentian Great Lakes in that it has ecological communities dominated by native species in both nearshore and offshore areas. However, the Lake Superior ecosystem is undergoing significant changes to both nearshore and offshore food webs, including prey fish population declines. These changes are likely affecting ecosystem functions, trophic dynamics, and fishery yields. The objective of this study was to use EcoPath with EcoSim to explore how the declines in the prey fish populations influence Lake Superior ecosystem dynamics. The secondary objective was to assess potential ecosystem-level effects of changing Sea Lamprey management strategies, specifically, 1) if we double and 2) if we halve the Sea Lamprey exploitation rate. We focus on the population-level responses of the native piscivores, Lean and Siscowet Lake Trout (*Salvelinus namaycush namaycush* and *S. n. siscowet*), along with the major prey fish (*Coregonus* spp., *Osmerus mordax*, *Cottus* spp., *Myoxocephalus thompsonii*.)

## **A Multi-Scale Approach to Identifying and Addressing the Causes of Minnesota's Declining Yellow Perch Populations**

Jeffrey Reed, Bethany Bethke, Michael McInerny, David Staples

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Affiliation: MN Department of Natural Resources

Often considered a keystone species in north-temperate lakes, declines in the abundance of Yellow Perch in assessment netting across Minnesota have become a concern of fisheries managers. Due to their ecological importance, we examined state-wide trends, individual lake case histories, as well as soliciting insight from fisheries managers to identify potential causes for the declines. Since 1970, state-wide decline, as measured by gill net catch per unit of effort, approximating 35% has been observed. Individual case studies indicate that declines are likely the result of a combination of factors, including increases in water clarity, predator stocking, and the introduction of invasive species. In some lakes such as Carlos and Horseshoe, substantial declines began over 40 years ago. However in other lakes where none of those factors occurred and the declines are more recent, larger ecological drivers of change, such as watershed development and land use changes and climate change may be contributing to declines. We used an influence diagram to solicit input from managers for potential causes for declines; allowing for the use of important localized knowledge about population declines. Although the decline in Yellow Perch populations is generally a state-wide phenomenon, some populations are not demonstrating decline. The scale of decline indicates this is a complex problem with no easy answers. However, by comparing stable populations with those in decline, using state-wide data, individual case studies and manager input we look to address the causes of decline and offer suggestions for stabilizing or reversing that decline.

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## Concurrent Session 2 – Professional Presentations State

### Genetic Origin and Movements of Lake Sturgeon in the St. Louis River and Western Lake Superior

Dan Wilfond, Dr. Justin VanDeHey, Dr. Joshua Rabbe, Patrick Schmalz, Deserae Hendrickson, Kayden Estep, Andrew Carlson, Paul Piszczek, Brian Borkholder

Presenter: Dan Wilfond, dan.wilfond@state.mn.us  
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Lake Sturgeon (*Acipenser fulvescens*) were extirpated in the St. Louis River (SLR) by the early 1900's. Nearly complete extirpation along with improvements in water quality and habitat led to a joint effort by the Minnesota and Wisconsin Departments of Natural Resources to re-establish Lake Sturgeon in the SLR. Lake Sturgeon from the Wolf River (Lake Michigan) drainage were stocked from 1983-1994. Lake Sturgeon from Lake Superior sources, the Bad (1988) and Sturgeon Rivers (1998-2000), were also stocked into the SLR. Recently, natural reproduction has been documented, however questions still exist about the genetic origins of spawning fish. Our objectives were to determine (1) the genetic origin of Lake Sturgeon collected in the SLR and (2) if Lake Sturgeon remain in the SLR throughout the year or immigrate to Lake Superior. During 2016 and 2017, 383 adult Lake Sturgeon ranging from 82-166 cm in length were collected in the SLR using electrofishing. One hundred five Lake Sturgeon received acoustic transmitters, 45 in 2016 and 60 in 2017. The 45 fish that received acoustic transmitters in 2016 all genetically assigned to the Wolf River strain. From April 2016 to April 2017 all 45 tagged fish were detected on acoustic receivers placed in the SLR. Twenty-six of 45 fish tagged in 2016 and 25 of 56 fish tagged in the spring of 2017 exited the SLR, moving into Western Lake Superior; Sturgeon exited primarily between June and September, but as late as December. Nineteen fish did not emigrate in 2016 and as of autumn 2017 a total 31 tagged fish had not emigrated, suggesting a resident population in the SLR. Knowledge of genetic origins and movement patterns will aid in management for this species of concern in Lake Superior and throughout the Great Lakes Basin.

### Protecting Fisheries Through Forestry

Daniel Steward, Heather Baird, Lindberg Ekola, Peter Jacobson

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The forested ecoregion of Minnesota contains many lakes with high water quality and excellent fisheries. And that is not accident - water quality is a key component those high quality fisheries. Previous research by Minnesota DNR Fisheries has shown that if we can keep 75% of a lake's watershed forested, we should have good water quality into the future. Unfortunately, development and conversion to agriculture threatens many of the private forest lands in those watersheds. An emerging lake protection methodology will be described that protects the forested watersheds of high priority lake fisheries in the forested zone of Minnesota. BWSR, DNR Fisheries, DNR Forestry, and the Minnesota Forest Resources Council are working with local units of government and NGOs to incorporate lake protection into their water plans and, most importantly, are now implementing those plans.

## **New Yellow Perch Sampling Net Reveals Surprising Results**

Marc Bacigalupi

Presenter: Marc Bacigalupi, marc.bacigalupi@state.mn.us

Affiliation: MN Department of Natural Resources

Yellow Perch are ecologically important, and of particular interest to fisheries managers as a critical forage species for walleye. A new monofilament small mesh gillnet was employed to successfully catch yellow perch at small sizes, Ages 0-III, in 2 large North-central Minnesota lakes in September 2017. Catches of perch in the gillnet surpassed catches in standard MN DNR Lake Survey gear, quarter-inch trapnets and night time boom-electrofishing runs and the size distribution of the catch provides useful information to fisheries managers that was previously unavailable. In Gull Lake and Pelican Lakes (Cass and Crow Wing Counties, MN) males and females were caught in equal proportions but matured at smaller than expected sizes, and the maximum length of males sampled was unexpectedly low at 144 and 163 mm, respectively. A number of management implications and future work will be discussed.

## **Concurrent Session 2 – Professional Presentations Senate/Congress**

### **The Influence of Land use Disturbance on Cisco Population Characteristics in Minnesota Lakes**

Tyler D. Ahrenstorff

Presenter: Tyler D. Ahrenstorff, tyler.ahrenstorff@state.mn.us

Affiliation: MN Department of Natural Resources

Understanding how Cisco (*Coregonus artedii*) populations respond to anthropogenic disturbance is fundamental to understanding how future disturbance may influence Cisco populations, pelagic food-webs, and management decisions. We used vertical gillnets and hydroacoustics to evaluate how Cisco population dynamics (e.g., body condition, average length and weight) varied across a range of lakes (N=34) in central Minnesota with differing amounts of disturbance (e.g., total phosphorous). Our analyses revealed that the majority of the Cisco population metrics were significantly correlated with various disturbance measures. Mitigating future land use disturbance and maintaining water quality, for example through the protection of forests surrounding Cisco lakes, is imperative for supporting populations of abundant Cisco of an adequate size for predator consumption.

## **Variable Thermal Stratification and Potential Impacts on Hypolimnetic Oxygen, Nutrients, Lake Productivity, and Pelagic Fish Distribution.**

Tim Martin, Lesley Knoll, Casey Schoenebeck, Gretchen Hansen, Peter Jacobson, James Cotner, Jeff Reed

Presenter: Tim Martin, tim.martin@state.mn.us  
Affiliation: MN Department of Natural Resources

Changes in a lake's thermal structure should hypothetically affect abiotic and biotic dynamics; however data are rarely available to elucidate these relationships. We used continuous water temperature loggers deployed in five of Minnesota's Sentinel Lakes to describe the duration and intensity of lake stratification over multi-year timespans. Furthermore, we examined how annual changes in stratification relate to other lake factors such as epilimnetic temperature, hypolimnetic oxygen, hypolimnetic phosphorus, chlorophyll, cyanobacteria, and fish distribution. We hypothesized positive relationships between indices of stratification and hypolimnetic nutrients and phytoplankton and negative relationship with hypolimnetic oxygen. We also examined the interaction between hypolimnetic oxygen and pelagic fish distribution. Our preliminary findings show that lake stratification duration can vary by more than a month among years depending on the lake. We also found that stratification duration relates positively to stratification stability. We found no strong relationships between stratification and the other lake factors when evaluated across all lakes; however, some relationships were observed at the individual lake level. Future work is underway to incorporate additional lakes and account for variable responses due to lake trophic state and geographic location.

### **From Water Chemistry to Fish: The Impacts of Zebra Mussels Across Multiple Trophic Levels in Lake Carlos, MN**

Casey Schoenebeck, Lee Engel, Heidi Rantala, Jodie Hirsch, Gary Montz, Donna Perleberg, Pete Jacobson, Gretchen Hansen, Derek Bahr, Brian Herwig, Jeff Reed, Steve Heiskary

Presenter: Casey Schoenebeck, Casey.Schoenebeck@state.mn.us  
Affiliation: MN Department of Natural Resources

Zebra mussels (*Dreissena polymorpha*) are known to disrupt trophic dynamics but long-term monitoring data rarely exist to evaluate changes through multiple trophic levels. We examined changes in water chemistry, phytoplankton and lake productivity, aquatic macrophytes, zooplankton, macroinvertebrates and fish in one of Minnesota's long-term monitoring lakes, Lake Carlos. Six years after their discovery in 2009, site-specific ZM density ranged from 43/m<sup>2</sup> to 33,843/m<sup>2</sup> in 2015 with densities less than 10,000/m<sup>2</sup> for most of the 117 sites sampled. Additional changes in the benthos included a decline in native fingernail clams. Chlorophyll-a decreased post ZM establishment as did phytoplankton species richness and total phosphorus. Water transparency doubled which may have allowed greater macrophyte growth as the percent of sites with aquatic macrophytes increased. Total zooplankton density and biomass decreased post ZM establishment with mean biomass consistently less than 100 ug/L and mean total density less than 20 number/L. To date, few changes have been observed in the littoral or pelagic fish communities.

