Wisconsin Chapter of the

American Fisheries Society

Poster Presentation Abstracts

48th Annual Meeting

February 19-21, 2019

Tundra Lodge, Green Bay, WI

Development of a genetic linkage map for cisco (*Coregonus artedi*) to facilitate integrated studies of adaptive diversity

Presenting author: Danielle Blumstein, *UW-Stevens Point*
Co-authors: Wendylee Stott and Wes Larson

Abstract - Throughout their circumpolar range, species within the coregonine complex are ecologically and socioeconomically important and are heavily impacted by human activities. In the Laurentian Great Lakes, abundance and diversity of ciscoes is well below historic levels. The species complex has generally been preserved in Lake Superior, Lakes Huron and Michigan still contain at least one deepwater cisco form and one pelagic form, Lake Ontario only contains pelagic form, and ciscoes have been extirpated from Lake Erie. Accurate identification of forms is critical for the development of effective restoration and management plans. Currently, form classifications are based on morphometric variation. However, the relative influence of phenotypic plasticity and heritable genetic differences in determining these forms is not well understood. Here we use modern genomic techniques to construct sex-specific linkage maps for C. artedi collected in northern Lake Huron. The female map contained 20025 loci and the male map contained 6350 loci. The linkage map will be used as a genetic resource that will facilitate research with the aim of determining the degree of heritable genetic differences among cisco forms.

Overlaps in fish diet structure in two north temperate lakes

Presenting author: Matthew Chotlos, *UW-Madison*
Co-authors: H. Embke, K. Perales, and J. Vander Zanden

Abstract - To investigate interspecies relationships, University of Wisconsin researchers conducted a whole-lake manipulation by removing centrarchids from an experimental lake in northern Wisconsin. A reference lake nearby was also monitored. In order to understand shifting community structure, the trophic position of each species in the two lakes was calculated based on weighted diet contents. We constructed food webs for June, July, and August of 2017 in each lake. In the both the experimental lake and the reference lake, centrarchid and walleye diets show overlap. We will continue collecting diet information for both lakes after the removal that began in 2018. Due to diet overlap, we suspect decreasing the centrarchid populations will benefit walleye populations. The 2017 food web structures will act as a comparison to determine how the removal of these fishes affects the lake food web.

Comparison of lake sturgeon growth and survival using fin rays and capture-recapture data

Presenting author: Emma Easterly, *UW-Stevens Point*
Co-authors: Dan Isermann, Mike Donofrio, and Dan Dembkowski

Abstract - Lake sturgeon are a long-lived fish species with late maturation and slow growth and have shown significant population declines over the past two centuries. As a result, overharvest of lake sturgeon stocks that support recreational fisheries is a concern. The Menominee River system bordering Wisconsin and Michigan supports one of the largest naturally-reproducing stocks of lake sturgeon in Lake Michigan. These stocks have supported hook-and-line fisheries since 1946. Age and growth of lake sturgeon are often estimated using pectoral fin rays to avoid sacrificing fish, but the accuracy of these estimates is questionable, especially for older fish. Faben's (1965) growth model provides a method for estimating maximum length ($L\infty$) and the rate at which length at recapture approaches $L\infty$ (denoted as K) based on capture-recapture length data where age is unknown, but fish length at time of capture and time between subsequent recaptures is known. Our primary objective is to determine if potential differences in lake sturgeon growth and survival estimated using capture-recapture data and fin ray ages (both raw and corrected) affect conclusions regarding the effects of exploitation and choice of minimum length limits for regulating harvest. Preliminary results suggest that estimates of asymptotic maximum length ($L\infty$) and Brody growth coefficient (K) from von Bertalanffy growth models were similar when using the raw and corrected fin rays ages, but estimates of Fabens's (1965) $L\infty$ and K are relatively high compared to the von Bertalanffy estimates, which is expected since $L\infty$ from the Fabens model represents a maximum and not an asymptote.

