2017 Wisconsin AFS MEETING
Abstracts

Oral Presentations

Short-term survival of lake whitefish following surgical implantation of acoustic transmitters using two forms of anesthesia

Daniel Dembkowski, Wisconsin Cooperative Fishery Research Unit
Co-authors: Daniel Isermann, Christopher Vandergoot, Scott Hansen

Abstract- We evaluated 48-h survival of lake whitefish *Coregonus clupeaformis* following the surgical implantation of acoustic transmitters using chemical (i.e., AQUI-S 20®; synthetic clove oil) and electroanesthesia by conducting a series of surgery trials during November 2016. Adult lake whitefish (N = 121; TL range = 400-585 mm; mean = 463 mm) were collected from the Menominee River using daytime electrofishing and transported to holding tanks in the Menominee Dam hydroelectric facility. Fish were randomly assigned to one of five treatments: 1) a loop tag; 2) a loop tag and implantation of dummy acoustic transmitter with no anesthesia; 3) a loop tag and dummy transmitter using AQUI-S; 4) a loop tag and dummy transmitter using electroanesthesia; or 5) reference fish. In treatments involving anesthesia, fish were monitored for induction and recovery times, and all fish were monitored for post-trial mortality. All fish undergoing anesthesia of both types were alive 48-h after surgery and only 4 of 25 fish that were implanted with a transmitter without anesthesia were dead after 48-h. Both induction and recovery times were substantially lower for fish anesthetized using electroanesthesia than for those anesthetized using AQUI-S. Results indicate that survival of lake whitefish following surgical implantation of acoustic transmitters was high when surgeries were conducted under anesthesia. While mortality rates did not differ between anesthesia methods, our results suggest that electroanesthesia may offer a better option than AQUI-S for tagging lake whitefish in a field setting due to substantially lower induction and recovery times.

Genetic evaluation of Wisconsin's feral walleye brood stocks

Michael Vaske, UW-Stevens Point

Co-authors: Justin A VanDeHey, Brian L. Sloss, Keith Turnquist

Abstract- Conservation of genetic resources is vital to Walleye *Sander vitreus* management in Wisconsin, especially within the propagation program. Our objectives were to (1) determine genetic origins, diversity, and inbreeding levels within Wisconsin's feral Walleye broodstocks and compare them with diversity levels in naturally recruiting Wisconsin Walleye populations and established minimum threshold values, and (2) determine if varying levels of sampling effort influence measured genetic diversity levels. Genetic diversity within the broodfish was similar to other Wisconsin populations. Significant differences in the mean number of private alleles were observed between Teal Lake (0.36 ± 0.46) and the Upper Chippewa management unit (0.98 ± 0.52) and the 2016 Tomahawk Lake broodstock (0.19 ± 0.36) and the Upper Wisconsin management unit (1.09 ± 0.62), likely due to high levels of gene flow caused by stocking. Inbreeding levels within the broodstocks (e.g. Long Lake 0.010 ± 0.083) were considerably lower than their respective management unit averages (e.g. Upper Chippewa 0.092 ± 0.061). Some broodstock populations (Teal and Long lakes) were not genetically representative of the regional genetic stock, suggesting alternative broodstock populations should be used. Results also suggest that increased temporal sampling would increase genetic diversity in the broodfish. For example, in 2015, broodfish were collected on Tomahawk Lake for two days with 36 rare alleles sampled; an additional 15 rare alleles were sampled on day three. Overall, the WDNR's feral Walleye broodstock program is conserving a large amount of genetic variation, but slight increases in temporal sampling effort would further benefit the program.

Post-release survival and movement of lake trout stocked at four historical spawning sites in Lake Michigan