## **The Use of Angler Data in a Population Estimate in Mille Lacs Lake: What Worked and What Didn't.**

Thomas S. Jones

Presenter: Thomas S. Jones, tom.jones@state.mn.us  
Affiliation: MN Department of Natural Resources

In 2017, a mark/recapture population estimate was conducted for smallmouth bass in Mille Lacs Lake. Bass were collected pre-spawn by electrofishing, and double-tagged with numbered Hallprint anchor tags. All recapture events were conducted by anglers. Four different groups of anglers were asked to collect data; anglers fishing in competitive bass tournaments, anglers fishing in Bass Nation club events, members of the Mille Lacs Lake Smallmouth Bass Alliance fishing recreationally, and bass anglers randomly encountered at access sites. Anglers were given data forms and asked to record fish length, the presence of one or more tags, and the location of the tag or the tag number. Anglers reported tags on 177 of over 7,000 smallmouth bass caught between late May and October. Tournament anglers were the most likely to participate, in part because of agreements with tournament organizers to collect data in exchange for regulation exemptions. Participation for all other anglers was purely voluntary, and participation was generally poor, although a handful of interested anglers contributed observations on 2,500 smallmouth bass. Despite varying levels of participation between groups, proportion of examined fish with tags was the same for all groups, suggesting that the data is robust. The process of angler participation resulted in relationships that increased trust and credibility between bass anglers and the DNR.

### **City of Eagan & DNR FiN Cooperate to Promote Urban Fishing**

Jessie Koehle, Eric Macbeth, Tim Ohmann, Jim Levitt, TJ DeBates

Presenter: Jessie Koehle, jkoehle@cityofeagan.com  
Affiliation: City of Eagan Water Resources Division

One of the City of Eagan's Water Resources program goals is for 12 of the City's lakes to support public fishing opportunities, giving most residents a place to fish about a mile from home. The Minnesota Department of Natural Resources (DNR) has routinely conducted fish assessments on only about five of these lakes, therefore the City has developed the capacity to assess each of the remaining seven lakes once every five years. In the resulting collaboration, the City shares findings, analysis, and management decisions with DNR, benefitting from their expertise and sharing resources when possible. The partnership promotes communication and support between the two government entities in other lake management areas as well, such as plant management and winter lake aeration. This presentation will give details about Eagan's fisheries population sampling methods, management history, and program goals.

## Concurrent Session 3 – Professional Presentations University A

### Evaluating The Northern Pike Special Regulation for Lake Vermilion 15 Years Post-Implementation

Matthew J. Hennen, David F. Staples

Presenter: Matthew J. Hennen, matthew.hennen@state.mn.us

Affiliation: MN Department of Natural Resources

The effects of a 24-36-in protected slot length limit on northern pike (*Esox lucius*) in Lake Vermilion were evaluated 15 years post-implementation. The regulation was implemented in 2003 as part of a state-wide initiative to improve the size structure of northern pike populations while having limited impact on abundance. Changes in relative abundance and size structure were evaluated using pre-regulation gill-net (1984-2002) and ice-out trap-net data (1997 and 1998) compared with post-regulation gill-net (2005-2017) and ice-out trap-net data (2017). The gill-net catch rate of northern pike ranged from 0.86 to 1.65 fish/net from 1984-2017 with a declining trend observed since 2002; the declining catch rate was also observed for fish >24 in. Both gill-net and trap-net data showed a shift towards a larger size structure post-regulation. The mean length of northern pike sampled in gill nets was significantly larger post-regulation (n = 193; mean = 27.3 in) compared to pre-regulation (n = 342; mean = 25.7 in). Additionally, the proportion of fish >24 in captured in gill nets significantly increased from 62% to 74%. Trap-net results were similar as the mean length of fish sampled significantly increased from 22.6 in (n = 806) pre-regulation to 23.4 in (n = 397) post-regulation. A significant increase in the proportion of fish >24 in captured in trap nets was observed when comparing the pre-regulation (27%) and post-regulation (42%) surveys. Though substantial normal variation in the size structure and abundance of the northern pike population undoubtedly occurs, these analyses suggest the protected slot has shifted the population's size structure. With the upcoming changes to statewide northern pike regulations, an opportunity exists to simplify regulations on Lake Vermilion without significantly impacting the northern pike population.

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## Stable Isotope Patterns in Food Webs of Minnesota Lakes Reflect Productivity Gradients

Kyle Zimmer, Ryan Grow, Angela Tipp, Pete Jacobson, Brian Herwig, David Staples

Presenter: Kyle Zimmer, kdzimmer@stthomas.edu

Affiliation: University of St. Thomas

Stable isotopes  $^{13}\text{C}$  and  $^{15}\text{N}$  are often used in food-web studies of lakes to assess energy sources and trophic position, respectively. However,  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  can also be influenced by biogeochemical processes in lakes, but these processes are poorly understood. We sampled  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  in mussels, Cisco (*Coregonus artedii*), and in seston and zooplankton in both the epilimnion and hypolimnion in 22 Minnesota lakes. The lakes ranged from the Canadian border to west of the Twin Cities, capturing a large gradient in lake productivity. We also measured temperature-oxygen profiles, total phosphorus, and photosynthetic compensation depth in each lake to assess factors influencing isotope patterns. All isotope samples were baseline corrected using mussels in each lake (sample - mussel) to control for landscape-level differences in isotope values. Results showed  $\delta^{13}\text{C}$  in Cisco was positively related to hypolimnetic zooplankton  $\delta^{13}\text{C}$ , and zooplankton  $\delta^{13}\text{C}$  was positively related to hypolimnetic seston  $\delta^{13}\text{C}$ . Hypolimnetic seston  $\delta^{13}\text{C}$ , in turn, was negatively related to the ratio of compensation depth: mixed layer depth, such that seston was most depleted in lakes where light penetrated deepest into the hypolimnion. This was likely due to hypolimnetic phytoplankton using respired  $\text{CO}_2$  depleted in  $\delta^{13}\text{C}$  in clear-water lakes. Results also showed a positive relationship between Cisco  $\delta^{15}\text{N}$  and hypolimnetic zooplankton  $\delta^{15}\text{N}$ , and that hypolimnetic zooplankton  $\delta^{15}\text{N}$  were positively related to hypolimnetic seston  $\delta^{15}\text{N}$ . Hypolimnetic seston  $\delta^{15}\text{N}$ , in turn, showed a negative relationship with total phosphorus, likely due to differences in microbial degradation of seston and denitrification rates between low and high phosphorus lakes. Overall our results indicate differences in the abiotic environment and microbial processes can generate patterns in isotopic differences between epilimnetic organisms (mussels) and hypolimnetic organisms that change along lake productivity gradients. These patterns should be accounted for in isotope studies of whole-lake food webs.

### Open Lands Analysis of The Lost River: What Does it Mean for the Fish?

Jamie Schultz, Heather Baird, Tim Quincer

Presenter: Heather Baird, heather.baird@state.mn.us

Affiliation: MN Department of Natural Resources

Open lands, forested lands clear cut or forests younger than 15 years of age, can contribute to an increase in sediment and discharge to streams in the forested landscape. Some north shore trout stream watersheds have been analyzed to determine how much open lands are in these important watersheds, however this analysis has not been conducted in other areas of the state. The Lost River near Orr, MN is located in a high timber harvest production area and has one of the only trout streams in this part of the state. An open lands analysis was conducted in this watershed using Lidar data to determine if open lands in the Lost River and its tributaries were reaching the threshold of 60% open lands that can contribute to increase flows and sediment to this important trout stream.

## Foraging Mechanisms of Siscowet Lake Trout on Deepwater Sculpin: Effect of Light Intensity And Substrate Composition on Native Predator Prey Interaction

Thomas R. Hrabik, Trevor Keyler and Lorenzie Rodgers

Presenter: Thomas R. Hrabik, thrabik@d.umn.edu

Affiliation: University of Minnesota Duluth

The foraging characteristics of siscowet lake trout (*Salvelinus namaycush siscowet*) in response to deepwater sculpin (*Myoxocephalus thompsonii*) were studied under ecologically relevant light intensities ( $9.0 \times 10^8$  to  $1.62 \times 10^{11}$  photons  $m^{-2} s^{-1}$ ) and on varying substrates (pea gravel, sand, and black fabric). We also determined the response of sculpin to siscowet predators for varying light intensities and substrates. Siscowet reaction distance increased with increasing light intensity up to  $6.0 \times 10^9$  photons  $m^{-2} s^{-1}$  thereafter remaining constant, but was not affected by substrate type. When compared to pelagic prey data, average reaction distances were lower at each light intensity for benthic prey. Prey capture increased with increasing light intensity and a strong correlation was found between the overall probability of prey capture and siscowet reaction distance at corresponding light intensities. Siscowet reaction distance to deepwater sculpin was not significantly different between  $60^\circ$  increments along the siscowet midline (forward, lateral or rear visual sectors) and siscowet remained active at all non-zero light levels. Finally, a predictive model for reaction distance to benthic prey was successfully developed to determine reaction distances for siscowet in various photic environments. Comparatively, deepwater sculpin reaction distance to siscowet was affected by both light intensity and foraging arena substrate. Sculpin reaction distance to siscowet showed a parabolic trend with increasing light intensity characterized by suppressed reaction distances in the dark, peaking at mid-range light intensities (between  $3.05 \times 10^9$  and  $6.0 \times 10^9$  photons  $m^{-2} s^{-1}$ ) and declining again at the upper tested light intensities. Study results indicate prey morphology, behavior and habitat may affect foraging by predators and ultimately, foraging success.