Yellow perch recruitment synchrony in six northern Wisconsin lakes

Presenting author: Ryan Eastman, *UW-Stevens Point*
Co-authors: Dan Dembkowski and Dan Isermann

Abstract - Yellow perch *Perca flavescens* recruitment can vary substantially among populations, which can influence not only perch population characteristics (i.e., population size structure, growth, mortality) but also the dynamics of fishes dependent on them as prey. Consequently, knowledge of trends in yellow perch population fluctuations has important implications for management of multiple species. As a cursory examination of yellow perch population characteristics in Wisconsin, we evaluated recruitment dynamics and relationships among catch-curve residual values indicative of relative year-class strength to determine the extent of synchrony in perch recruitment in six northern Wisconsin lakes. Recruitment appeared to be moderately variable across the six populations with recruitment coefficients of determination ranging from 0.33 to 0.67. Correlation coefficients for the 15 bivariate combinations of catch-curve residuals ranged from -0.69 to 0.97 (mean = 0.15), indicating that recruitment was not synchronous among populations. Our preliminary results suggest that recruitment dynamics are independent among lakes and are likely influenced by localized factors rather than factors acting over a broad spatial scale.

Creating a safe operating space for walleye

Presenting author: Holly Embke, *UW-Madison*
Co-authors: Stephen Carpenter, Dan Isermann, M. Jake Vander Zanden

Abstract - Walleye, a cool-adapted piscivorous species, have experienced recruitment and abundance declines in the north-temperate region of Wisconsin over the past decade, but the cause is not understood. Multiple factors have been proposed as potential explanations for these declines, including rising lake temperatures, habitat degradation, harvest, and species interactions. Others have documented the rise of warm-adapted fish species, such as basses and sunfishes (i.e., centrarchids), in this region, indicating that competition and/or predation may be contributing to declines in cool-adapted species. To investigate these interspecies relationships, we are conducting a whole-lake manipulation to remove as many centrarchids as possible from an experimental lake in northern Wisconsin (McDermott Lake) while measuring the response of Walleye. A reference lake (Sandy Beach Lake) nearby is also being monitored. This project began with baseline monitoring of both lakes in 2017 and fish removals in 2018. In total in 2018, we removed ~85,000 individual fish (~2,000 lbs) from McDermott Lake consisting of Bluegill, Pumpkinseed, Rock Bass, Black Crappie, Green Sunfish, Smallmouth Bass, and Largemouth Bass. We will continue monitoring and removals in 2019 and will monitor both lakes for changes in 2020 and 2021. This information will be used to inform an understanding of the conditions necessary to foster self-sustaining Walleye populations.

Influence of sex ratio and flow conditions in lake sturgeon (*Acipencer fulvescens*) egg fertilization success

Presenting author: Angela Grimm, *UW-Green Bay*
Co-authors: Stefan Tucker and Patrick Forsythe

Abstract - Lake Sturgeon (*Acipenser fulvescens*) populations have become severely depressed across their range and a focal species for rehabilitation efforts. While population growth hinges on reproductive success, their unique reproductive ecology complicates restoration actions and many knowledge gaps still exist on the biotic and abiotic factors influencing the success of egg fertilization. Broadcast spawning is a strategy utilized by Lake Sturgeon, where gametes are freely expressed in a communal setting across a wide range of environmental conditions as a way to maximize reproductive output. However with the dramatic shifts in adult population structure and altered environmental conditions at spawning locations, there has been little research conducted to explore basic biotic (sex ratios) and abiotic (flow) influences on reproductive success. The objective of this study was to estimate egg fertilization success across a range of sex ratio and flow conditions. Lake Sturgeon gametes were collected from wild spawning individuals and transferred into a controlled laboratory setting. Mimicking natural scenarios, gametes were released in and experimental flume to test fertilization rates under combinations of two different flow regimes, high (0.55±0.01 m/s) and low (0.18±0.01 m/s), and three different sex ratios (males: females = 1:1, 2:1 and 3:1). Sex ratio was predictive of egg fertilization yet egg fertilization only was significantly greater under a 3:1 sex ratio, and water flow was not predictive of fertilization success. The results of this study improve the knowledge of basic principles/conditions for reproductive success and effective breeding population structures which promote natural reproduction.