Matthew Kornis, USFWS

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Abstract- Since the late 1950s, fisheries agencies have used stocking, sea lamprey control, and harvest regulations to rehabilitate lake trout (*Salvelinus namaycush*) in Lake Michigan and support recreational fisheries. We identified factors related to post-release survival of coded-wire tagged (CWT) lake trout stocked at four historically important spawning sites, and determined how much lake trout stocked offshore contributed to recreational fisheries. Data from long-term fishery-independent surveys were used to compare relative post-release survival of lake trout, estimated by catch-per-unit-effort corrected for the number of fish stocked (CPUE), across 173 CWT tag lots of the 1994-2003 year classes. Boosted regression trees indicated stocking location (60.6% relative influence), genetic strain (13.2%), and total length at release (12.0%) influenced lake trout CPUE more than rearing hatchery (6.2%), predator density (4.8%), and mortality at release (3.1%). CPUE was lowest for fish stocked in the north, where there was a truncated age structure and higher rates of sea lamprey wounding. At the other three locations, CPUE was higher from Lake Michigan remnant genetic strains and from fish with larger length at stocking. Lake trout stocked at southern offshore areas (Mid-lake refuge and Julian's Reef) were commonly recaptured by fishery-independent surveys in nearshore areas accessible to the recreational fishery. Moreover, the majority of hatchery lake trout harvested by open-water anglers in 2016 originated from offshore stocking locations, including 60% of catch lakewide and 89% in Wisconsin waters. Our results have implications for stocking strategies and dispel the notion that offshore-stocked lake trout are not accessible to anglers.

Use of pop-off satellite archival tags (PSAT) on Lake Trout in Lake Superior

Michael Seider, USFWS

Co-authors: Frederick Goetz, Shawn Sitar

Abstract- Multiple forms of lake trout inhabit Lake Superior including shallow water (lean) and deepwater (siscowet) forms that are distinguishable morphologically and genetically. As part of ongoing lake trout restoration efforts in the other Great Lakes, agencies have begun to stock a deepwater form; with the presumption that those stocked fish will inherently seek out deep water. Pop-off satellite archival tags (PSAT) were used to test if depth preference of the two lake trout morphotypes is a genetic trait. PSATs have been used extensively in marine environments, but this is one of the first studies in the Great Lakes region to use this technology. The external tags collect a suite of information from the fish's environment over a predetermined amount of time. When the mission is complete, the tags disconnect from the fish and float to the surface where they begin to transmit data and their position for physical recovery. Transmission of data via satellite has been found insufficient, but physical recovery of tags has produced a tremendous data set describing lake trout habitat preference.

Using Coded-wire tags to understand growth and condition of Lake Michigan Chinook salmon

Allen Lane, USFWS

Co-authors: Matthew S. Kornis, Kevin W. Pankow, Darin G. Simpkins, James L. Webster, and Charles R. Bronte

Abstract- Fisheries managers are concerned that predator/prey imbalance is affecting the valuable recreational Chinook salmon fishery in Lake Michigan. Understanding spatial and temporal patterns in hatchery-reared Chinook salmon growth and condition may provide important information for decision makers. In this study, we evaluate the growth and condition of recaptured known-aged, coded-wire tagged, hatchery-reared Chinook salmon from various recovery regions and stocking locations in Lake Michigan. We also assess temporal changes by comparing growth and condition of among the 2011-2014 year classes. We used length and weight-at-age data from about 15,000 sport-caught Chinook salmon that were examined at 48 ports during the 2012-2015 open water fishing seasons. We use Von Bertalanffy growth model parameters L_∞ and K to examine growth among locations and year classes, and compare predicted vs. actual weights-at-length for condition. Results indicated that regional recapture and stocking location has little effect on growth or condition, which is consistent with tag return data showing a largely mixed population in Lake Michigan from April to August. Growth did differ among the 2011 to 2014 year classes showing progressively reduced length-at-age over time. This may be related to trends in lower alewife abundance over the same period. Our results demonstrate that Chinook salmon growth may track forage abundance, but growth is similar across stocking and recovery locations do to the ubiquitous spatial use of Lake Michigan by the species.

Wild Age-0 Salmonid Abundance and Outmigration in Wisconsin Tributaries to Lake Michigan