### Long-term Trends in a Catch-and-Kill Fishing Contest for Brown Trout

Neal Mundahl, Mark Reisetter, Mike Mauer

Presenter: Neal Mundahl, nmundahl@winona.edu

Affiliation: Winona State University

To examine possible, long-term effects of changing management, changing angler practices, and stream habitat improvement on stream trout fisheries in southeastern Minnesota, we analyzed data on 1289 weekly winners from Mauer Brothers Tavern Big Brown Trout Contest (Whitewater River watershed, Elba, MN), a catch-and-kill contest spanning 54 years (1963 to present). Winning fish averaged 1508 g (SD = 744 g), but weights declined significantly (~10 g/year for all fish, >20 g/year for each year's largest fish) across the years. Winning weights also declined (34 g/week) from beginning to end of a typical 25-week harvest season. There were 125 no-entry weeks (9.7% of total contest weeks), with most (84%) occurring within the last 21 years (1996 – 2016). The Middle and North Forks together contributed 45-50% of weekly winners through the 1990s, but recently (2010-2016) <15% of winners came from these streams. Over 700 anglers were weekly winners, with 23% winning multiple times (one angler won 38 times). Most winning anglers (84%) were watershed residents. More winning fish were caught with bait (69%) than with artificials, although the percentage of winners caught with artificials has more than doubled from the 1960s (19.5%) to the 2010s (44%). The weights of weekly winners did not differ among streams. Interpretation of contest results must take into consideration the various regulations (size limits, mandatory catch-and-release, artificials-only) placed on some reaches during and after the 1980s, the increasing voluntary catch-and-release practices of contemporary anglers, and the expanding stream habitat improvements within the watershed.

## Concurrent Session 3 – Professional Presentations University B

### Status of Peripheral Redside Dace Populations in Minnesota, 2017

Douglas J. Dieterman, Steve DeLain, Andrew Herberg, Chris Dawald

Presenter: Douglas J. Dieterman, Douglas.Dieterman@state.mn.us

Affiliation: MN Department of Natural Resources

Redside Dace in Minnesota represent genetically unique peripheral populations on the extreme western edge of their native range with uncertain population status. Stratified random surveys were conducted with electrofishing gear to assess status of populations in the Cannon and Zumbro river systems and to collect important life history traits for comparison to core populations in eastern North America. Minnesota Redside Dace grew faster but died younger than dace in core populations. The oldest Redside Dace in Minnesota was age-3 but dace reach age-4 in several core populations. Sex ratios did not differ from 1:1 in the Cannon population but was skewed to about three female dace for every male dace in the Zumbro population. Female dace matured at age-2 and about 80 mm in the Cannon population and 83 mm in the Zumbro population. Males matured at age-1 and 70 mm. Redside Dace in core populations mature at either age-2 or age-3. Spawning peaked in early May and females produced up to 962 eggs that weighed up to 24.8% of body weight. Recruitment was erratic over the years 2014, 2015, and 2016, but the 2015 year-class was very strong. Incidence of hybridization was low (0.3%) as only one Redside Dace x Southern Redbelly Dace hybrid was found. Redside Dace were found to persist in four of eight sub-watersheds in the Zumbro system. The estimated population size in the Little Cannon River was 9,251 (95% C.I. 8,300-10,201) and for all age-2 and older dace was 6,600 (95% C.I. 5,789-7,411). These values exceed a demographic-based minimum viable population estimate of 3,305 (nearly double) suggesting that Redside Dace, barring a catastrophic watershed-scale event, should be able to persist for at least the next two decades (until  $\approx$  2040) in Minnesota.

### Computational Agent-Based Model of Fish Swimming Through Mississippi River Locks and Dams to Block Invasive Carp Passage

Anvar Gilmanov, Dan Zielinski, Peter Sorensen

Presenter: Anvar Gilmanov, agilmano@umn.edu

Affiliation: University of Minnesota

Millions of bighead and silver (invasive) carps are living in the Mississippi River south of the Iowa border and moving north into Minnesota waters, which creates a significant problem for Minnesota aquatic ecosystems. To save the existing ecosystem balance in Mississippi and St Croix River, it is critical to stop this invasion. One approach of spread prevention of these invasive species is to use the existing system of Lock and Dams (L&Ds), which can make it virtually impossible for such species to continue swimming upstream when they attempt to pass through the dam. The main idea consists in generation of such velocities of fluid flow in L&Ds that fish would not be able overcome them. It can be achieved easily and at minimum cost by changing gate regulations of L&Ds. To address these issues we have used high-resolution agent-based model of flow through the Mississippi River Lock and Dams #4, #5, resolving hydraulic patterns at fine spatio-temporal scales. In this talk we will present preliminary results for Lock and Dam #4 (Alma, Wisconsin) and Lock and Dam #5 (Winona, Minnesota), a locations of critical importance because it is South of the Minnesota River. We will discuss a possible enhancement and development of this computational approach. This work is funded by the Environment & Natural Resources Trust Fund, MN.

## Assessing The ‘Site Effect’ with Species Distribution Models

Andrew Carlson

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Affiliation: MN Department of Natural Resources

Many of Minnesota’s aquatic ecosystems are composed of heterogeneous habitat, and correspondingly, much of the biota responds to this variability. As part of the Minnesota Department of Natural Resources’ Lake Survey Program, gillnets are one of the primary tools used to assess the status of fish communities. The timing and location of the gillnet sets were fixed by the mid-1990s and in subsequent evaluations of catch statistics from individual lakes, patterns emerged among years at specific sites – the ‘site effect’. These site-level patterns may be explained by the local habitat sampled by each net. The science of evaluating species distributions against environmental conditions has advanced tremendously in the past decade following technological improvements in tagging and monitoring systems. Using data collected from acoustically tagged adult Walleye, generalized linear mixed models were developed to predict the probability of occurrence at depth given temperature and oxygen within stratified lakes. Following, using data from a survey-specific temperature and oxygen profile, the relative odds of occurrence for Walleye was calculated throughout the water column and at the depths at each of the gillnet sites. Comparisons between modeled probability of occurrence and observed catch rates at specific sites were made to evaluate the degree to which site-level patterns can be explained by the habitat sampled. Integrating and accounting for known measures of environmental variability that systematically influence catch statistics will improve the quality and subsequent interpretation fisheries data to support management decisions.

### Reproductive Dynamics of a Native Brook Trout Population Following Manipulative Reduction of an Invader

Loren M Miller, R John H Hoxmeier, Douglass Dieterman

Presenter: Loren M Miller, loren.miller@state.mn.us

Affiliation: MN Department of Natural Resources

Removal of non-native brown Trout (*Salmo trutta*) from a stream in southeastern Minnesota provided the opportunity to examine reproductive dynamics of native Brook Trout (*Salvelinus fontinalis*) in the context of release from this competitor. We used data from 14 microsatellite DNA loci to estimate genetic effective population size, sibships and parentage across five cohorts (2008-2012). We hypothesized that Brown Trout reduction would allow more Brook Trout to successfully spawn and more evenly distribute reproductive success among individuals, thus increasing the effective number of breeders ( $N_b$ ) and maintaining greater genetic diversity. Contrary to expectations,  $N_b$  estimates changed little between pre- and post-removal cohorts (21-29 pre; 14-23 post), while  $N_b$  to census size ratios decreased slightly (0.17-0.19 pre; 0.08-0.17 post). The generational effective population size ( $N_e$ ) was 24.8. Variance in family size was not reduced at lower adult Brook Trout abundances, indicating a lack of genetic compensation by which small populations can slow losses of genetic diversity. Most individuals matured at about 125 mm, but reproductive success increased markedly with fish length beginning at about 185 mm. Larger full sib families were often widely dispersed by their first fall and their distribution was not useful for locating likely spawning sites. However, Brook Trout sampled in fall close to the spawning period tended to concentrate in a few stream sections. One section favored by Brown Trout prior to removal was later favored by Brook Trout, and parentage confirmed their high contribution of offspring. At least initially, increased abundance of adult Brook Trout has not lead to increased  $N_b$ , and  $N_e$  remains low for this population. Managers should consider assisted migration from nearby populations to enhance genetic diversity in this isolated population.

## **Just When you Thought it was Safe to go Back in the Water...Meet the Bladderworts, the Carnivorous Plants of Minnesota Lakes**

Donna J. Perleberg

Presenter: Donna J. Perleberg, donna.perleberg@state.mn.us  
Affiliation: MN Department of Natural Resources

Bladderworts (*Utricularia*) are known as Minnesota's carnivorous aquatic plants because they capture prey through trap doors of pressurized sacs. Eight species are known in the state and they differ in morphology, life history, distribution, and habitat, including water chemistry. Ecologically, these small plants can powerfully impact aquatic systems and their population dynamics may provide insights into climate change. Cross discipline research opportunities with bladderworts range from questions about pollination vectors to possible moose mortality due to mercury bioaccumulation. Culturally, this genus includes species valued and traded by terrarium enthusiasts, state-listed rare species that trigger environmental review discussions, and species that have been labeled as "nuisances". Learn how to locate, identify and document these fascinating plants to enhance local and statewide lake management. Don't worry, unless you're a rotifer, these plants won't eat you alive. (Specimens of bladderworts will be available for review at companion poster session).