Genetic and genomic applications in aquatic species management

Presenting author: Kristen Gruenthal, *UW-Stevens Point*
Co-authors: Wesley Larson and Greg Sass

Abstract - Because of their great potential for dispersal and reproduction, as well as inherent difficulties in tracking and monitoring their activities, aquatic species present unique challenges for natural resource management. Genetics is a powerful tool that is increasingly used to enhance our understanding of movement, behavior, connectivity, and adaptation over evolutionary and contemporary timescales. I have used a variety of genetic and genomic methods in attempts to understand these characteristics in wild populations of highly-fecund mollusks and finfish, in particular, and then tailored management recommendations to species' needs. Some of this research has included using: (1) nucDNA and mtDNA gene sequencing, microsatellites, AFLPs, and RADseq to inform restoration planning for depleted and endangered California abalone species; (2) byssal thread adhesive protein gene length polymorphism for species identification of mytilid mussels in support of studies into larval transport and copper sensitivity; (3) mtDNA barcoding to organize a local sequence database of all identified California fish species; (4) microsatellites and parentage analysis to elucidate seasonal spawning dynamics and maternal reproductive exhaustion in wild-caught white seabass broodstock; (5) RADseq to study population connectivity and local adaptation in Pacific cod across the northeast Pacific, including a severely-depleted DPS in the Puget Sound, and track steelhead recolonization of the Elwha River after dam removal; and (6) predictive modeling to simulate demographic and fitness impacts of escapees from marine aquaculture. Here, I showcase work on four species – green abalone, Pacific cod, white seabass, and steelhead – that covers a range of genetic and genomic applications. I also touch on some exciting research at the University of Wisconsin – Stevens Point Molecular Conservation Genetics Laboratory, where I am now a Research Scientist and Lab Manager, that harnesses an array of established and emerging technologies to enhance our ecological and genetic understanding of local and regional aquatic species.

Differential predation of round goby by walleye, yellow perch, and lake whitefish

Presenting author: Alexandria Keiler-Klein, *UW-Green Bay*
Co-authors: Dan Dembkowski, Dan Isermann, and Lucas Koenig

Abstract - Round goby *Neogobius melanostomus* are an invasive species that was introduced to the Great Lakes in the 1990s and are now abundant in many portions of the Great Lakes and connected waterways. Despite their status as an invasive species, round gobies serve as important prey items for native fishes including walleye *Sander vitreus*, yellow perch *Perca flavescens*, and lake whitefish *Coregonus clupeaformis*. Predation by native fishes may regulate abundance of round gobies and different native fishes may prey on different segments of the goby population based on gape limitations. We processed diets of walleye, yellow perch, and lake whitefish collected from numerous locations in Green Bay to determine if total length (TL) of round gobies consumed varied among predators and if TL of round gobies consumed increased in relation to predator TL. Round goby TL varied significantly among walleye, yellow perch, and lake whitefish; walleye consumed the largest round gobies, followed by perch and lake whitefish. Furthermore, round goby TL increased with predator TL for walleye and yellow perch but we did not observe any relationship between predator and prey TL for lake whitefish. Our results suggest that walleye, yellow perch, and lake whitefish consume different segments of the round goby population and that larger predators (especially walleye and perch) are less gape-limited and able to consume larger round gobies than smaller conspecifics.

WI-AFS Continuing Education Committee

Presenting author: Allen Lane, *U.S. Fish and Wildlife Service*

Abstract - The Continuing Education Committee of the Wisconsin Chapter was established to develop and implement both training and educational opportunities for Wisconsin Chapter members. Here at the Annual Meeting we are soliciting members for their innovative training and education ideas. All ideas are considered and the Continuing Education chair and board work towards implementing the best suggestions into future activities. Examples of courses offered in the past include, Fish Health, Telemetry Techniques and Application, and Fisheries Statistics Refresher.

