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Beating life into a dead horse: 35 years of data on the old crib vs. tree-drop debate

Presenting author: Zach Lawson, *Wisconsin DNR*

Abstract - Coarse woody habitat plays an integral role in lake ecosystems. Previous studies have shown that woody habitats can provide critical food, spawning habitat, refuge, and attraction for various species. For this reason, fisheries managers often prescribe woody habitat augmentation to systems. Although woody habitat additions are conducted in different ways, fish cribs and treedrops are among the most commonly installed structures by managers and requested by resource users. Despite the widespread application of these habitat projects over the last 75 years, little is known about their impact on fish communities. Further, the underwhelming body of literature on the effect of woody habitat augmentation on fisheries makes habitat recommendations difficult for managers, and confusing for public user groups. To address this knowledge gap, I evaluated a dataset spanning 35 years on 18 different lakes within the Chequamegon-Nicolet National Forest where woody habitat projects occurred to determine if there were any measurable effects on the fisheries.

Yellow perch population characteristics in northern Wisconsin lakes

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

Abstract - Yellow perch *Perca flavescens* are one of the most ubiquitous panfish in Wisconsin and are highly sought by anglers fishing Wisconsin's inland waters. In addition to their role as a sport fish, yellow perch are also an important prey item for larger piscivores that support important fisheries of their own. Despite their recreational and ecological importance, relatively little is known about the status (i.e., demographics and dynamics) of many yellow perch populations in Wisconsin. Consequently, we evaluated population size and age structure, growth, recruitment, and mortality of 18 yellow perch populations in northern Wisconsin and explored whether populations could be grouped into discrete categories based on similarities in population characteristics. Preliminary analyses suggest that yellow perch demographics and dynamics vary substantially across northern Wisconsin. Among the 18 populations, the number of year classes present ranged from 3-11, age-class diversity from 0.58-2.0, proportional size distribution from 0-58, mean total length at age 4 from 152-195 mm, recruitment coefficients of determination from 13-91, and total annual mortality from 20-68%. Principal components analysis did not identify discrete groups of populations, suggesting instead that yellow perch populations exist along a continuum with a high degree of variation in demographic and dynamic characteristics. Additional samples will be collected from central and southern Wisconsin yellow perch populations in 2019, and future analyses will examine relationships between perch population characteristics and local- and landscape-level explanatory variables.

Characterizing the Angling and Tribal Spearing Walleye Fisheries in the Ceded Territory of Wisconsin, 1990-2015

Presenting author: Lawrence Eslinger, *Wisconsin DNR*
Co-authors: Joseph Mrnak, Stephanie Shaw, Thomas Cichosz, and Greg Sass

Abstract: Assessment of the angling and tribal spearing Walleye (*Sander vitreus*) fisheries in the Ceded Territory of Wisconsin (CTWI) is critical for the sustainability of this resource. Key to these assessments is an understanding of harvest demographics, exploitation, catch and harvest efficiency, and relationships between catch/harvest and adult density. We characterized the size distribution and the means for length of harvested Walleye, harvest, exploitation rate, and catch (angling) or harvest (spearing) rate for both fisheries during 1990-2015. Then, we evaluated catch and harvest rates in relation to adult density and tested for self-regulation/hyperstability in each fishery. Size distribution and mean length of harvested Walleye in both fisheries were statistically different, but biologically similar. Anglers harvested significantly more Walleye and the mean exploitation rate was greater in the angling fishery. Spearfishers had significantly higher mean harvest rates compared to angler catch rates. Catch and harvest rates followed an asymptotic relationship with adult density, with the spear fishery showing more hyperstability than the angling fishery. In the CTWI, naturally reproducing Walleye populations are managed for densities ≥ 7.4 adults/ha. Our results suggest that maintaining adult Walleye densities near the point of diminishing returns of the asymptotic relationship (10-15 Walleye/ha) will result in a sustainable fishery that also maximizes tribal harvest and angler catch. However, maintaining adult Walleye densities within this range in unproductive lakes typical of the CTWI may be unrealistic. Due to the hyperstability observed in each fishery, active management of the spear fishery should continue, and monitoring of the angling fishery should also continue given recent declines in natural recruitment and production observed in the CTWI to maintain Walleye populations in a "safe operating space". An empirical understanding of CTWI Walleye angler and spearfisher effort dynamics is critically needed to mechanistically explain the observed hyperstability in each fishery.

Growth of Green Bay muskellunge using a long-term mark-recapture dataset

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

Abstract - Understanding growth dynamics of fish populations is important for effective fisheries management and conservation. Traditional methods (e.g. von Bertalanffy growth models) used for estimating population growth parameters often require length-at-age data. However, in managing long-lived species or recovering fish populations, collection of accurate age data using lethal methods or fin rays may be unfeasible. Thus, methods that estimate growth parameters in the absence of age data may provide beneficial alternatives. The Fabens growth model (FGM) uses mark-recapture data to estimate growth parameters and does not require age data. We used a long-term mark-recapture dataset for Green Bay muskellunge to demonstrate the applicability of the FGM and compare results to those derived using a common length-at-age model. Our results suggest that the FGM is effective at estimating population growth parameters using mark-recapture data and can be applied in management frameworks for fish species in which traditional collection of age data may not be feasible.