### **Concurrent Session 4 – Professional Presentations University A**

#### **Walleye and Salmon and Shrimp – Oh My! The Future of Food-Fish Aquaculture in Minnesota**

Donald Schreiner

Presenter: Donald Schreiner, schr0941@d.umn.edu  
Affiliation: Minnesota Sea Grant

Aquaculture production is one of the fastest growing segments of agriculture in the world and a growing industry in the Midwestern United States. Global seafood demand is at an all-time high, with more than half of the seafood consumed coming from aquaculture. In 2016, NOAA reported that more than 90% (by value) of all fish and seafood consumed in the U.S. was imported. This situation creates a \$14 billion deficit that U.S. aquaculture can overcome if the industry is developed appropriately. Improvements in aquaculture technology, concerns about the safety and quality of imported seafood and demand for locally produced foods combine to create new opportunities to develop a food-fish and seafood aquaculture industry in Minnesota. To explore these new trends in aquaculture, and how they relate to the aquaculture industry, Minnesota Sea Grant held Minnesota's first food-fish aquaculture workshop in April 2017. Aquaculture experts from industry, academia and government agencies were invited to exchange information and start the discussion on food-fish aquaculture. The goal of the workshop was to answer the question "Can an environmentally responsible and sustainable food-fish aquaculture industry be established in Minnesota?" The consensus answer to this question by workshop participants was "yes," but it will take a balanced, thoughtful and collaborative approach among many stakeholders. The workshop was organized around three themes: 1) Prioritizing production strategies and species for food-fish aquaculture in Minnesota, 2) Identifying research needs and information gaps, 3) Examining policy and regulatory issues. This presentation will summarize the results of the workshop by discussing the main outcomes and recommendations that participants identified under each theme. A summary of the workshop and videos of keynote presentations are on the Minnesota Sea Grant website: [www.seagrants.umn.edu/aquaculture/workshop2017](http://www.seagrants.umn.edu/aquaculture/workshop2017).

## **Cisco in Lake Superior: Evaluating a Moving Target**

Beth Holbrook, Cory Goldsworthy, and Josh Blankenheim

Presenter: Beth Holbrook, beth.holbrook@state.mn.us

Affiliation: MN Department of Natural Resources

Cisco (*Coregonus artedii*) in Lake Superior have supported a commercial fishery since the early 20th century. Lakewide total Cisco harvest peaked in the 1940s followed by a widespread population crash in the 1970s, largely due to overharvest and the establishment of invasive species. Following this population decline, the Minnesota Department of Natural Resources began actively managing the Cisco commercial fishery through the use of gear restrictions and partial season closures. In 2007, the agency restricted the number of commercial licenses and instituted a total allowable catch-based fishery using population estimates derived with hydroacoustic methods. Over the past five years, hydroacoustic sampling and analysis methods were evaluated and refined in an effort to improve the precision of Cisco population estimates. Standardizing methodology was important for facilitating meaningful comparisons among years. Of the analysis methodologies evaluated, the application of gear calibrations and the treatment of backscatter from non-Cisco sized targets had the greatest influence on biomass estimates. Applying a standardized analysis method to a 10-year hydroacoustic data series indicated that Cisco populations have fluctuated throughout the time series, with low populations following periods of minimal recruitment. Scientifically documented sampling and analytical protocols are essential for effective management and evaluation of this important multijurisdictional resource.

## **The Sport Fish Restoration Program: A Conservation Success Story**

Hanna Kruckman, Craig Kelling, Paul Glander, Ann Schneider

Presenter: Hanna Kruckman, hkruckman@gmail.com

Affiliation: U.S. Fish and Wildlife Service

The Sport Fish Restoration Program (SFR) was created in 1950 to provide funding to State fish and wildlife agencies for fisheries restoration, conservation, and management. In addition, funds can also be used to acquire land, provide aquatic education, and increase public access and angling opportunities. The program has four sources of funds: 1) manufacturers' excise taxes paid on fishing equipment and electric outboard motors 2) import duties on fishing tackle, pleasure boats, and yachts; 3) federal fuel tax revenues attributable to the sale of gasoline for use in motorboats and small engines, and 4) accrual of interest on the trust fund in which revenue from these sources are held. Through this program, millions of dollars in grant funds are distributed to State fish and wildlife agencies through a permanent and indefinite appropriation, making it one of the most successful user pay, user benefit programs in the world. The SFR program in Region 3 (IA, IL, IN, MI, MN, MO, OH, WI), is administered by the U.S. Fish and Wildlife Service (FWS) Regional Office in Bloomington, MN where a team of biologists, fiscal specialists, and FWS leadership work in partnership with State agencies to ensure sport fish are conserved and managed for the use and enjoyment of current and future generations. SFR funds received by the Minnesota Department of Natural Resources have been applied to a variety of programs, including fisheries research, management, production and stocking, aquatic education, public access, and technical assistance. With changing user groups and demographics, understanding the role this program plays in agencies, organizations, and universities is imperative to its continued success. Sharing the successes of this program while working to adapt and remain relevant in a changing society will require the collaboration and partnership of all who support, enjoy, and work for our nation's natural resources.

## Electrofishing Non-Wadeable River: Does Sampling Design Affect Bioassessments?

Nathan Mielke

Presenter: Nathan Mielke, nathan.mielke@state.mn.us

Affiliation: Minnesota Pollution Control Agency

We evaluated the effects of electrofishing design on fish assemblage, metric values, and overall index of biological integrity (IBI) scores. One-hundred and thirty-three visits between the Minnesota Pollution Control Agency's Northern and Southern Rivers IBI class were evaluated in this effort. Data representing three different passes (inside, outside, and mid-channel) were extracted from each visit and analyzed. A parametric test comparing metric and IBI scores, detected significant differences for most scores when individual passes were removed. The percent change in metric values declined sharply with the addition of the mid-channel pass and varied less than 10% for most metrics. A correspondence analysis showed that species composition was associated with channel position, suggesting habitat variables within each pass could influence metric values and overall IBI score. Although scores tended to increase with the addition of the mid-channel pass, there was no significant change in water quality assessment results. This demonstrates that designs that sample at least 1,000 m of shoreline are sufficient for bioassessments on non-wadeable rivers. However, our correspondence analysis suggests it may be advisable to divide distance fished between both banks to ensure an "even" amount of the thalweg and shallows are sampled.

### **Stable Isotopes Indicate Zebra Mussels (*Dreissena polymorpha*) Increase Dependence of Lake Food Webs on Littoral Energy Sources**

Brian R. Herwig, Margaret C. Thompson, Kyle D. Zimmer, Ryan S. Trapp, Claire E. Herzog, Catherine E. Hegedus

Presenter: Brian R. Herwig, Brian.Herwig@state.mn.us

Affiliation: MN Department of Natural Resources

We assessed impacts of zebra mussels on energy flow by comparing two Minnesota lakes. Lake Carlos has a dense population of zebra mussels, while upstream Lake Ida was free of zebra mussels until 2014 and densities remained extremely low during our study. We used  $^{13}\text{C}$  and  $^{15}\text{N}$  stable isotopes to assess patterns of energy flow as  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values differ in organisms supported by phytoplankton production (lower  $^{13}\text{C}$ , higher  $^{15}\text{N}$ ) relative to organisms supported by littoral energy sources, such as periphyton and benthic algae. We used traditional mixing models and calculated standard ellipse areas to estimate and compare percentages of littoral vs. pelagic energy sources supporting various fish species present in Carlos and Ida lakes. Results indicate that percentage of littoral energy sources was significantly higher in Lake Carlos compared to Lake Ida for nearly all fish species analyzed. Effect size was often large, with reliance on littoral energy by some fish species approximately 1.5-fold higher in the presence of zebra mussels. We posit that this greater reliance on littoral energy sources in the Lake Carlos food web is likely driven by high zebra mussel densities reducing phytoplankton abundance. Subsequent reductions in zooplankton likely force remaining consumers to shift diets towards littoral food sources.

## **Concurrent Session 4 – Professional Presentations University B**

### **Blowing in the Wind: Quantifying the Wind-Wave Effect on Nearshore Lake Habitat**

Tim Cross, Bill Herb, Pete Jacobson, Josh Raabe, Doug Zentner

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The composition of nearshore littoral zone substrates are thought to strongly influence lake ecosystems and fish communities. Evidence of this influence on fish communities is shown by correlations that directly link shoal substrate composition to fish populations assessed in MNDNR standardized lake surveys. These relationships support long held knowledge regarding the influence of specific habitat factors (e.g. aquatic vegetation and spawning substrates) on individual fish species. Because wind-wave energy is a key factor influencing the structure and composition of nearshore substrates, we investigated how nearshore substrate composition in many Minnesota lakes can be predicted from readily obtainable data on wind energy applied to lake morphometric data. We also measured nearshore currents that resulted from wind driven wave action. These measurements showed flows toward (accumulating nearshore drift), parallel (transport along nearshore zone), and away (transport to limnetic zone) from the shoreline with nearshore substrates as large as cobble distributed to distinct areas of erosion, transport, and deposition. The primary factors regulating flow direction relate to shoreline morphometry and relationship to wind direction. However, at two sites we observed nearshore currents altered by emergent vegetation. New and valuable insight on the suitability of habitat for numerous aquatic vegetation and animal species could be developed once nearshore wind-wave driven currents are further quantified and developed into spatial models (maps).

### **Shovelnose Sturgeon and Paddlefish Populations and Movements in The Minnesota River**

Michael C. Wolf, Mike Vaske, Tony Sindt

Presenter: Michael C. Wolf, [michael.wolf@state.mn.us](mailto:michael.wolf@state.mn.us)  
Affiliation: MN Department of Natural Resources

Globally, Sturgeon spp. and Paddlefish are in need of conservation as populations have been negatively impacted by habitat loss and commercial harvest for their valuable roe. Unfortunately, life history traits of Sturgeon spp. and Paddlefish make them particularly susceptible to overharvest and habitat fragmentation. In Minnesota, both recreational and commercial harvest of Paddlefish is prohibited since the species is listed as threatened while Shovelnose Sturgeon were recently de-listed as a species of special concern. Relatively little is known about Shovelnose Sturgeon and Paddlefish populations in the Minnesota River. Elsewhere in the Mississippi River Basin both species are commercially targeted and Paddlefish are considered a valued sport fish. Therefore, as part of a project funded by the Environment and Natural Resources Trust Fund, we evaluated Minnesota River populations of Shovelnose Sturgeon and Paddlefish. Starting in August of 2017, Shovelnose Sturgeon and Paddlefish were sampled throughout the Minnesota River with a variety of sampling techniques. To date, we captured 313 Shovelnose Sturgeon and 66 Paddlefish from several sites along the Minnesota River. A sub sample of the fish caught (14 Paddlefish and 36 Shovelnose Sturgeon) were implanted with acoustic transmitters and their movements were recorded with both active and passive tracking methods. In general, most Shovelnose Sturgeon remained near their initial capture location while several Paddlefish traveled long distances (>200 miles) out of the Minnesota River. For example, the first Paddlefish tagged as part of this study left and returned to the Minnesota River multiple times, traveling over 500 river miles in less than one year. While the history of Shovelnose Sturgeon and Paddlefish populations in the Minnesota River is unclear, increased encounters may be an encouraging sign for the future of the Minnesota River.