Precision metrics summarized from 20+ years of fish age estimation studies

Presenting author: Joshua Lyons, *Northland College*
Co-authors: Derek Ogle

Abstract - Age estimation of fish is necessary for the assessment of fish population dynamics and stock structure. Precision is the consistency or repeatability of age estimates among multiple readings from calcified structures. Three common measures of age precision are percent agreement, average percent error (APE), and average coefficient of variation (ACV). Campana (2001) reviewed the use of these precision measures in the fisheries literature, suggested that the ACV should be used in most instances, and indicated that ACV values less than the modal observed ACV of 5% indicated adequate ageing precision. We analyzed 313 age precision studies published since 1983. Our objective was to determine if recent papers primarily used ACV, to reassess the modal observed ACV value, and to determine if these items differed based on number of readings, range of observed ages, class of fish, and type of calcified structure. The ACV was used in two-thirds of reviewed studies published after 2001. Usage of ACV did not differ between type of comparison (between- or within-readers) or class of fish studied (Actinopterii or Elasmobranchii), but did differ among number of repeated readings, range of observed ages, and calcified structure used. Median ACV was lower when only two repeated readings were made, lower when more than 10 ages were estimated, and lower for otoliths than spines, fin rays, and vertebrae, which had a lower median ACV than scales. The overall median ACV was 9.3%, with a modal ACV of 9-10%. These results suggest that the ACV is higher than what Campana reported in 2001 and varies among aspects of the analyses. Our results provide a modern perspective on the questions raised by Campana and allow for more focused comparisons of age precision results.

Comparison of different otolith aging techniques of lake whitefish

Presenting author: Madeline McKeefry, *UW-Green Bay*
Co-authors: Andrew Ransom, Stefan Tucker, Patrick Forsythe, Chris Houghton, and Scott Hansen

Abstract - Accurate fish aging is an important aspect of fisheries management that leads to a better understanding of population demographics resulting in informed management decisions. A wide variety of bony structures are used to age fish, of which otoliths (inner ear bones) are popular. Methods of preparing these structures include thin sectioning, where otoliths are embedded in an epoxy and cut thin for aging under a microscope, and crack and burn, where the otolith is cracked in half and lightly scorched to identify growth rings. These two techniques are widely used by state and federal agencies, but have not been directly compared for differences in precision for Lake Whitefish (*Coregonus clupeaformis*). With the mixed stock fisheries typical of the Great Lakes, age estimation consistency is vital for successful management. To investigate these unknowns, we analyzed otoliths of Lake Whitefish, an important commercial species in the Midwest and Canada, using these two common preparation techniques. Age estimation bias and precision was assessed using age bias plots, Chang's coefficient of variation (CV), and average percent agreement. Results indicated overall precision was slightly higher for thin sectioning (CV= 13.59) compared to crack and burn (CV= 14.14), but percent agreement within one year was higher for crack and burn (42%) than thin sectioning (31%). Additionally, while crack and burn was more time and cost efficient, thin sectioning produced subjectively clearer images. The two techniques did produce differences for Lake Whitefish, emphasizing the importance of maintaining consistent age estimation and using caution when multiple methods are utilized for inter-agency management.

Dynamics of *Salmincola edwardsii* infection of naïve brook trout in Ash Creek, Wisconsin

Presenting author: Matt Mitro, *Wisconsin DNR*
Co-authors: Lavinia Unverdorben, Dan Walchak, and Aaron Nolan