Trends and stability of angler catch rates and size selectivity of Wisconsin panfish

Presenting author: Zachary Feiner, *Wisconsin DNR*
Co-authors: Max Wolter and Alexander Latzka

Abstract - Understanding relationships between fish abundance, size structure, angler harvest rates, and size selectivity can elucidate the quality of angler experiences and impact of management actions. Non-linear relationships between population characteristics and angler behavior, such as the phenomenon of hyperstability, where catch rates remain high even as population abundance declines, can complicate fisheries management by masking population declines or producing unexpected angler responses to new regulations. Wisconsin panfish, including bluegill, black crappie, and yellow perch, represent popular harvest-oriented fisheries predominantly managed with no size limits and liberal bag limits, which allowed us to investigate patterns in recreational angler catch rates and size selectivity. We used data from panfish surveys and creel interviews across ~250 lakes from 1990 to 2017 to examine temporal trends and test for relationships between i) population density (catch per unit effort) and angler catch and harvest rates (fish/angler-hr), and ii) population size structure (median size and proportional stock density) and angler size selection (median harvested fish size and Chesson's α). Density and catch rates were stable or increasing in bluegill and black crappie, and stable or declining in yellow perch. Catch and harvest rates were significantly hyperstable across all three species. Bluegill size structure and yellow perch harvested size increased over time, while all other size metrics were stable. Angler size selection exhibited non-linear relationships with population size structure with consistent preferences for 175-mm bluegill, 250-mm black crappie, and 200-mm yellow perch. Angler catch rates and size selection may show limited responses to shifts in abundance or size structure unless population changes are substantial, providing important insights into the potential effects of bag or size limits on Wisconsin panfish fisheries.

Optimizing electrofishing effort in streams for precise trout relative abundance metrics

Presenting author: Tim Parks, *Wisconsin DNR*

Abstract - In a recent DNR work planning assessment, we found sampling distance or effort allocated in our past trout trend surveys was 457% (103-988%) more than the current standard protocol for allocating sampling distance required for single-pass wadeable electrofishing surveys. This finding has created significant concerns related to logistics, cost-effectiveness, and interpretation of these excessively long-distance trout surveys. In lieu of this current problem, we designed a systematic survey design and collected catch data to simulate the minimal amount of effort needed to estimate catch per unit effort (CPE) of ≥ stock-size brook trout and brown trout with a precision goal of a relative standard error (RSE) ≤ 25%. Brown trout CPE simulations indicated that a RSE ≤ 25% precision goal was attained after sampling 103-167 m per survey, whereas brook trout CPE simulations showed the precision goal attained after sampling 195-785 m per survey. Precision estimates of brook trout require considerably more effort, than what was needed for brown trout. This suggested that minimum effort goals should be geared towards brook trout at trend stations occupied both species. Additionally, we observed for both species that our estimates survey effort appeared to increase with stream size which suggested survey effort could be potentially modeled using mean channel width. We were able to reduce our trend survey effort in trend surveys by 50-79% which increased our sampling efficiency allowed our team to expand trout surveys to other streams receiving considerably less attention.

Can we improve brown trout growth by reducing density in a Driftless Area stream?

Presenting author: Matt Mitro, *Wisconsin DNR*
Co-authors: Kirk Olson and Jordan Weeks

Abstract - Land use changes and stream habitat development projects since the mid-20th century have led to abundant Brown Trout populations in many Driftless Area streams. Perceptions of poor growth in high density trout populations have raised the question of whether encouraging more harvest can improve trout growth. We experimentally reduced Brown Trout density in a high density (2,200 trout/km) stream to evaluate growth response. We transferred 69% of Brown Trout from a 400-m site in Spring Coulee Creek, Wisconsin, in spring 2013, and an additional 20% in 2014 and 28% in 2015. We tagged trout in the 400-m experimental site and in 200-m and 100-m adjacent control sites to quantify survival and movement; we used length and weight data to characterize size structure and relative body condition; and we used spring-to-autumn tag-recapture data to estimate instantaneous growth rates for the 2013-2017 period. Year-to-year movement among adjacent stream sites was low (0.04), and annual survival ranged from 0.27 to 0.58. Brown Trout density decreased at all sites from 2013 to 2014 and began to increase at all sites in 2016, but not to 2013 levels. Relative body condition, measured as site-specific means of residuals around length-weight regressions, did not show any conclusive improvement in fish condition at the experimental site. Mean instantaneous rates of growth for 200- to 299-mm Brown Trout were significantly different among years but not among experiment and control sites. We conclude that manipulating Brown Trout density in Driftless Area streams is unlikely to effect a significant positive change in body condition and growth. There is the capacity to support increased harvest opportunities in high-density streams given current low levels of harvest, but annual variability in trout population dynamics is likely to preclude persistently-high densities and habitat features may be a more important determinant of fish size and condition.