## Using Analyses of Lake Sturgeon Tissues to Inform Decisions About Prevention and Management of Invasive Carp in Two National Park Service Units

Jeffrey Ziegeweid, Steven Zigler, Lynn Bartsch, Michelle Bartsch, Jay Glase, Byron Karns, Seth Love, Joel Stiras

Presenter: Jeffrey Ziegeweid, jrziege@usgs.gov

Affiliation: U.S. Geological Survey

Reproducing populations of invasive carp could alter aquatic food webs and negatively affect native migratory fishes in the Mississippi National River and Recreation Area and the St. Croix National Scenic Riverway. However, proposed invasive carp barriers also may threaten populations of native migratory fishes by preventing movements between rivers that could be needed to fulfill life history requirements. In this study, nonlethal chemical techniques were used to determine the trophic positions and migratory histories of lake sturgeon (*Acipenser fulvescens*) captured in the Mississippi and St. Croix rivers. Analyses of carbon and nitrogen stable isotopes demonstrated differences in trophic position among sturgeon captured in different locations among the two rivers. Ratios of strontium to calcium (Sr:Ca) and barium to calcium (Ba:Ca) in collected water samples were characterized at six sampling locations among the two rivers. Laser ablation data obtained from cross sections of lake sturgeon pectoral fin rays indicated that lake sturgeon Sr:Ca values were different between rivers, but Sr:Ca values were similar for natal and capture locations of lake sturgeon captured in the same river. However, Sr:Ca data showed that some fish likely moved between rivers. Lake sturgeon captured in the Mississippi River had similar length-weight relations but higher length-at-age compared to lake sturgeon captured in the St. Croix River. Growth and Sr:Ca analyses provided evidence that the Mississippi and St. Croix rivers have separate populations of lake sturgeon that interact through migrations of individual fish between rivers. Results of this study will provide managers information about the feeding ecology and migratory histories of lake sturgeon within two National Park Service units and provide pre-invasion data for lake sturgeon should populations of invasive carp become established. In addition, laser ablation techniques presented here could be used to study other migratory fishes that serve as dispersal agents for at-risk mussel species.

## Largemouth Bass Population Dynamics in Minnesota: Implications of Limited Harvest

Tanner Stevens

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Affiliation: MN Department of Natural Resources

Population dynamics of Largemouth Bass were quantified for seventeen lakes in northern and central Minnesota in order to model the effects of limited harvest and evaluate potential population enhancement actions. Fish were collected using electrofishing from spring 2015 through spring 2017. Otoliths were taken from a subsample of fish for age and growth analysis. Population dynamics were quantified using Von bertalanffy growth curves and catch curves. Maximum age estimates by lake from otoliths varied greatly from a low of 7 to a high of 24. Average maximum length at infinity also showed similar variation from a low of 377 mm to a high of 470 mm. Similar to maximum age and growth, annual mortality also exhibited a large amount of variation (4.5%-42.5%). While Largemouth Bass harvest often appears to be low, this limited harvest may have large population level effects. Models showed that just a 2 percent increase in annual mortality can lead to a 13 percent reduction in preferred size fish. With some populations ranging from 3.59 fish/acre to 4.30 fish/acre this could have large impacts on Largemouth Bass populations in many small-medium lakes. Longevity and slow growth of Largemouth Bass in many Minnesota lakes present the potential for quality overfishing even with limited harvest, and underline a need for protection of these populations.

## Field Test of a Low-Voltage, Portable Electric Barrier to Guide Common Carp Into a Trap During Seasonal Migrations

Przemek Bajer, Aaron Klaus, Jordan Wein, Emil Kukulski, Matt Kocian

Presenter: Przemek Bajer, [bajer003@umn.edu](mailto:bajer003@umn.edu)

Affiliation: University of Minnesota

Common carp (*Cyprinus carpio*) is known for its extensive seasonal migrations. Often, 1,000s of adult carp migrate between lakes and marshes (spawning grounds) in early spring in large, synchronized events. If these fish could be directed into traps, sustainable carp management schemes could be developed for many lake-marsh systems. In this study, we used a portable, low-voltage electric guidance system (EGS) to direct common carp into a mock trap in a relatively large, natural stream (Rice Creek). The system was tested on 6 occasions: 3 days with EGS off and 3 days with EGS on. Approximately 50 adult carp were used in each test. PIT tags/antennas and visual markers were used to monitor the behavior of the carp. When the EGS was on, 74% of the carp were successfully guided into the mock trap within 24 hours, and no carp were able to cross through the EGS (despite over 200 attempts); the remaining carp presumably remained downstream of the EGS. When the EGS was off, only 18% of carp swam into the mock trap, and carp were able to swim through the inactive EGS. Electric field used in the EGS was mild and did not cause fish paralysis. The EGS required little on-site engineering and was deployed in 2 days. This new type of EGS was recently successfully tested for sea lamprey (*Petromyzon marinus*) and might prove useful for managing invasive fish or for conservation of native species.

### Poster Session

#### The Effects of Stocking Yellow Perch in Shallow Southern Minnesota Lakes

Spencer Whilm, Casey Clemensen, Ben Miller, Brian Herwig, Dr. Kyle Zimmer

Presenter: Spencer Whilm, [wihl2907@stthomas.edu](mailto:wihl2907@stthomas.edu)

Affiliation: University of St. Thomas

Habitat quality in shallow lakes in southern Minnesota often becomes degraded (turbid, with macrophyte loss) once populations of Fathead Minnow, Black Bullhead, and Common Carp become established and reach high densities. Managers often perform drawdowns to induce fish winterkills, or use the fish toxicant rotenone, to reduce undesirable fish populations and improve habitat quality in lakes. Following such treatments, piscivorous fish (e.g., Northern Pike) are sometimes stocked to help control remaining or reinvading fish populations in these highly interconnected systems. Initially, prey fish may be low following treatment, so managers have been experimenting with stocking Yellow Perch as an initial food source to get Northern Pike populations through a growth and survival bottleneck. Yellow Perch are invertivorous at small sizes, but can become strongly piscivorous at larger sizes. So, this leaves the question, what are the effects of stocked Yellow Perch populations in rehabilitated shallow lakes: are they a significant top-down control on prey fish, or are they impacting invertebrates and water quality much like the nuisance fish populations that managers are attempting to control? We studied Yellow Perch populations and diets in Geneva, Rice and Pickerel lakes in southern Minnesota where such treatments and subsequent fish stocking has occurred and developed bioenergetics models to estimate and compare consumption patterns among lakes. Juvenile Yellow Perch from each lake ate almost exclusively zooplankton. Diets of larger Yellow Perch varied considerably among lakes. In Rice and Geneva lakes, Yellow Perch were highly piscivorous, consuming mostly Fathead Minnows. In Pickerel Lake, Yellow Perch exclusively consumed invertebrates, which may further exacerbate reduced invertebrate and zooplankton populations, possibly leading to increased algae populations. We conclude that the effects of stocking Yellow Perch are different depending on the characteristics of the lake and that the effects are more dynamic than lake managers had initially thought.

## **Retention of Morphological and Ecological Traits of Lake Superior Cisco *Coregonus Artedi* After Translocation Into Inland Lakes**

Peter C. Jacobson, Simon K. Emms, Jennifer L. Cruise, Kyle D. Zimmer, Ryan C. Grow, Jillian Nielsen Angela R. Tipp, Loren M. Miller

Presenter: Peter C. Jacobson, peter.jacobson@state.mn.us  
Affiliation: MN Department of Natural Resources

Introductions of *Coregonus artedi* from Lake Superior into several inland lakes in Minnesota in the 1920s and 1930s constituted a natural experiment of how phenotypic plasticity and adaptation can shape cisco diversity. Genetic data were consistent with a Lake Superior origin for the introduced populations, which resembled contemporary Lake Superior cisco in possessing large, elongated bodies and short fins, and in maturing at older ages. Native inland cisco had smaller, deeper bodies, longer fins, and matured at younger ages. Introduced populations also retained the Lake Superior characteristic of inhabiting the upper portion of the water column and showed a high degree of planktivory. However, introduced cisco exhibited small but measurable shifts in body shape and fin lengths toward native inland forms. These morphological shifts were possibly associated with greater benthivory after translocation. Assuming that native inland populations were well adapted to inland lakes and that selective pressures on native and introduced populations were similar, these results indicated that substantial further phenotypic, behavioral, and life history change is required before the introduced populations become similarly adapted to their new environments. The findings suggest that anthropogenic environmental alterations such as climate change and eutrophication might occur at a faster pace than adaptive evolutionary responses. In addition, translocated Great Lakes coregonines could possibly maintain traits exhibited in their source lake, and may not fully restore ecological functions of extirpated populations.