Abstract - Infection of Brook Trout by the ectoparasitic copepod *Salmincola edwardsii* has been of increasing concern in Wisconsin and elsewhere in North America, but little is known about the short-term dynamics of infection. We exposed naïve Brook Trout to *S. edwardsii* in Ash Creek, Wisconsin, by holding 40 age-2 and 10 age-3 F1 hatchery Brook Trout in each of 2 cages in the stream and by stocking 80 age-2 and 20 age-3 trout directly into the stream on 29 June 2018. Brook Trout in the cages were inspected for signs of gill infection weekly from 5 July to 30 August. At the end of the 9-week study, all caged Brook Trout were retained for laboratory analyses, and we electrofished a 2-km reach of Ash Creek to recover the Brook Trout stocked directly in the stream. We recovered 9 Brook Trout from the stream and were unable to determine if the others migrated out of the study area or did not survive. In the cages, 96% of the Brook Trout survived the duration of the study. We first noted signs of infection by the presence of white tissue and clubbing of the gills (i.e., signs of hyperplasia and hypertrophy of gill lamellae) in week 2, followed by the presence of immature *S. edwardsii* by week 4 and mature female *S. edwardsii* by week 7. After 9 weeks, 77% of the Brook Trout were infected with 1 to 41 mature female *S. edwardsii*. This study provided proof of concept for using cages in situ to test susceptibility of different genetic strains of Brook Trout to *S. edwardsii* infection. Study results will also be useful for modeling *S. edwardsii*-Brook Trout dynamics in streams to evaluate parasite control options.

Brook trout movements, spawning, and survival in the Little Plover River prior to watershed restoration

Presenting author: Zach Mohr, *UW-Stevens Point*
Co-authors: Ben Schleppenbach

Abstract - The Little Plover River is a self-sustaining Brook Trout (*Salvelinus fontinalis*) stream and a focal study system for groundwater issues in central Wisconsin. The stream has experienced reduced water levels in recent years including dry reaches in 2005 through 2009, potentially due to a combination of drought conditions and groundwater pumping. The Village of Plover has begun facilitating watershed restoration efforts to increase stream flows. Our study sought to learn about the Brook Trout population and to provide baseline data prior to restoration efforts. Since Autumn 2015 a subset of Brook Trout (> 120 mm) were implanted with a passive integrated transponder (PIT). Beginning in Spring 2016, PIT antennas at four locations throughout the river were used to detect tagged Brook Trout, evaluate movements and migrations, and estimate survival rates. Weekly redd surveys were conducted in late 2017 to locate important spawning habitat. Preliminary results indicate daily movements shifted from nocturnal to diurnal during the spawning period (late Autumn to early Winter) when river-wide migrations also occurred. Redds were located throughout the river, with concentrations in certain areas. Monthly survival estimates were variable with a mean around 0.9. This information will expand knowledge on Brook Trout from a unique system and provide baseline data to analyze potential effects of watershed restoration efforts.

RFishBC

Presenting author: Derek Ogle, *Northland College*

Abstract - The RFishBC package helps fisheries scientists collect measurements from calcified structures and back-calculate estimated lengths at previous ages. RFishBC replaces much of the functionality provided by the fishBC software, which is closed-source, no longer runs on up-to-date operating systems, and is not scheduled to be updated by its developer. RFishBC allows for easy extraction of accurate measurements from marks (e.g., annuli) made on calcified structures (e.g., otoliths or scales), flexibly archives and compares marks made on calcified structures, and deliver a unified structure (within the R language) to back-calculate lengths at previous ages from marks made on calcified structures. This poster will provide further details and a brief demonstration of this new package.

Lake whitefish larval production from Wisconsin tributaries to Green Bay

Presenting author: Andrew Ransom, *UW-Green Bay*
Co-authors: Patrick Forsythe and Chris Houghton