Genetic origins and movements of lake sturgeon in the St. Louis River and western Lake Superior

Presenting author: Kayden Estep, *UW-Stevens Point*
Co-authors: Justin VanDeHey, Joshua Raabe, Patrick Schmalz, Deserae Hendrickson, Dan Wilfond, Andrew Carlson, Paul Piszczeck, and Brian Borkholder

Abstract - Lake Sturgeon *Acipenser fulvescens* were extirpated from the St. Louis River (SLR) by the early 1900s. Improvements in water quality and habitat, and virtual elimination of exploitation led to efforts by resource management agencies to re-establish Lake Sturgeon in the SLR. From 1983-2000, Lake Sturgeon from multiple sources, including Lake Michigan and Lake Superior drainages, were stocked into the SLR. Recently, natural reproduction has been documented however questions still exist about the genetic origins and movements of spawning fish. Our objectives were to determine (1) the genetic origin of Lake Sturgeon collected in the SLR, (2) the frequency and magnitude of migrations between the St. Louis River and Lake Superior, and (3) if spawning sites of Sturgeon differed among genetic strains. During the spring of 2016, 2017, and 2018, 721 adult Lake Sturgeon were collected in the SLR; 139 were implanted with acoustic transmitters. Most fish sampled during the project (n = 428/541; 79%) assigned genetically to the Wolf River strain. By autumn of 2018, 78 tagged fish had exited the SLR into Western Lake Superior while 61 fish remained in the SLR suggesting both a migratory and resident component to the population. Emigration to Lake Superior peaked during late May and June in 2016, 2017, and 2018 with some fish traveling approximately 300 kilometers from the tagging site. Spawning activity was only detected at one site. However, we do not believe spawning habitat is currently limited for sturgeon in the SLR. Our results suggest that management of this recovering population should include strategies to benefit both migratory and resident Sturgeon.

Population status and demographics of lake sturgeon in the Bad and White rivers, Wisconsin

Presenting author: Joshua Schloesser, *U.S. Fish and Wildlife Service*
Co-authors: Henry Quinlan

Abstract - The rehabilitation plan for Lake Sturgeon *Acipenser fulvescens* in Lake Superior describes goals for restoration, identifies issues that limit recovery and strategies to overcome them, and recommends research and management actions for effective population recovery. The Bad and White rivers, Wisconsin host a genetically unique Lake Sturgeon population which has been considered self-sustaining, but whose status and demographics have not been thoroughly described. This study will help managers balance Lake Superior-wide rehabilitation efforts with local harvest management. Lake Sturgeon were sampled in the Bad and White rivers with gill nets over a 17 year period between 2001 and 2017. Over that time the size structure in the spawning run remained unchanged. The observed gender ratio in annual spawning runs was 2.2:1 (male:female), but calculated at 1.6:1 for the entire adult population based on abundance estimates. Condition was lower compared to other large North American populations using a standardized modified form factor, suggesting lower female fecundity. Annual spawning run size estimates over time indicated the population trajectory was stable to slightly increasing, and during 2016 was 739 and 241 individuals in the Bad and White rivers, respectively. Total population size (including non-spawners) exceeded 1,500 individuals, which met Lake Superior rehabilitation criteria for a self-sustaining population. Estimates of 1,426 males and 882 females were considered conservative because 472 unknown gender fish could not be accounted for in return time and abundance models. Breeding return times were two or three years for males and four to six years for females, longer than many other populations. Exploitation by sport anglers and Tribal subsistence fishermen falls below 2% of the total population and meets the rehabilitation plan target of less than 5%. These findings help evaluate rehabilitation success in Lake Superior and inform more effective Lake Sturgeon conservation strategies.

Stock discrimination of lake sturgeon in the Lake Winnebago system using otolith and fin ray microchemistry

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

Abstract - Lake sturgeon (*Acipenser fulvescens*) spawn in multiple tributaries of the Lake Winnebago system (LWS) but the relative contribution of recruits from these tributaries to annual spearing harvest is not known. Microchemistry of calcified structures is often used to determine natal origins of fish. Although otoliths are commonly analyzed for this purpose, pectoral fin rays provide a non-lethal sampling method that could be used for microchemical analysis. The efficacy of using microchemistry in calcified structures for determining natal origin has not been evaluated for lake sturgeon. Thus, the objectives of our study are to determine if: 1) otolith microchemistry can be used to assign lake sturgeon to specific rivers where spawning occurs; 2) chemical signatures are consistent between otoliths and fin rays; and 3) contribution to spearing harvest varies among rivers. To accomplish our objectives, we will use laser ablation inductively-coupled mass spectrometry to assess the microchemistry of calcified structures in larval, juvenile, and adult sturgeon. We will collect larval and juvenile fish downstream of spawning locations in the Wolf, Fox, Embarrass, and Little Wolf rivers in late spring (larvae) and late summer (juveniles). Chemical signatures from these age-0 fish will allow us to determine the extent to which we can discern among fish originating from the 4 rivers. Otoliths and fin rays from adult fish harvested by spearers will be used to determine the contribution of different spawning locations to overall harvest.