Eric Wegleitner, Wisconsin Cooperative Fishery Research Unit

Co-authors: Daniel Isermann, Nicholas Legler, Pradeep Hirethota

Abstract- Introduced salmonids (i.e., chinook and Coho salmon, rainbow and brown trout) support important recreational fisheries within the Lake Michigan ecosystem. These fisheries are primarily supported by stocking. However, some natural reproduction is known to occur within some Wisconsin tributaries to Lake Michigan. Specifically, anadromous rainbow trout (i.e., steelhead) stocked into Lake Michigan are known to exhibit an adfluvial life history, migrating up tributaries to spawn. Wild offspring have been encountered in some of these tributaries, but it is unknown whether these fish successfully outmigrate from these streams into larger tributaries or Lake Michigan. The primary objectives of our research are to determine if: 1) abundance of wild age-0 salmonids (primarily steelhead) varies among selected streams in relation to available habitat; 2) wild age-0 salmonids successfully outmigrate from Wisconsin tributaries into Lake Michigan or into larger tributaries and 3) potential bottlenecks related to stream temperature or annual flow regimes prevent successful outmigration from some streams. Our initial year of sampling indicated that northern streams exhibited higher levels of natural reproduction. Outmigration during fall was minimal or non-existent as we detected fish at the antennas, but few or no fish left the stream.

Evaluation of alternative sampling designs for estimating abundance of salmonid runs from video recordings at Bois Brule River fishway

Iyob Tsehaye, Wisconsin DNR

Co-authors: Paul P. Piszczek and Kirk W. Olson

Abstract: We analyzed temporal (daily and hourly) patterns in salmonid runs in the Brule River, Wisconsin using eleven years of video census data (2004-2014) with the aim to explore optimal sampling designs to estimate abundances of these spawning runs, mainly including steelhead, Coho salmon, Chinook salmon, and brown trout. We evaluated two types of two-stage stratified sampling designs with varying numbers of samples of days within a year (1st stage samples) and hours within a day (2nd stage samples) drawn from the annual census data using simulations. The number of days sampled within the year, divided into five strata, varied from 30 to 200 days, in 10-day increments, and the number of hours sampled within the day varied from 2 to 24 hours in 2-hour increments. Hours were sampled randomly with equal probabilities (uniform probability designs) in the first set of sampling designs and with probabilities proportional to abundance of salmonid runs in each hour (non-uniform probability designs). Sample-based abundance estimates were compared with true values (based on census data) using relative root mean square error (RMSE). Our results showed that reducing the number of days sampled to 100 resulted in of about 10% RMSE in abundance estimates on average depending on the species. Very little increase in accuracy was obtained by increasing the number of hours sampled in a day beyond eight hours, so surveying more days resulted in greater accuracy than surveying more hours. Non-uniform probability designs did not considerably improve accuracy of estimates over random sampling designs, especially for steelhead, the most abundant species comprising the salmonid runs.

Lake Michigan: A rocky bathtub (ouch)

John Janssen, UW-Milwaukee

Abstract- Except for her islands and bays (which are for sportsmen (Lightfoot, 1976)), managers have treated Lake Michigan as if it was a smooth-bottomed bathtub. Fishers know better, but adequate maps of the rocks that the Paleozoic (really old), Pleistocene (somewhat old), and bluff erosion (recent) left us have been mostly lacking. Maps are now emerging via diverse technologies, so it's time to take a tour of the rough lakebed and rethink management from a stronger habitat perspective.

Assessment and Mapping of the Milwaukee Estuary Habitat

Brennan Dow, UW-Milwaukee

Co-authors: John Janssen

Abstract- With minimal habitat management, the Milwaukee Harbor has developed a diverse fishery for a seasonal variety of both warm water game species, such as black basses, as well as salmonid species. Milwaukee Harbor's brown trout fishery is world class, with the IGFA catch and release world record coming from the harbor in 2011. When Milwaukee was founded, its estuary was a significant source of both commerce and recreational activity. Subsequent industrial development greatly diminished the fishery, but in response to the Clean Water Act and redevelopment efforts, new opportunities exist for a truly functional estuary â€" one in which industry, ecological services and human activities co-exist in a novel ecosystem. Currently landscape architects focus on the shoreline of the estuary; but to plan fish habitat improvement using an ecosystem approach, managers need to know what is underwater. Our assessment focuses on the diversity and location of existing fish forage and habitat. Preliminary data includes roughly 66 km of shoreline mapped with sidescan sonar, totaling to 1.77 sq. km of seven different benthic substrate categories throughout the Milwaukee Estuary area. Fine (64.86%), rocky boulder (10.80%), rocky fine (10.81%), and wood/steel piling(s) (9.65%) are the most prevalent substrate classes. One of the final products of this project will be a layered map that fills knowledge gaps to provide stakeholders crucial information about the harbor habitat.