## **Effects of Northern Pike and Yellow Perch Stocking in Shallow Lake Ecosystems**

Claire E. Herzog, Catherine E. Hegadus, Kyle D. Zimmer, and Brian R. Herwig

Presenter: Claire E. Herzog, herz0026@stthomas.edu  
Affiliation: University of St. Thomas

Northern Pike and Yellow Perch (hereafter pike and perch, respectively) are often stocked in an attempt to maintain clear-water states by controlling undesirable fish, but to date impacts of stocking are largely unknown. We assessed impacts of stocking these fish by sampling  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  in food web components of four large shallow lakes in southern Minnesota in summer of 2017. We used  $\delta^{15}\text{N}$  to test whether trophic position of fish species differed in each lake, and whether patterns of trophic position for each species across the four lakes were linked to fish community characteristics. We also tested whether reliance on littoral carbon differed across the four lakes for each species using  $\delta^{13}\text{C}$ . Results showed trophic position differed among multiple fish species in just three of four lakes, and only two lakes (Lake Geneva and Rice) had trophic positions of perch and pike generally higher than other non-piscivorous fish. Trophic position of all fish species was also positively related to CPUE of perch, such that trophic position of individual fish species was highest in lakes with highest CPUE of perch. Perch effects on trophic position are likely driven by perch serving as a forage base for larger piscivores and by perch reducing competition for macroinvertebrates by preying on smaller planktivorous fish. Our  $\delta^{13}\text{C}$  results showed fish were more reliant on littoral energy in the two lakes (Geneva and Pickerel) with higher abundance of submerged plants relative to the other two lakes. Overall our results indicate higher densities of perch facilitate upward shifts in trophic positions of all fish species, and basal sources of energy flow differ between lakes in turbid and clear states. Thus, management activities inducing state shifts or favoring high densities of perch will result in major changes in predator-prey interactions and energy flow in shallow lakes.

## **The Sport Fish Restoration Program: A Conservation Success Story**

Craig J. Kelling, Hanna G. Kruckman, Paul A. Glander, Ann L. Schneider

Presenter: Craig J. Kelling, [craig\\_kelling@fws.gov](mailto:craig_kelling@fws.gov)  
Affiliation: U.S. Fish and Wildlife Service

The Sport Fish Restoration Program (SFR) was created in 1950 to support state restoration, conservation, and management of sport fish for public use, including providing access facilities for anglers and boaters. The program has four sources of funds: 1) manufacturers' excise taxes paid on fishing equipment and electric outboard motors 2) import duties on fishing tackle, pleasure boats, and yachts; 3) federal fuel tax revenues attributable to the sale of gasoline for use in motorboats and small engines, and 4) accrual of interest on the trust fund in which revenue from these sources are held. Through this program, millions of dollars in grant funds are distributed to State fish and wildlife agencies through a permanent and indefinite appropriation, making it one of the most successful user pay, user benefit programs in the world. The SFR program in Region 3 (IA, IL, IN, MI, MN, MO, OH, WI), is administered through the U.S. Fish and Wildlife Service (FWS) Regional Office in Bloomington, MN where a team of biologists, fiscal specialists, and FWS leadership work in partnership with each State agency to ensure sport fish are conserved and managed for the use and enjoyment by current and future generations. Since 1987, the Minnesota Department of Natural Resources has received an average of \$10,132,829.00 in SFR funds that have been applied to a variety of programs, including fisheries research, management, production and stocking, aquatic education, public access, and technical assistance. With changing user groups and demographics, understanding the role this program plays in agencies, organizations, and universities is imperative to its continued success. Sharing the successes of this program while working to adapt and remain relevant in a changing society will require the collaboration and partnership of all who support, enjoy, and work for our nation's natural resources.

### **Drone Intelligence - Elevate your insight**

Shelly Carroll

Presenter: Shelly Carroll, [shelly.carroll@sc-recon.com](mailto:shelly.carroll@sc-recon.com)  
Affiliation: SC Recon-Drone Intelligence

Unmanned Aircraft Systems (drones) are becoming common tools in resource management. The technology has matured to provide incredible value to waters and fisheries professionals. In this session you'll meet a multi-mission drone close up, learn about sensing capabilities, view examples of fisheries applications, and discuss considerations when planning aerial data capture. Learn more at [www.sc-recon.com](http://www.sc-recon.com).

## **Brown Trout Spawning Redds and Stream Habitat Improvement in Garvin Brook**

Neal Mundahl, Cody Swoboda

Presenter: Neal Mundahl, nmundahl@winona.edu

Affiliation: Winona State University

We examined the abundance, locations, and physical attributes of Brown Trout spawning redds during October-November 2016 and 2017, within a 4.8-km reach of Garvin Brook undergoing a series of habitat improvement projects. The upstream, 1.8-km stream section was unimproved, the middle 1.9-km section was improved in 2015, and the lower 1.1-km section was improved in 2017. We observed 162 redds in 2016 and 210 redds in 2017. Redd abundance (redds/100 m stream length) did not differ significantly among stream sections or between years: 3.4 and 4.4 redds/100 m in 2016 and 2017, respectively. Water depths and current velocities at redd sites differed among sections and between years, both generally increasing from upstream to downstream. Redds in the three stream sections averaged 1.4 to 1.7 X larger in area in 2017 compared to 2016, suggesting multiple use or larger spawners. Approximately 70% of redds in upper and lower stream sections were grouped (two or more clustered together) in both years, whereas only 53% of redds were grouped within the middle section. Over 40% of all redds were associated with some form of cover (e.g., overhanging terrestrial or aquatic vegetation, logs, boulders), but presence of cover did not affect redd size. Cover association increased 7-fold (5% in 2016, 37 % in 2017) within the lower section following stream habitat improvement. Over 30% of redds in the unimproved section, but <10% of redds in improved sections, were associated with logs or sticks. Brown Trout spawning redds were abundant in both improved and unimproved stream sections, and differences in redd habitat and cover association among stream sections were likely related to natural channel changes, as well as riparian habitat changes associated with stream habitat improvement.

## **Effects of Anthropogenic Stressors on Fish Community Condition in Minnesota Lakes**

Derek Bahr

Presenter: Derek Bahr, Derek.Bahr@state.mn.us

Affiliation: MN Department of Natural Resources

Numerous anthropogenic stressors have the potential to alter the diversity and composition of fish species found in lakes. Examples of such stressors include eutrophication, riparian lakeshore development, connectivity loss, and oxythermal habitat reduction. The objective of this study was to evaluate relationships between various anthropogenic stressors and fish community condition, which was measured by using a fish-based index of biological integrity developed for most Minnesota lakes. Fish communities were sampled in lakes across the state using a combination of seines, backpack electrofishing units, trap nets, and gill nets. Data quantifying various anthropogenic stressors were either collected concurrently with fish sampling (e.g. Score the Shore habitat assessment) or obtained from alternative sources (e.g. Minnesota Pollution Control Agency water quality database and Minnesota Department of Natural Resources watershed health assessment framework). Generalized additive models were used to evaluate the effects of each stressor independently on the overall fish-based index of biological integrity score, while also accounting for natural lake characteristics. Results from this study will provide additional information regarding effects of anthropogenic stressors on fish community condition and will better inform the stressor identification process used during the Minnesota Pollution Control Agency's watershed assessment approach to restore and protect water quality.

## Using Side-scan Sonar to Characterize and Map Physical Habitat and Anthropogenic Underwater Features in the St. Louis River.

Mark S. Pearson, David Bolgrien, Jonathon Launspach, and Greg Peterson.

Presenter: Mark S. Pearson, [pearson.mark@epa.gov](mailto:pearson.mark@epa.gov)  
Affiliation: U.S. Environmental Protection Agency

Characterizing underwater habitat and other features is difficult and costly, especially in large river systems. The St. Louis River is the largest US tributary to Lake Superior and the lower portion consists of a 48.5 km<sup>2</sup> complex of wetlands, tributaries, and bays. We surveyed 82 km of shoreline habitat in the St. Louis River using recreational grade side-scan sonar (SSS) in the recording mode. Sonar TRX software 13.1 was used to extract the data and generate georeferenced images at a 10cm resolution. GIS tools were used to highlight homogeneous and heterogeneous areas (texture) of the image followed by measuring aspect from bathymetry data to highlight areas facing the same direction. GeniePro software 2.4 was used to classify this 3-band composite image by adaptive feature extraction resulting in a 1m resolution output. We used ArcGIS 10.3 to post-classify areas of smooth and rough substrate, aquatic vegetation, woody debris, and a variety of anthropogenic features (docks, piling, and sunken ships). When fully developed our method will help resource managers prioritize habitat management projects and further develop the concept of Remediation to Restoration to Revitalization of Great Lakes Areas of Concern. This abstract does not necessarily reflect EPA policy.

### How to Identify Minnesota's Carnivorous Lake Plants, The Bladderworts (*Utricularia*).

Donna Perleberg

Presenter: Donna Perleberg, [donna.perleberg@state.mn.us](mailto:donna.perleberg@state.mn.us)  
Affiliation: MN Department of Natural Resources

Eight species of bladderworts (*Utricularia*) occur in Minnesota but most field staff are familiar with only the most common species. All bladderworts form the characteristic bladder or sac, through which they trap prey. Because each species differs in life history, distribution and habitat characteristics, it is important to identify them to the species level. Learn how to identify bladderworts in the field and how to document new occurrences. Specimens of bladderworts will be available to review. (Additional information on bladderwort biology will be provided at the companion paper session.)

## **A Field Test Examining The Ability of a Boat Motor Sound to Deter Common Carp From Passing Through The Lock of a Mississippi River Lock and Dam**

Andy Riesgraf, Jean-Sebastien Finger, Clark Dennis III, Peter Sorensen

Presenter: Andy Riesgraf, riesg029@umn.edu

Affiliation: University of Minnesota

Preventing the spread of invasive species is one of the most pressing issues in fisheries management. In the 1970s, bigheaded carp (*Hypophthalmichthys sp.*) from Asia escaped from ponds in Arkansas and are spreading northwards. These species are presently established 400km south of the Minnesota border, leaving Lock and Dam #8 as the chokepoint to prevent their invasion into our waters. Our research team has shown that carp passage through the spillway gates of Lock and Dam #8 is minimal and can be greatly reduced by small changes in gate operations. This leaves the lock as the Achilles heel. Because all carp have an exceptional sense of hearing, we are examining whether sound might be used to deter carp from the lock. Laboratory studies have shown that bigheaded and common carp (*Cyprinus carpio*) avoid the sound of a boat motor (> 70% deterrence); however this sound has not been tested in the field (Mississippi River). This study addressed this issue by determining whether the upstream passage of wild common carp through the lock chamber at Lock and Dam #8 (monitored by acoustic tags and ARIS imaging sonar) was altered when a boat motor sound was played during lockages. We conducted six 2-week long trials (i.e., 3 trials- sound off and 3 trials- sound on) using a naïve group of 20 carp for each trial. Our results showed no significant effect of sound on fish passage, with 8% of carp passing whether the sound was on or not ( $P>0.05$ ). This lack of response could have been caused by habituation and/or the sound levels being reduced to accommodate the navigation industry. We now plan to test a new-pulsed sound at Lock and Dam #8, which laboratory studies suggest to have much greater potential (see talk by Clark and Sorensen). (Funded by the MN DNR).