Evaluation of elevator captures and lake sturgeon downstream behaviors in the Menominee River

Presenting author: Josh Raabe, *UW-Stevens Point*
Co-authors: Nicholas Porter, Dan Isermann, Darren Kramer, Mike Donofrio, Shawn Crimmins, Rob Elliot, and Michael Robinson

Abstract - Fish passage structures are installed to facilitate fish movement at dams, but evaluations and operating protocols are limited for various designs and target species. A fish elevator was installed at the Menominee Dam on the Menominee River, Michigan and Wisconsin, to allow selective upstream passage of Lake Sturgeon Acipenser fulvescens while limiting spread of invasive species and diseases. This is the first elevator in central North America and to specifically target Lake Sturgeon whose behaviors near dams are relatively unstudied. Therefore, our objectives were to determine if environmental conditions (e.g., season, photoperiod) or operating procedures (e.g., attraction flow, soak durations) influenced captures and to learn about Lake Sturgeon behaviors downstream of the elevator using telemetry. A total of 943 elevator lifts (686 h soak time) captured 4,665 individuals across 34 species in spring and autumn 2017 and 2018. Analyses indicate Lake Sturgeon (n = 305) and salmonid (n = 611) elevator captures may increase with higher attraction flows, longer soak times, and diurnal operation; season and water temperatures were also important with higher Lake Sturgeon captures around 13 ºC. Acoustic telemetry near the elevator provided Lake Sturgeon availability patterns and limited recaptures indicate relatively low capture rates. Radio telemetry triangulations near the dam suggest Lake Sturgeon prefer to reside near the main current outflow in autumn but show a mixed distribution during spring. Our goals are to provide operating guidelines to optimize elevator captures and to offer information on sturgeon behaviors near dams that may benefit other managers considering passage.

Evaluation of methods for estimating age and growth of lake sturgeon

Presenting author: Aaron O'Connell, *Wisconsin DNR*
Co-authors: Ryan Koenigs and Dan Isermann

Abstract - Age estimation via sectioned pectoral fin rays is the current preferred method for estimating age of Lake Sturgeon (*Acipenser fulvescens*), as well as other sturgeon species. However, previous research has shown that age estimates from pectoral fin rays underestimate true age of Lake Sturgeon ≥ age 14. Age estimates from otoliths were previously reported as valid for Lake Sturgeon, but difficulties in otolith availability, collection, and processing have resulted in little to no comprehensive work. We are evaluating five different techniques for estimating age and growth of Lake Sturgeon including: use of sectioned pectoral fin rays, use of otoliths prepared via alternative sectioning methods, the applications of a correction factor and age-error matrices to correct pectoral fin ray ages, and the Wang variation of the Fabens mark-recapture growth model. Preliminary findings indicate that only 20% of otolith sections are readable. Further, initial configurations of the Fabens-Wang growth model have yielded plausible growth trajectories that are based on observed changes in length of Lake Sturgeon implanted with passive integrated transponders (PITs) and recaptured on later dates.

Length, age, and growth of deepwater sculpin from shallow and deep waters of Lake Superior

Presenting author: Will Otte, *Northland College*
Co-authors: Derek Ogle and Mark Vinson

Abstract - Age and growth studies are critical for understanding population dynamics. Deepwater Sculpin (*Myoxocephalus thompsonii*) are the most abundant benthic fish in Lake Superior and are a key trophic link between *Mysis diluviana* and Lake Trout (*Salvalinius namaychush*), yet little is known about their age and growth in Lake Superior and elsewhere. In 2017 we collected Deepwater Sculpin at 40 sites throughout Lake Superior and compared length, sectioned otolith ages, and growth between fish caught at sites <150 meters and >200 meters deep. Ages ranged from 1-17, which was more than double the maximum age previously reported from Lake Superior. Lengths and ages were greater in fish collected at depths >200 m. Based on the Francis parameterization of the von Bertalanffy growth function mean length at all ages differed between the two depth classes. Despite some difficulty interpreting otoliths we found that Lake Superior Deepwater Sculpin experience slower growth and greater longevity than previously thought. Our new insights into Deepwater Sculpin life history can be used to guide management decisions regarding the conservation and re-establishment of Deepwater Sculpin throughout the Great Lakes.

Assessing the balance between salmonines and their prey in Lake Michigan

Presenting author: Iyob Tsehaye, *Wisconsin DNR*
Co-authors: Nick Legler

Abstract - Maintaining balance between predator and prey populations is critical for successful fisheries management. Control of stocking rates is likely the most important tool for management of predator–prey balance in Lake Michigan (major cuts 1986, 1992, 1998, 2006, 2013, and 2017). Over the last decade or so, stock assessment models have been used to assess relative changes in abundance of salmonine populations and their prey in Lake Michigan, with the goal of providing information needed to evaluate the lake's predator–prey balance to help guide stocking decisions. Retrospective analyses of historical changes in relative predator and prey abundances estimated by these models have led to the identification of a potentially powerful indicator of predator–prey balance, a ratio of Chinook salmon biomass to alewife biomass (PPR), which appeared to reliably indicate when predation risks are large enough to trigger serious consideration of stocking reductions. The PPR for Lake Michigan increased steadily from the 1960s to mid-1980s as stocking numbers increased, until the alewife population crashed leading to Chinook salmon die-off, causing a drop in the PPR. The PPR increased gradually as the Chinook salmon population rebounded following adjustments to stocking. Over the last decade, as the alewife population declined to historically low levels, the PPR increased to levels that caused concerns about predator–prey balance (PPR > 0.08), triggering additional adjustments to stocking rates in recent years. These adjustments to stocking rates proved reasonable as they brought back the PPR to desirable levels (~0.05), but alewife abundance over the last decade has remained at very low levels, suggesting that the predator–prey system has stabilized at relatively lower levels of predator and prey abundances.