A Novel Ecosystem at a Modified Boulder Breakwall

Eric Geisthardt, UW-Milwaukee

Abstract- The US Army Corps of Engineers (USACE) is mandated to maintain and repair aging breakwall structures in all commercial ports on the Great Lakes. The Milwaukee Harbor USACE "Green" Breakwall created complex rocky aquatic habitat by depositing cobble-sized stone as a veneer over standard 6-8 ton boulders, thus creating "control" (boulder) and "treatment" (cobble) habitats. The breakwall is home to a prolific population of *Hemimysis anomala*, the introduced Ponto-Caspian mysid, which is significantly more abundant on cobble versus boulders ($p<0.05$, using a novel trap for Hemimysis). This nearshore lithophilic mysid may provide a significant new seasonal food resource in the Milwaukee Harbor for pelagic prey fishes during spawning migrations and upwelling events. Alewife and rainbow smelt fed heavily on Hemimysis with some individuals consuming hundreds of mysids. Night scuba diving surveys and gill netting confirmed that rainbow smelt preferred to forage on the cobble section ($p<0.05$), and also consumed more Hemimysis there than they did at the control breakwall site ($p<0.05$). Hemimysis made up a significant portion of the diets in YOY yellow perch, YOY largemouth bass, and juvenile rock bass caught on the MHGBW. We believe that the construction of the MHGBW has aided the productivity of this benthopelagic macroinvertebrate to create a novel ecosystem benefiting forage fish and creating nursery habitat for nearshore gamefish juveniles.

Using GIS to Predict Nearshore Substrate Composition in Lakes

Douglas Zentner, UW-Stevens Point

Co-authors: Joshua Raabe, Timothy Cross, and Peter Jacobson

Abstract- Nearshore habitat is an integral component of lake ecosystems that is threatened by shoreline development. Quantifying habitat offers insight into species requirements, allowing for the evaluation of potential limiting factors and the identification of areas for protection or restoration. However, quantifying habitat is typically labor intensive or requires specialized equipment, time, and training. Therefore, we developed a model using GIS to determine if we could accurately predict nearshore substrate composition in lakes. Model predictor variables lake size, shoreline length, effective fetch, maximum depth, bathymetric aspect, and riparian height were all derived from GIS data layers available to the Minnesota Department of Natural Resources. Nearshore habitat data were collected along transects in 28 lakes across Minnesota during the summers of 2014-2016. Prior to modeling, substrates from transects were grouped into three general categories, Muck, Sand and Fine Gravel, and Coarse Substrates, based on results from K-means clustering analyses. We randomly selected 85% of our data to construct and "prune" Classification Trees and used the remaining 15% of data for model testing. Our top candidate model correctly assigned over 70% of data points to the appropriate substrate category, indicating the potential to use GIS to predict substrate composition along shorelines. We envision numerous applications for this GIS model, such as understanding factors that influence substrate distributions, predicting locations of important habitat (e.g., walleye spawning habitat), and assisting management decisions on habitat protection and restoration or shoreline development.

What are those Feds up to now?

Jacob Richter, USFWS

Abstract- The Green Bay Fish and Wildlife Conservation Office (GBFWCO) has several well established and widely recognized programs, such as the Native Species and Habitat programs, which focus on native fish and habitat restoration. A less familiar program is the relatively new Aquatic Invasive Species (AIS) program. My intent is to provide an overview and timeline review of the AIS program at the GBFWCO since inception in 2012. The AIS program is built around an adaptive early detection and monitoring framework that has evolved, following an annual cycle of sampling, evaluation, and refinement. After initial AIS risk assessments, sampling efforts began in 2013 and involved the novel technique of eDNA water sampling for Bighead and Silver Carp, as well as an assortment of traditional gears for capturing juvenile and adult fishes. Since then, the AIS program has continued to grow, assess, and improve sampling efforts. In 2017, AIS sampling efforts will be extensive, with the implementation of a diverse suite of techniques that target larval, juvenile, and adult native and non-native fishes, as well as benthic macroinvertebrates and the collection of eDNA water samples for Bighead and Silver Carp.