Abstract - A resurgence of the Lake Whitefish (*Coregonus clupeaformis*) population within the waters of Green Bay has been documented in recent years, contrasting with the low, stable numbers reported for Lake Michigan proper. Migratory adult Lake Whitefish have been observed moving into the four major tributaries to Green Bay (Fox, Oconto, Peshtigo, and Menominee Rivers) during the time of spawn in late fall. In Lake Michigan, spawning typically occurs in rocky, nearshore areas, and these migrations into Green Bay tributaries may indicate expansion into novel habitats. In March and April of 2017 and 2018, larval production was confirmed for the first time in each of the four tributaries using active trawl ichthyoplankton sampling. A total of 1,371 larvae were collected in 881 individual trawls over the two sample years. The Fox and Menominee Rivers produced proportionally more larvae than the Peshtigo and Oconto Rivers, but larval output was variable by year. This historic documentation of Lake Whitefish larval production in tributaries to Green Bay could imply a changing stock dynamic in Lake Michigan driven by expansion into these novel habitats. Future studies should seek to investigate survival of these riverine produced larvae past early life history bottlenecks, and determine proportional contribution to the metapopulation.

3rd Annual WIAFS Fishing Contest Results

Presenting author: Luke Roffler, *Wisconsin DNR*

Abstract - No ground-breaking research or exciting monitoring results here, just good old fashioned fishing fun with your WAFS buddies! Come check out the results of the 3rd Annual WAFS Fishing Contest and see who is the proud winner of a year's worth of bragging rights.

Impacts of bullhead removal on fish communities

Presenting author: Aaron Schiller, *Wisconsin DNR*
Co-authors: Greg Matzke and Mike Preul

Abstract - Many walleye populations in Wisconsin's ceded territory have declined within the last two decades. Many of these lakes have also experienced a shift from a percid dominated fish community to a centrarchid dominated fish community. In Forest and Florence counties, a high percentage of lakes that have recently shifted to centrarchid fish communities also contain abundant bullhead populations. In an attempt to increase walleye survival, bullhead were removed from Lake Metonga starting in 2008 by the Mole Lake Chippewa Community Biologist Mike Preul. This bullhead removal effort increased walleye survival and reproduction in a lake that had not historically been able to sustain a naturally reproducing population. In 2011 WDNR biologist Greg Matzke noticed an overly abundant bullhead population in Patten Lake, which had recently experienced the community shift from percid to centrarchid and a decrease in overall walleye population and reproductive success. In an attempt to increase survival of a naturally reproducing walleye population bullhead were removed from Patten Lake. The preliminary results showed an increase in walleye and perch populations and a decrease in northern pike, and bluegill populations. Further results indicate largemouth bass recruitment decreased while crappie recruitment increased. Pickerel and Crane lakes in Forest County used to support a very abundant walleye population, but more recently have become very centrarchid dominated and contained an overabundant bullhead population. Bullhead removals were conducted on both lakes and preliminary results indicate that percid species benefitted from the bullhead removal while centrarchid species declined. While our removals have only been conducted in a few handpicked lakes, the results suggest that bullhead removals can help shift fish communities back to favor the percid species in certain circumstances and should be examined further for more widespread use of biomanipulations to benefit percid populations.

Movements and habitat use of muskellunge in Green Bay, Lake Michigan

Presenting author: Robert Sheffer, *UW-Stevens Point*
Co-authors: Dan Dembkowski, Steve Hogler, Josh Raabe, and Dan Isermann

Abstract - Green Bay and its tributaries support a world-class fishery for trophy muskellunge that attracts anglers from across North America. The Lower Fox River and Green Bay muskellunge population is largely supported by stocking because natural recruitment is limited, possibly due to habitat limitations. While previous work has identified potential spawning locations, it is unknown whether muskellunge hatch at these locations and habitat attributes associated with successful hatching have not been determined. Our objectives are to: 1) determine the proportion of muskellunge spawning in tributaries to lower Green Bay or in Green Bay proper; 2) determine the proportion of adults that return to stocking locations to spawn; 3) determine if muskellunge return to the same spawning locations in consecutive year; 4) define habitat conditions that result in successful hatching and 5) characterize general movement patterns of muskellunge. We will identify spawning sites of tagged muskellunge (N = 60) using radio and acoustic telemetry and conduct spawning habitat surveys. Presence or absence of eggs and larvae at spawning sites will be used to develop predictive maps of suitable habitat throughout the Green Bay ecosystem.