Large-scale hybridization between longnose gar and shortnose gar in the Fox River drainage

Presenting author: John Lyons, *Wisconsin DNR (retired)*
Co-author: Justin Sipiorski

Abstract - Hybridization among gar species has only recently been documented, and relatively few wild occurrences have been reported. In the Fox River drainage of Wisconsin, apparent hybrids of longnose gar (*Lepisosteus osseus*) and shortnose gar (*L. platostomus*) were widespread and numerous and may constitute nearly half of the total gar population. Presumed hybrids could be readily distinguished by either their intermediate values for the ratio of snout length to snout width, or a low ratio value characteristic of shortnose gar coupled with the presence of conspicuous spots on the top of the snout, a longnose gar characteristic. Genetic evidence suggests that both male shortnose gar × female longnose gar hybrids and female shortnose gar × male longnose gar hybrids were present. Apparent hybrids occur commonly throughout the Fox River drainage, including the upper and lower Fox River, the Wolf River, lakes Poygan, Winneconne, Butte des Morts, Winnebago, and Little Butte des Morts, and Green Bay. Possible hybrids may also occur in the Mississippi River basin, but there they are uncommon and localized. Extensive hybridization in the Fox River drainage may have been facilitated by the much greater abundance of longnose gar relative to shortnose gar, the apparent relatively recent colonization of the drainage by the shortnose gar, and the substantial modification and loss of gar spawning habitat caused by dams and artificial water level regulation.

Growing Wisconsin's Friday night fish fry: Bayesian models of growth in Icelandic cod

Presenting author: Paul Frater, *Wisconsin DNR*
Co-authors: Gunnar Stefansson, Birgir Hrankfelsson, and Bjarki Elvarsson

Abstract - If you've ever eaten Friday night fish fry in Wisconsin, chances are you've consumed cod from Iceland. We assembled a suite of Bayesian models to assess how growth of Atlantic cod (*Gadus morhua*) differed across gender, year, cohort, and area in Icelandic waters. Model comparison using deviance information criterion (DIC) indicated that the model which included gender, year, and area had the best fit to paired age-length data sampled across nearly 50 years. von Bertalanffy growth parameters varied across time and differed among regions surrounding the island. Mean length was generally similar between males and females at younger ages, but at older ages females tended to have greater mean length as predicted by the models. This work is an example of one of the many types of multilevel fisheries models that can be fit using Bayesian techniques.

A perch is a perch is a perch: the role of individual trait variation in invasive species management

Presenting author: Ben Martin, *UW-Madison*
Co-authors: Jake Vander Zanden

Abstract - Spiny water flea (*Bythotrephes longimanus*) is a predatory invasive zooplankton that was first detected in Lake Mendota in 2009. The invasion has greatly decreased the abundances of *daphnia* spp., which are the lake's major algae grazers. Costs of the invasion are estimated to be in excesses of 160 million dollars, largely due to the loss of 1 meter of water clarity. Recovery efforts have focused on reducing phosphorus run-off into the lake to decrease algae growth, but there's been little research into taking a top-down approach on spiny water flea (planktivory). Herein, we sought to investigate the contemporary predator-prey dynamics of planktivores and SWF in Lake Mendota. Initially focusing our work on the feeding behavior of yellow perch (*Perca flavescens*), we found that recent work in several Swedish lakes show the closely related European yellow perch (*Perca fluviatilis*) exhibits substantial trophic polymorphism, where there is a deep-bodied littoral morphotype and a fusiform pelagic morphotype. Our preliminary results using digital geometric morphometrics and principal components analysis showed morphological variation in principal component one was consistent with the littoral and pelagic morphotypes of European yellow perch. Principal component two was significantly related to body length, representing an ontogenetic shift in morphology from a thinner to deeper body depth. Stomach contents showed yellow perch abundantly consume spiny water flea along with a mix of other prey items including other zooplankton, macroinvertebrates, and fish. Stable isotope analysis (C & N) is ongoing and will help better detail potential trophic polymorphism. While yellow perch are only one of the many planktivorous fish in Lake Mendota, this study supports the need to account for individual trait variation to better understand community interactions, especially in novel ecosystems.