Environmental factors associated with the spatio-temporal distribution of ichthyoplankton in Lower Green Bay, Lake Michigan

Marian Shaffer, USFWS

Co-authors: Patrick Forsythe, Ryan McManamay, Timothy Strakosh

Abstract- Ichthyoplankton (i.e., fish eggs, larvae) distribution and the dynamics driving them remain largely unknown in large freshwater lakes (e.g., the Great Lakes). In this study, paired bongo nets and light traps were used to assess spatial and temporal influences and environmental conditions on the distribution of ichthyoplankton in Lower Green Bay and the Fox River in Lake Michigan. Sampling occurred biweekly during summers 2014 and 2015. Fish eggs (N=65,531) and larvae (N=37,917) were collected totaling 19 species from 12 families. AIC modeling revealed that temperature, pH, dissolved oxygen, and depth influenced variation in the abundance and distribution of fish eggs and larvae; however, space combined with environmental factors also contributed to some variability. Preferred spawning and nursery habitats, in association with environmental factors, were considered to be the major causes of spatial variation. Although best-fitting models did not include the effect of temporal autocorrelation, abundance of fish eggs and larvae showed temporal variation, possibly due to the reproductive strategy of adult fishes. Results highlight the significance of critical spawning and nursery habitats that exist in Lower Green Bay and the Fox River; thus, the protection and preservation of these areas is important for diversity and enhancement of the fishery.

Influence of river plumes on the spatiotemporal distribution of near-shore Lake Michigan fishes and associated ichthyofauna

Bradley Smith, USFWS

Co-authors: Darin G. Simpkins, Timothy R. Strakosh

Abstract- River mouths and river plumes provide unique transitional habitats between tributary and lake systems. River mouths from large tributaries have unique chemical, biological, and physical attributes creating appealing habitats for many native and potentially invasive fishes. Lake Michigan is fed by numerous large tributaries but little is known about their localized impacts on fish communities in the productive near-shore zone. We sampled eight locations around Lake Michigan during spring, summer, and fall including five confluences of large tributaries to characterize fish communities around river mouth plumes, compare these areas to control locations, and identify whether invasive species disproportionately use river mouth habitats. We found that river mouths of large tributaries had greater abundances of invasive Rainbow Smelt and native Spottail Shiner, and White Sucker and fewer Lake Trout and invasive Round Goby than control locations. The influence of river mouths on abundance of small-bodied fishes like Rainbow Smelt and Spottail Shiner was confined to the area immediately adjacent to the river mouth, but impacts were broader for species like White Sucker where abundance was higher throughout the entire study area. Multivariate analyses revealed that river mouth study areas had the most distinct fish communities sampled during this study. Only one established invasive species, Rainbow Smelt, was definitively more abundant at river mouths than nearby control sites. Our study has improved understanding of lake-wide patterns of native and non-native fish distribution and abundance within the productive littoral zone of Lake Michigan, particularly with regards to unique river mouth habitats.

Larval studies at the Madgett and Genoa power plants

Greg Seegert, EA Engineering, Science and Technology

Co-authors: Joe Vondruska and Brad Foss

Abstract- In 2015, we began a study at the Madgett and Genoa power plants to meet the requirements of EPA's 316b rule requiring the conductance of an "Entrainment Characterization Study". At both plants we monitored entrainment in-plant using a 500 micron plankton net. We measured in-river larval drift at 3 points along a transect upstream of each plant. At the Madgett Plant, Drum dominated catches both in the plant and in the river. We estimated entrainment to be between 76 and 475 million eggs and larvae. This represented <1% of the in-river drift, which we estimated to be 54 billion eggs and larvae. Samples at the Genoa Plant were dominated by Drum, cyprinids and Common Carp. Entrainment estimates at Genoa ranged from 54-139 million eggs and larvae. This again represented <1% of the in-river drift.

An update on the Ontonagon River, Bergland Co. MI Streamside Rearing Trailer, 2013-2016.

Glen Miller, USFWS

Abstract: Since last talking to the WI AFS at the 2015 meeting the Ashland FWCO has had 3 successful years out of the last 4 rearing lake sturgeon. Our Stream Side Rearing Trailer (SSRT) located on the West Branch of the Ontonagon River, Bergland MI, has produced approximately 1,500 lake sturgeon fingerlings for stocking into this system. Growth has been consistent over the years, averaging 170- 180 mm and 25 – 29 grams. Individuals have been over the 200 mm and 30 gram mark. A new hydro acoustic project was also launched in 2016 tracking the migration of the stocked fingerling into the Ontonagon River system and Lake Superior.