2018 Green Bay walleye tagging survey results

Presenting author: Jeremiah Shrovnal, *Wisconsin DNR*
Co-authors: Steve Hogler and Steve Surendonk

Abstract - Major Green Bay tributaries likely sustain the large walleye population that is found in southern Green Bay. Some walleye spawning populations have been studied intensively in the past, such as those found in the Fox River, while walleye that utilize the Menominee, Oconto or Peshtigo Rivers have had less evaluation. Our goal is to build on prior studies analyzing these populations, specifically their structure, river fidelity and dispersal patterns, by tagging walleye and using angler returns and DNR surveys to assess movement.

Responses of walleye (*Sander vitreus*) to 50% annual exploitation on Sherman Lake, Wisconsin, 2006-2015

Presenting author: Logan Sikora, *Wisconsin DNR*
Co-authors: Stephanie Shaw and Greg Sass

Abstract - Estimates of sustainable exploitation rates for walleye (*Sander vitreus*) have been highly variable and reported to range from 15-84%. The current limit reference point for the joint tribal and recreational walleye fishery in the Ceded Territory of Wisconsin (CTWI) is ≤ 35% exploitation of an adult population annually. A study conducted on Big Crooked Lake, WI suggested that ten years of 35% annual adult exploitation led to an undesirable walleye population according to CTWI management goals. Our objective was to test for the influences of even greater sustained elevated exploitation rate on walleye. During 2006-2015, Sherman Lake, WI walleye were experimentally subjected to a 50% annual exploitation rate. We tested for differences in adult density, sex ratio, size structure, growth, and recruitment before (1996-2005) and after the 50% exploitation period. Mean adult walleye density and male:female sex ratios did not differ significantly between the pre-50% exploitation and the 50% exploitation period. However, the proportion of male and female walleye > 380 mm in the population declined significantly. Male and female walleye growth rates increased during the 50% exploitation period. Age-0 and age-1 walleye relative abundances and mean lengths did not differ between the pre-50% exploitation and the 50% exploitation period. Our results suggest that the Sherman Lake walleye population was resilient in some respects to 50% annual exploitation (i.e., recruitment), but would not meet desirable CTWI walleye management criteria in others (i.e., decline in walleye > 380 mm). Declines in walleye > 380 mm may have foreshadowed recruitment overfishing should sustained 50% annual exploitation have continued. Sherman Lake showed evidence of a productive, resilient, and stable naturally reproducing walleye population. Therefore, we caution the results of our study in relation to other CTWI lakes that have shown eroding walleye productivity in recent years.

Movement ecology and habitat hotspots for age-0 lake sturgeon (*Acipenser fulvescens*) in the Lower Fox River, WI

Presenting author: Stefan Tucker, *UW-Green Bay*
Co-authors: Patrick Forsythe, Christopher Houghton, and Brandon Harris

Abstract - Acoustic telemetry was used to quantify the residency and movement patterns, as well as identify critical habitat locations, of 20 wild Lake Sturgeon (176.0-212.0 mm TL) released into the lower Fox River (LFR), Green Bay, Wisconsin. The study took place over 40 days during August and September 2018. Survival rate of tagged individuals was 95% where the movements of 19 individuals were characterized. Two main movement groups were observed. Movement group 1 “out-migrants”, highlighted fish (n=10, 53%) that rapidly migrated downstream and emigrated the system between 6 and 13 days post-release. Movement group 2 “residents”, highlighted fish that remained within the river (n=9, 47%) during the course of the study. Both movement groups were further subdivided, using a cluster analysis, creating 7 total subgroups to showcase variations within movement patterns and differences in habitats selected. Movement pattern 2 confirmed that the LFR is capable of hosting young Lake Sturgeon and identified 5 habitat hotspots within the LFR using the Kernel Utilization Density Estimator (KUD). Habitat hotspots were located in the upper half of the river, and generally very small in size (mean=4.43 ha), suggesting the heavily modified lower portion is unfavorable for age-0 Lake Sturgeon. Each hotspot hosted 1-3 individuals where fish showed high fidelity (64-95% of occurrences) to selected hotspots. This study was the first to examine young Lake Sturgeon movements in the LFR and provide evidence that the LFR is capable of supporting young life-stages and high site fidelity. This work will be repeated in 2019 and expanded to describe the biotic and abiotic parameters of these habitat hotspots which can be used to guide habitat improvements and restoration projects on the LFR.