Maternal and temperature impacts on larval yellow perch growth

Presenting author: Anne Linkenheld, *UW-Milwaukee*

Abstract - Yellow perch (*Perca flavescens*) is a popular native fish around the Great Lakes region. In Lake Michigan, there was a huge population decline seen in the late 1990s that effectively closed all commercial fisheries on the lake. We see in both natural populations and in aquaculture, there is a gap in research surrounding recruitment stages, specifically factors impacting growth. The high mortality observed in these early life stages of fishes is size-dependent. These stages are critical for increasing recruitment of individuals. Water temperature has been reported to play a significant role in the development of early life stages. Maternal traits, such as size, age, and egg size at fertilization, are thought to have a positive influence on offspring size. The overall objective of this study is to determine how maternal traits and varying temperature shifts impact larval growth in yellow perch. Results suggest both maternal effects as well as temperature impacting larval development, indicated by high mortality. The oil drop volume to total egg volume percentage indicated a range in egg quality, which varied from 1.303% to 2.307%. Egg mortality ranged from 50.4% to 80.1%, the cold shock treatment having the lowest mortality through incubation. Larval mortality observed ranged from 52.67% to 75%, the heat shock treatment having the highest mortality rate. Larvae exposed to a cold shock took longer to hatch than any other treatment, however, they had the highest growth rate of 0.12071 millimeters per day. The steady temperature treatment had the worst growth rate of 0.10073 millimeters per day. This research aims to provide insight into year-class strength, effective populations, and reproductive viability of current wild yellow perch populations. Finally, this research provides a tool for yellow perch aquaculture rearing practices potentially yielding better survival.

Wisconsin farm-raised fish: consumer perceptions for producer marketing

Presenting author: Shiyu Yang, *UW-Madison*
Co-authors: Bret Shaw, Kristin Runge, Laura Witzling, Chris Hartleb, and Deidre Peroff

Abstract - Parts of the local food movement are thriving in Wisconsin. However, although the demand for local food products in Wisconsin is strong, many Wisconsin consumers are still unaware of the availability of local, farm-raised fish. Moreover, there is an uncertain climate of public opinion regarding aquaculture. Many consumers have questions about possible contaminants, antibiotics and effects on human and environmental health. On the one hand, research has identified media's negative representation of fish farming as a potential source of negative public perceptions regarding farm-raised fish; on the other hand, perceived consumer benefits to farm-raised fish have also been documented. To better understand constraints of the Wisconsin aquaculture industry and capitalize on the trend for local food, this study examines consumer perceptions and behaviors related to consuming local farm-raised fish and generates marketing recommendations that could be useful for fish farmers, retailers, restaurants and other venues that sell fish for human food. A state-wide mail survey was administered to a random sample of 3000 households in Wisconsin in summer 2018. Based on analyses of a final sample of 517 responses, we found that generally consumers prefer Wisconsin raised fish over U.S. and imported fish and prefer wild-caught fish over farm-raised fish. Consumers hold diverse but overall positive views of local farmed fish. Concerns surrounding Wisconsin farm-raised fish are low, but there is high uncertainty about the aquaculture industry's environmental impacts. Moreover, fish farmers in Wisconsin are well trusted by consumers. We also found that taste, freshness, appearance and price are the top qualities for consumers when they think about fish. These and other findings are discussed in further detail and marketing recommendations are drawn from these results.

Sea lamprey wounding on salmonines in lakes Michigan and Huron: evidence of alternate hosts to lake trout

Presenting author: Matthew Kornis, *U.S. Fish and Wildlife Service*
Co-authors: Darin Simpkins and Charles Bronte

Abstract - Sea lamprey predation on lake trout is well documented in the Great Lakes. However, relationships among sea lamprey abundance, lake trout abundance, and wounding rates are not always apparent. Other salmonine species in Lakes Michigan and Huron may be suitable alternate hosts due to their abundance and large body size, but wounding data on these species have been limited from fishery-independent surveys that target lake trout. We examined sea lamprey wounding rates in Lakes Michigan and Huron on five salmonines (lake trout, Chinook salmon, coho salmon, steelhead, and brown trout) from data on 63,145 angler-caught fish collected by the Great Lakes Mass Marking Program. We modeled relationships between the number of AI – AIII wounds per individual and total body length for each species using logistic regression, following published methods. Asymptotic maxima (θ; wounding rate on fish at sizes where length and wounding are no longer related) and curve inflection points (β; total length at which wounding rate is ½ the asymptotic maximum) were calculated for each species. Lake trout had the highest wounding rate in Lake Michigan (5.3%), followed by brown trout (2.0%) and Chinook salmon (1.3%), with negligible wounding on steelhead and coho salmon. By contrast, wounding rate was substantially higher on Chinook salmon than lake trout in Lake Huron (9.4 and 3.4%, respectively), where there may be fewer hosts per lamprey as suggest by lower β values (527 – 565 mm) than in Lake Michigan (600 – 678 mm). In addition, there were far fewer healed wounds observed on Chinook salmon than on lake trout in both lakes, which may indicate more vulnerability to lamprey-induced mortality and thus affect our interpretation of AI – AIII wounding rates. These data demonstrate that sea lamprey can utilize Chinook salmon as an alternate host to lake trout, with implications for fishery management.