### **Inventory of Minnesota River Backwater Fish Communities**

Michael Vaske, Michael Wolf, Anthony Sindt

Presenter: Michael Vaske, michael.vaske@state.mn.us

Affiliation: MN Department of Natural Resources

Floodplains are an important component of large river ecosystems and serve a vital role in ecosystem function. The Minnesota River floodplain contains hundreds of backwater habitats that provide critical spawning and rearing habitat, refuge from high-flow conditions, and zooplankton rich foraging areas for many fish species. Utilization of backwater habitats is dependent on a variety of physical features (i.e., size, depth, connectivity, macrophyte cover), thus, not all backwaters are equal. Despite the importance of Minnesota River backwater habitats, very little is known about their ecosystem function or fish communities. Our objectives were to (1) develop and evaluate fish community survey protocols for Minnesota River backwater habitats; and (2) characterize fish communities in at least 12 Minnesota River backwaters. During 2016 and 2017, backwater fish communities were sampled using seines, boat electrofishing, gill nets, and fyke nets. We measured total length and weight of all sampled fish and recorded physical habitat characteristics of backwaters and their surrounding land. To date, eight of twelve backwaters have been sampled, varying in size from 5 to 100 acres with species richness varying from 14 to 30, for a total of 48 unique species. Overall, fish communities inhabiting the eight backwaters surveyed are similar to fish communities recorded in other previously surveyed Minnesota River backwaters. At least four additional backwaters will be surveyed during 2018 to encompass more variability in backwater habitats. Outcomes of this study will increase understanding of the importance of backwater habitats for fish communities and help prioritize habitats for conservation, restoration, and protection efforts.

## **Bimodal Length Distribution of Age-0 Largemouth Bass in Two Minnesota Lakes**

William French, Casey Shoenebeck, Tim Martin

Presenter: William French, Will.french@state.mn.us

Affiliation: MN Department of Natural Resources

Largemouth Bass *Micropterus salmoides* (LMB) in Minnesota typically spawn from mid-May through early June when water temperatures reach 15.5°C. Disruption of spawning activity by short term environmental changes (e.g. fluctuations in water level or water temperature) can create variability in hatch date (earlier and later dates) resulting in a bimodal length distribution of the age-0 LMB cohort. Bimodal length distributions can have consequences for age-0 growth and survival by reducing the number of growing days, altering dynamics of competition for limited food resources, and delaying or eliminating ontogenetic diet shifts. Reductions in age-0 growth and overwinter survival have the potential to reduce year class strength and recruitment to the adult population. We documented bimodal length distributions in the 2017 age-0 LMB cohort in Lake Carlos and Elk Lake during targeted fall sampling as part of the Sentinel Lakes Program. Continuous littoral water temperature data from both lakes showed a 5°C decrease in water temperatures during late May 2017 that likely interrupted spawning of LMB and may be responsible for the observed bimodal length distributions. The data provided by the Sentinel Lakes program not only allowed us to detect these changes, but will also allow an assessment of the frequency and potential consequences of LMB spawning interruptions in other Minnesota lakes moving forward.

### **Prioritizing Lakes for Conservation in Lake-Rich Areas: The Value of Water Quality Protection and Restoration**

Paul Radomski, Kristin Carlson

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Affiliation: MN Department of Natural Resources

Identifying lakes in which to invest water quality conservation efforts can help more effectively target efforts and more efficiently utilize limited resources. The objective of this study was to compare different approaches to prioritize Minnesota lakes primarily for water quality protection or restoration. Lakes were objectively ranked using a multi-criteria values-based model that included phosphorus-loading resilience, level of watershed degradation, and feasibility of water quality protection or restoration. We explored how the list of priority lakes might change when incorporating benefit:cost ratios that used a hedonic model to predict land value increases with total phosphorus loading reductions. In addition, we examined the influence of including data on lakes with unique or high quality biological communities. The multi-criteria values-based model was moderately correlated with the benefit:cost ratio approach; however, the exclusion of benefits and cost in the prioritization would likely result in the loss of a modest amount of potential benefit (~20%). A focus on impaired waters would likely result in considerable forgone benefit (~80%) and substantially higher costs. We provide recommendations on how to combine prioritization approaches along with a peer review process to produce lake priority lists that are both defensible and practical.

## **Fish Species of Greatest Conservation Need in the Upper Mississippi River, 2017**

Steve DeLain, Andrew Herberg, Douglas Dieterman, Chris Dawald

Presenter: Douglas Dieterman, Douglas.Dieterman@state.mn.us

Affiliation: MN Department of Natural Resources

Several fish species of greatest conservation need (SGCN) have primarily been documented in the Mississippi River in southeast Minnesota but their status is uncertain because of difficulties sampling this large complex river ecosystem. To verify their present SGCN classification and to provide baseline data using a standardized collection protocol, we sampled for Crystal Darter (Threatened), Bluntnose Darter (Special Concern), and Warmouth (Special Concern) over 219 rkm of the Mississippi River and 11 of the lower St. Croix. We captured three other SGCN species [Western Sand Darter (Special Concern), Mud Darter (Special Concern in Wisconsin) and Pirate Perch (Special Concern)] incidental to our target species resulting in establishment of additional baseline data. To sample benthic habitats in water up to 12 m deep, we used a benthic trawl towed downstream for a distance of 350 m at 15 randomly selected sites per Mississippi River pool. To sample backwater habitats, often heavily vegetated, we used 30 mini-fyke nets set overnight per pool. This 30 net sample size should ensure a 95% chance of verifying Warmouth presence in each pool. No Crystal Darters or Bluntnose Darters were captured in 83 benthic trawl tows or in the 288 mini-fyke nets set. However, a total of 143 Western Sand Darter, which are closely related to Crystal Darter, were collected. Mean catch rates of Western Sand Darter ranged from 2.1/tow in Pool 5 to 3.8/tow in Pool 7. In backwater habitats, a total of 39 Warmouth and 25 Pirate Perch were collected and exhibited clumped distributions. Absence of Crystal Darter confirms their classification as state Endangered. Even fewer Bluntnose Darter have historically been collected in Minnesota (12 total records/specimens) and their absence in 2017 suggests that their classification should probably be Endangered also.

### **Walleye Recruitment in Minnesota Large Lakes 1984-2016**

David F. Staples

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Affiliation: MN Department of Natural Resources

Metrics of year class strength (YCS) are useful for management evaluation of fishery status and are necessary for detecting correlates with successful recruitment. Minnesota DNR Fisheries developed a linear mixed effect (LME) model of age-specific gill net catch rates that accounts for annual variation in catchability, and provides a standardized YCS metric that is comparable across lakes, unlike raw gill net catch rates, which are not directly comparable. Walleye YCS for 10 Minnesota Large Lakes was estimated using 1984-2016 standard gill net survey data, with model diagnostics and simulations used to evaluate reliability and precision of model estimates. The Large Lake YCS comparisons showed evidence for a large-scale correlation in walleye recruitment, and to a lesser extent, evidence for a small correlation in gill-net catchability.

## Seasonal Fluctuations of Zooplankton, Dissolved Oxygen, and Temperature in Lake Bemidji, Minnesota

Cody Coyle, Dr. Andrew Hafs

Presenter: Cody Coyle, coylecf62@gmail.com

Affiliation: Bemidji State University

With the current influx of aquatic invasive species in Minnesota lakes, the status of zooplankton has become vital. Zooplankton are at the base of all food chains in aquatic ecosystems, ecosystems that vary greatly throughout a year's time. The objectives of this study were to 1) track the location of zooplankton throughout the water column for an entire year, and 2) establish relationships between zooplankton location and specific water column characteristics. Zooplankton, dissolved oxygen, and temperature samples were collected bi-monthly at various depths at the deepest point in the southern basin of Lake Bemidji. Zooplankton were most abundant in the summer with densities ranging from 5-31 specimens per liter, with the highest densities being found in 3-8 meters of water. Densities during the winter ranged from 3-14 specimens per liter while being more homologous in the water column. Dissolved oxygen remained high in the epilimnion throughout the year, peaking at 14.91mg/L on 2 May 2017. A steady decline of dissolved oxygen as depth increased was observed in both winter and summer months with the lowest reading being 0.01mg/L at 15 meters of depth on 15 September 2017. Temperature peaked in the epilimnion at 21.5°C in the summer with it ranging from -0.5-3.4°C in the winter. Hopefully these results will help fisheries managers and others interested in this field better understand the trends in zooplankton densities in lakes.

### Predicting Zebra Mussel effects on Benthic Carbon Dynamics in Lake Bemidji

Samuel Peterson, Dr. Debbie Guelda

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Zebra mussel (*Dreissena polymorpha*) infestation in North America has resulted in extensive research to aid in maximizing biological quality and control over our natural resources. Previous studies have shown that the biomass of macroinvertebrate communities, inorganic material, and carbon are enhanced once a heterogenous benthos consisting of *D. polymorpha* has been established. Literature on predicting how *D. polymorpha* may fundamentally alter benthic communities and carbon is rare. Lake Bemidji, an uncolonized open mesotrophic system, had tiles constructed with artificial druse communities (n=60) at zero, low, medium, and high densities and placed onto suitable colonization sites (n=5) for 3, 9, and 12 month periods. Carbon was extrapolated using the Ash Free Dry Mass (AFDM) of both inorganic material buildup and colonized macroinvertebrate biomass. This attempt to mimic effects of *D. polymorpha* on a lentic benthos may result in a better understanding of how this exotic mollusk may alter uncolonized habitats.