Influence of cisco *Coregonus artedi* on muskellunge *Esox masquinongy* population size structure and maximum growth potential in northern Wisconsin lakes

Presenting author: Spencer Vanderbloemen, *Wisconsin DNR*
Co-authors: Jeremiah Gorne, Greg Sass, and Stephanie Shaw

Abstract - The availability of energetically profitable prey may be a key determinant of fish population size structure and maximum growth potential. Cisco (*Coregonus artedi*) are a high-energy density, pelagic, cold water forage fish native to some inland Wisconsin lakes and muskellunge (*Esox masquinongy*) are known to consume them. Anecdotally, cisco presence is often linked to greater maximum growth potential in muskellunge. We tested whether cisco presence/absence influenced muskellunge population size structure and maximum growth potential in the Ceded Territory of Wisconsin during 2015-2018. Mean length and mean maximum length of muskellunge was significantly greater in cisco than non-cisco lakes. Mean lengths of muskellunge in cisco and non-cisco lakes were 36.7 and 34.8 inches, respectively. Mean maximum muskellunge length in cisco lakes was 45.4 inches and was 41.8 inches in non-cisco lakes. Muskellunge proportional size distribution values (30, 38, 42, 45, 48, 50 inches) were always greater in cisco versus non-cisco lakes. However, mean length of the top ten (50.2 inches/cisco vs. 50.4 inches/non-cisco), twenty (both 49.8 inches), and thirty (both 49.4 inches) longest muskellunge observed in our datasets did not differ among lake types. Our results suggest that cisco availability may improve muskellunge population size structure, but not maximum growth potential or the frequency of maximum-sized individuals. Because about 30% of the cisco populations in Wisconsin inland lakes have been extirpated, conservation of remaining cisco populations may be critical for maintaining highly size structured muskellunge populations and meeting angler desires. Future studies should further test for the influences of density, stocking, lake productivity, alternative prey, and highly conservative minimum length and bag limits on muskellunge population size structure and maximum growth potential.

Crystal mix 2.0: potential food web shifts following a whole-lake manipulation

Presenting author: Matthew Zink, *UW-Madison*
Co-authors: Isaac Barber

Abstract - Invasive rainbow smelt (*Osmerus mordax*) were found in Crystal Lake in the 1980s. Soon after, the perch population crashed and the invasive smelt took over the food web. Crystal Mix, a project led by Lawson et al., was a whole lake mixing experiment to eradicate smelt and restore the yellow perch fishery. Researchers from UW-Trout Lake Station deployed GELIs to mix the lake. The invasive smelt are a cold-water species, and the de-stratification of Crystal Lake warmed temperatures throughout the water column beyond the smelts' thermal tolerance. The mixing experiment successfully eradicated approximately 90% of the smelt population (Lawson et al. 2015). Crystal Mix 2.0 was launched in summer 2018 when NTL-LTER monitoring showed continued low populations for rainbow smelt and a growing perch population. Current research is processing stable isotope data collected from 2018 and the original Crystal Mix stable isotope data, along with diet data, age specific growth, and environmental shifts. We are working to determine how (or if) the food web has shifted post-manipulation in order to assess how the perch population started to recover. Crystal Lake is also a possible candidate for a cisco re-introduction and walleye re-introduction to apply competitive and predatory pressure on smelt. Continued monitoring will be needed to assess the status of the invasive smelt in Crystal Lake.