Gathering phenological data on sucker migrations using citizen scientists

Presenting author: Karen Murchie, *Shedd Aquarium*
Co-authors: Peter McIntyre

Abstract - The use of citizen scientists to collect data continues to gain traction in the field of fisheries. Networks of citizen scientists can be efficient, cost-effective, and reliable sources of field data, as well as becoming invigorated advocates for the environments they help to study. We present a case study involving citizen science to overcome the general lack of phenological data available for migratory fishes. Our project is documenting the phenology of sucker (Catostomidae) migrations into Great Lakes tributaries, creating numerous opportunities for communication with a diverse spectrum of volunteers. From soliciting new volunteers to ensuring high quality data, we are developing strategies for successful execution of citizen science projects in fishery biology that are readily transferable. Our project also illustrates opportunities to use media coverage to showcase both the involvement of the public in conservation activities and scientific results from citizen science efforts.

Population genetic structure of smallmouth bass in inland Wisconsin and Lake Michigan

Presenting author: Peter Euclide, *UW-Stevens Point*
Co-authors: Jenna Ruzich and Wes Larson

Abstract - Analysis of population genetic connectivity and structure can reveal signatures of current processes such as spawning behavior and migration while identifying historical events such as bottlenecks, colonization patterns, or genetic impacts of stocking. Here we describe the population genetic structure of 1,215 smallmouth bass (*Micropterus dolomieu*) from 32 sites throughout inland Wisconsin and Lake Michigan at 16 microsatellite loci. Smallmouth bass populations were characterized by variable genetic diversity and moderate genetic structure that could largely be explained by isolation by distance. Inland populations were more divergent each other and from populations in Lake Michigan than Lake Michigan populations were from each other. Only a single site (Pallette Lake) broke from the overall isolation by distance pattern. Smallmouth bass from Pallette Lake also had low diversity compared to all other sites, likely the result of being introduced. Overall, smallmouth bass showed similar patterns of structure as found throughout their range.

Using a rapture panel to investigate genetic diversity in inland cisco across the Great Lakes region

Presenting author: Amanda Ackiss, *UW-Stevens Point*
Co-authors: Wesley Larson, Wendylee Stott, Keith Turnquist, and Greg Sass

Abstract - Recent surveys indicate that native inland cisco (*Coregonus artedi*) populations have been lost from roughly 30% of lakes in Wisconsin. This trend has been attributed to cisco preference for cold, well-oxygenated water when lakes are facing steadily increasing thermodynamic changes due to climate change. A growing interest to preserve and restore inland cisco populations necessitates a better understanding of the genetic stock structure across the habitat range. To address this need, we used restriction-site associated DNA (RAD) sequencing combined with bait capture to sample the genomes of cisco from 38 lakes across Minnesota, Wisconsin, Michigan and Indiana to examine genetic differentiation and diversity. Analysis with 10,000+ loci indicate inland cisco populations are highly differentiated on relatively small spatial scales. Across the sampling region, we found two major divergent clusters associated with the Great Lakes and Mississippi River basins. In Wisconsin, genetic lineages were strongly linked to river basins, particularly in northern Wisconsin where genetic similarity sorts lake populations by the Chippewa or Wisconsin River basins. Genetic diversity did not correlate to either spatial distribution or latitude, a pattern similar to that found in recent surveys of inland cisco abundance, suggesting that complex factors are contributing to the success or decline of inland lake populations.

Interactions among walleye, lake whitefish, and yellow perch in Green Bay, Lake Michigan

Presenting author: Lucas Koenig, *UW-Stevens Point*
Co-authors: Daniel Isermann, Daniel Dembkowski, Wesley Larson, Iyob Tsehaye, Scott Hansen, Steven Hogler, Tammie Paoli, and Troy Zorn

Abstract - Green Bay supports important fisheries for walleyes, lake whitefish, and yellow perch and these species likely interact in a variety of ways. A better understanding of these interactions is needed to guide management decisions. Specifically, there are concerns that high walleye abundance could negatively influence abundance of lake whitefish and yellow perch, primarily through predation. However, the prevalence of round gobies within the ecosystem may provide a predation buffer for lake whitefish and yellow perch. Moreover, the lake whitefish population in and around Green Bay is comprised of multiple genetically distinct stocks. Consequently, if walleye predation on lake whitefish varies across time and space, this predation could affect certain stocks to a greater degree than others. To help address some of these uncertainties, our research objectives are to determine if: 1) lake whitefish and yellow perch represent important prey for walleyes in Green Bay; 2) diets of these three species very spatially and temporally and if diet overlap among species is evident; 3) the extent of walleye predation is sufficiently high to influence recruitment potential of lake whitefish and yellow perch; and 4) extent of walleye predation varies among individual genetic stocks of lake whitefish. We are integrating an intensive assessment of diet composition for all three species with bioenergetic modeling, statistical catch-at-age models, genetic stock identification, and otolith microchemistry to address our objectives. A brief discussion of the innovative experimental framework we are using to address these objectives, along with preliminary results and observations of our diet analyses will be provided.