## Food Habits and Prey Taxa and Size Selectivity of Age-0 Largemouth Bass in a West-Central Minnesota Lake

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Understanding larval Largemouth Bass (*Micropterus salmoides*) food habits and prey taxa and size selectivity provides necessary early life history for this economically and ecologically important species. Larval Largemouth Bass were opportunistically sampled from Lake Carlos, Minnesota from 7 to 11 July 2017. Stomach contents were removed, identified to the lowest possible taxa, and enumerated. Zooplankton were concurrently sampled using a column sampler and filtered through an 80µm plankton net. Comparisons of selection were made using the Strauss prey electivity index (L). Larval Largemouth Bass (n = 38) at this size (averaged 21.9 mm and 0.10 g) were predominately zooplanktivorous consuming on average 91 zooplankton per fish (SE = 6) but some macroinvertebrates (mostly Chironomidae) and zebra mussel (*Dreissena polymorpha*) veligers were also consumed (8 per fish). Cyclopoids (averaged 31 per fish) and Calanoids (averaged 23 per fish) were the most frequent prey taxa consumed. Larval Largemouth Bass opportunistically consumed prey in proportion to availability in the environment with the exception of a marginal positive selection for Cyclopoids (L = 0.15) and a negative selection for abundant zebra mussel veligers (L = -0.20).

### Relationships Between Double-Crested Cormorant Consumption and Taxa Specific Catch Rates in Leech Lake, MN

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The recolonization of Double-Crested Cormorants (*Phalacrocorax auritus*) on Leech Lake, Minnesota in the early 1990's has raised questions about their effect on the fishery. Management of the birds began in 2005 when percid catch rates declined as the cormorant numbers increased. Our objectives were to 1) estimate consumption mass (total kg) by fish taxa during years diets were collected, and 2) to compare consumption estimates with catch rates of these fishes from standardized trawl and seine hauls collected annually by the Minnesota Department of Natural Resources. The diets of 1,978 total cormorants were processed in the years 2005 - 2007, 2010, and 2017. Fish were categorized to lowest identifiable taxonomical group. Relationships between taxa-specific cormorant consumption and both trawl and seine CPUE will be presented.

### Take a YCS Model for Walleye, Add a Dash of Age-Length Key Likelihood, and Avoid The Catchability Mess.

Charles Anderson

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Because of size-selective sampling, a survey sample and the population of interest have different age distributions, different length distributions, and different length-at-age distributions. Such bias is a bummer, eh? Nevertheless, Year-Class Strength models can provide estimates of relative YCS. In addition, the expected probability of age at a given length  $P(\text{age}|\text{length})$  is not changed by size-selective sampling (the principle of age-length keys). The hybrid model provides estimates of sorts for survival and growth, ages 1 to 4, with catchability as an afterthought.

## Floating Leaf and Emergent Vegetation: A Summary of Statewide Data

Josh Knopik

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Shallow water plant communities, specifically emergent and floating leaf communities, provide numerous benefits including littoral habitat for fish and wildlife, and reducing riparian erosion. They are degraded by development and eutrophication thus can potentially be an indicator of environmental stress and possibly provide change detection. Accurately mapping these communities poses numerous logistic challenges. The use of Collector of ArcGIS has greatly simplified and improved the efficiency and quality of collecting this data. We now have over 430 lakes across Minnesota that have high resolution delineations of plant communities. This poster will display a summary of this increased data-set.

### Diet Patterns of Stocked and Native Fishes in Shallow Southern Minnesota Lakes

Ben Miller, Brian Herwig, Casey Clemensen, Spencer Whilm, and Kyle Zimmer

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We sampled and analyzed diets of stocked Northern Pike (NOP) and Yellow Perch (YEP) in three southern Minnesota lakes (Geneva, Pickerel, Rice) where fish stocking was used as a tool to potentially extend the number of years that rehabilitated lakes exhibit clear-water conditions following water level drawdown or fish toxicant treatments. We also collected and analyzed diets of native and nonnative (Common Carp) fishes present in the three treatment lakes and a reference lake (Minnesota). Initially, prey fish populations may be low following rehabilitation treatments, so managers have been experimenting with stocking YEP as an initial food source to get NOP populations through a growth and survival bottleneck. We hypothesized that NOP would be highly piscivorous, but we were less certain about the ecological feeding niche of YEP and how it compares to other native and nonnative fish in shallow lakes. In this preliminary analysis of first year project data, we assembled a data set of 388 fish diet samples for eight fish species. We selected multiple predictor variables to help us understand patterns among sites and species, or associated with fish length and various site characteristics (e.g., submerged plant abundance and YEP Catch-Per-Effort). Canonical Correspondence Analysis was implemented on these data sets and 32% of the variation was explained in our diet response matrix. Ordination plots revealed that NOP were the most piscivorous species while Fathead Minnow, Golden Shiner, and Black Crappie had signature zooplankton diets. Orangespotted Sunfish, Bluegill, and Green Sunfish relied most heavily on macroinvertebrates, while YEP appeared to have a generalist feeding strategy. Fish length explained the most variability in our model, and was correlated with increased piscivory. Patterns in piscivory (including cannibalism), zooplanktivory, and invertivory varied by lake and may be related to ecological state, prey abundance, and other factors to be detailed.

## Fecundity of Female Walleyes in the Red Lakes, Minnesota

Benjamin J. Miller, Benjamin D. Erb, Phillip Oswald, Andrew W. Hafis

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Following the recovery of the Red Lakes' Walleye (*Sander vitreus*) fishery in the 2000s, more study is needed to ensure the avoidance of future population crashes. Of particular importance is recruitment, of which fecundity is an integral aspect. Walleye fecundity has not been studied in the Red Lakes since their recovery and is therefore in need of reexamination. The development of relationships regarding fecundity and Walleye characteristics will result in a better understanding of recruitment dynamics. Walleyes were sampled during their spawning run in the Tamarac River in the spring of 2017. In this preliminary analysis of first year data, 29 walleye were analyzed. Walleye weight, fork length, and age ranged from 439 to 2,260 g, 366 to 594 mm FL, and 6 to 13 years, respectively. Linear models relating fecundity to morphological features were developed. Median estimated total fecundity (eggs per fish) was 43,878 (IQR=34,562) with a range of 22,242 to 147,767 eggs. Fecundity was significantly related with fork length ( $r^2 = 0.69$ ), weight ( $r^2 = 0.80$ ), and age ( $r^2 = 0.52$ ) and were explained by the equations  $\log_{10}F = -3.08 + 2.93\log_{10}FL$ ,  $\log_{10}F = 1.63 + 1.02\log_{10}W$ , and  $F = -13,739 + 8525A$ , respectively, where F = total fecundity, FL = fork length, W = weight, and A = age. Red Lakes Walleye were determined to have a normal fecundity when compared to other systems. Fecundity was found to be generally lower than in 1990, which is in accordance to existing theory regarding fecundity and overexploitation.

## Estimating Angling Effort on Four of Minnesota's Fishing in The Neighborhood Lakes Via Time Lapse Cameras

Jonathan Hansen, Jim Levitt, Tim Ohmann

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The Minnesota Department of Natural Resources started the Fishing in the Neighborhood (FiN) program in 2001 to offer angling opportunities close to population centers throughout the twin cities metro area. Under increasingly tighter state budgets, program evaluation is critical both to determine if FiN efforts are paying off and to use limited resources more efficiently across the 40 ponds in the FiN program. Arguably the most important metric for evaluating program effectiveness and resource efficiency is angler effort at each pond, however conducting in person creel surveys is expensive. Fisheries professionals are increasingly utilizing technologies such as trail cameras and image processing software to estimate angling effort. We initiated a pilot project to estimate angling effort on four FiN lakes for the 2016-2017 angling season. If successful and cost-effective the camera creel effort would be integrated into the standard sampling rotation with the ultimate goal of identifying what ponds are used the most and why. Effort was successfully and cost-effectively estimated on four ponds. A customizable software (TimeLapse2) was critical in making image processing cost-effective. Annual effort ranged from 64 hours per acre to 428 hours per acre. Early summer saw the highest fishing effort, with June being consistently the most popular month. Some interesting patterns emerged, including the fact that the most popular pond was the farthest from dense populations but offered the greatest angling experience suggesting the importance of providing quality fishing opportunities. This project is continuing and likely expanding to incorporate camera based angling estimation into other statewide fisheries applications.

## **Spatial Genetic Structure of Smallmouth Bass Across Wisconsin**

Jenna Ruzich, Scott Hansen, David Rowe, Wesley Larson

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Smallmouth Bass are an important sport fish throughout Wisconsin and can be found in many aquatic ecosystems. Past studies have found that Smallmouth Bass may be an indicator species: sensitive to environmental changes. Therefore, bass could possess the evolutionary potential necessary for adapting to regional differences in climate, productivity, physical habitat, and ecosystem size. This could influence the genetic diversity between various Smallmouth Bass populations. Additionally, Smallmouth Bass have not been extensively stocked throughout the state of Wisconsin. This presents an important opportunity to investigate a species that has likely not been impacted by indiscriminate stocking. There is currently little information on the genetic integrity of Smallmouth Bass populations found spatially separated between and within lakes, rivers, and flowage systems in Wisconsin. The objective of this study is to determine if genetic structure exists between Smallmouth Bass populations sampled at various locations across the state of Wisconsin. Sixteen different bass populations will be sampled via electrofishing and fyke netting to collect fin clips for DNA analysis. Genetic diversity and population structure will be analyzed using 15 microsatellites developed for Smallmouth and Largemouth Bass. We anticipate that Smallmouth Bass populations will be highly structured throughout the state. The results of our research will be used to define stock boundaries and inform managers of this important species.

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