High throughput genetic stock identification and parentage assessment for Wisconsin and Minnesota walleye using single nucleotide polymorphisms

Presenting author: Matthew Bootsma, *UW-Stevens Point*
Co-authors: Keith Turnquist, Greg Sass, and Wes Larson

Abstract - Genetic tools can provide managers with accurate information regarding an individual's parentage and stock of origin. This information improves stocking practices by conserving adaptive differences among populations and preventing inbreeding in a captive rearing environment. Current genetic research of Midwestern walleye typically utilizes microsatellites, which can lead to difficulties in producing standardized data sets between labs due to the microsatellite's diverse nature. In turn, this has made mixed stock analyses difficult to conduct on a regional scale. Recent advances in sequencing technology, however, have facilitated de novo identification of thousands of single nucleotide polymorphisms (SNPs) in non-model organisms. In contrast to microsatellites, the biallelic nature of SNPs allow for consistent identification among labs; thus, enabling the construction of a data set that can perform genetic stock identification on a regional basis. By identifying 300 SNPs with high levels of differentiation among walleye populations across Wisconsin and Minnesota, and developing a GT-seq assay, my work aims to produce a high throughput genotyping assay that will provide managers with a cost effective genetic stock identification tool.

Impacts of stocked splake on lake trout and brook trout fisheries

Presenting author: Elizabeth Tristano, *Sea Grant*
Co-authors: Bradley Ray, William Fetzer, and Titus Seilheimer

Abstract - Fish stocking is a common means by which management agencies may enhance or create fisheries. However, stocking in the Great Lakes has been dynamic, with practices changing as new information becomes available. In Lake Superior, a variety of species have been stocked, with variable success. One such species is the lake trout x brook trout hybrid, splake (*Salvelinus namaycush* x *S. fontinalis*). Splake stocking began in response to declining lake trout populations in the 20th century, but the potential for introgression with its parent species suggests that splake may threaten recovering lake trout, as well as to brook trout populations. This study reviews the history of splake stocking and examines the risks and benefits of stocking splake into Lake Superior, including probability of introgression, competitive interactions between splake and brook or lake trout, splake harvest and economic returns, and long-term impacts to Lake Superior fisheries. Preliminary findings suggest that splake may have the capacity to reproduce with both parental species and with other splake, potentially to the detriment of brook and lake trout reproduction. Moreover, economic returns of splake appear to be low, with a return to creel of 0.00847 ± 0.00572 splake harvested/splake stocked. Moving forward, it is important to fully understand splake impacts on brook and lake trout and to weigh the risks of stocking splake into Lake Superior waters.

The seasonal migration of round goby in Lake Michigan near Milwaukee, Wisconsin

Presenting author: Erik Carlson, *UW-Milwaukee*
Co-authors: John Janssen

Abstract – The offshore migration habits of the invasive Round Goby (*Neogobius melanostomus*) in Great Lakes is based on anecdotal information. When Round Goby move offshore, they have the potential to become prey items for fishes like Lake Trout, Burbot, and Brown Trout. Due to the Round Goby's preference for rocky habitat, it is difficult to sample using traditional methods, such as trawls. To better understand this movement, and the factors that drive it, a remotely operated vehicle (ROV) equipped with a tracking system was used to observe the number of fish along transects, and to collect specimens for diet and aging purposes. In this study, six ROV transects per site were taken at depths of 10 meters to 40 meters in 10 meter increments. Initial observations showed more goby nearshore (10 m site) in September (1.71 fish per transect meter) and decreasing to 0.15 fish per meter, while at 30 m abundance increased from 0.03 fish per meter to 0.41 fish per meter by the end of October. A 2-Factor ANOVA, with depth and time of year as the two factors, showed significant results for the interaction between depth and time of year. The main factors are not interpretable when the interaction is significant. Additional transects will be conducted in spring to observe the return of Round Goby back to nearshore habitat.

Spatiotemporal patterns in salmonine diet and niche overlap in Lake Michigan

Presenting author: Matthew Kornis, *U.S. Fish and Wildlife Service*
Co-authors: David Bunnell, Heidi Swanson, and Charles Bronte

Abstract - In Lake Michigan, five salmonine species (lake trout, Chinook salmon, coho salmon, steelhead, brown trout) are managed through stocking to support and diversify sport fisheries and restore native fish populations. Recent declines in alewife, the main prey fish that supports all salmonines, has raised concerns over food supply for the fishery, and understanding niche partitioning among salmonines is critical to fisheries management. We evaluated δ13C and δ15N stable isotope ratios from salmonines and their prey to describe spatiotemporal patterns in diet and niche overlap. Samples were collected from four regions of Lake Michigan during early and late summer, spanned gradients of fish size, and distinguished between wild and stocked lake trout and Chinook salmon. Lake trout had the most unique trophic niche, with <18% overlap with Chinook salmon, coho salmon and steelhead but 60% overlap with brown trout. Compared to other salmonines, lake trout were enriched in δ15N, indicating greater reliance on offshore benthic prey. Wild lake trout were also more depleted in δ13C than hatchery-reared lake trout, suggesting heavier offshore feeding for wild fish. Lake trout and brown trout had wider isotopic niches than other species, indicating individual diet plasticity, and differed by region, which may indicate regional fidelity. By contrast, the three Pacific salmonines Chinook salmon, coho salmon, and steelhead had relatively high niche overlap (83 – 91%). Isotopes for these three species were also similar among regions, possibly due to inter-regional movement or consistency in diet. These results suggest competition for declining pelagic prey fish will be highest among Chinook salmon, coho salmon, and steelhead, while lake trout and brown trout appear to be diversifying their diets in response to forage base changes.