Downstream Passage Survival of Lake Sturgeon at the Shawano Paper Mill and Balsam Row Dams, Wolf River, Wisconsin

Ryan Koenigs, Wisconsin DNR

Co-authors: Ronald Bruch, Joanne Phipps, Paul Heisey, Chris Avalos

Abstract- Successful downstream passage of emigrating fish at hydro dams is necessary to sustain, increase, or restore both anadromous and resident sturgeon stocks. Mortality associated with passage through hydro turbines has been a major concern. Our objectives were to: 1) assess survival of sub adult and adult Lake Sturgeon passing downstream through spillway gates at the Balsam Row and Shawano Paper Mill Dams on the Wolf River, Wisconsin, 2) evaluate survival of age-0 and age-1 Lake Sturgeon entrained through the Shawano Paper Mill Dam hydropower turbine, and 3) evaluate survival of age-0 Lake Sturgeon passing downstream through spillway gates of the Shawano Paper Mill Dam. Downstream survival of sub-adult and adult Lake Sturgeon was evaluated using sonic telemetry data, while HI-Z tag-recapture techniques were used to evaluate survival of age-0 and age-1 fish. Passage survival rates for sub-adult and adult fish passing downstream through the spillway gates of the Balsam Row and Shawano Paper Mill dams were estimated at 99.1% and 100.0% respectively. All age-0 Lake Sturgeon passed successfully downstream through the spillway gates, while 88.7% of the age-0 and 90.6% of the age-1 treatment fish passed through the Shawano Paper Mill Dam hydro-turbine were recovered. All recaptured juvenile fish were alive and only one fish died during the 48h holding period. HI-Z Tags only (assigned dead) were recaptured from 7.3% of fingerling and 8.8% of yearling sized treatment fish. Survival estimates were 92.7% ± 3.5% for fingerlings and 90.6% ± 3.8% for yearlings. Based on the recapture of only one injured fish and absence of injuries to recaptured fish missing a HI-Z tag, the actual survival rates are likely higher. Our results indicate that downstream passage survival of all life stages of Lake Sturgeon was high at these facilities.

Effects of diet on the gut bacteria of *Acipenser fulvescens* (Lake Sturgeon) fingerlings

Julia Zimmer, UW-Milwaukee
Co-Authors: Dong-Fang Deng, Ryan Newton

Abstract- Lake Sturgeon (*Acipenser fulvescens*) have undergone massive population fluxes in the past two centuries due to the changing perception of their economical worth. At one time, these species were abundant across the Laurentian Great Lakes region, but European colonization led to massive harvests, which decimated many regional populations. Due to the long lifespan and late age of sexual maturity (approx. 10 years for males and 25 years for females), natural population sizes increase slowly. With the help of modern conservation efforts, *A. fulvescens* populations are now increasing, but in most locations aquaculture stocking programs are required to maintain this progress. One of the challenges faced in sturgeon aquaculture facilities is the cost, labor, and nutritional variability associated with maintaining live feeds. A formulated diet that is nutritionally optimized, yet financially practical, could bolster captive sturgeon breeding programs. However, a major unknown in aquaculture feed management is how feed formulation and rate influence host intestinal microbial communities, and in turn, whether the interplay between feed management and microbial community development influences host health. In conjunction with a study on growth outcomes for *A. fulvescens* fingerlings raised in a flow-through system from two feeding trials: 1) with and without replacement of "typical" live feeds by formulated diets and 2) across feeding rates spanning 0.5-12% body weight per day, we examined the relationship between feed management strategies and intestinal bacterial community composition. Feeding rates of 9.2% body weight per day were found to maximize weight gain over a 1-week period at 63 dpf (days post-fertilization) and 6.6% at 77 dpf. However, direct replacement of live feed with an artificial diet reduced survival by 20% at 28 dpf. Massively parallel sequencing of 16S rRNA genes was used to characterize the bacterial communities from the intestines of >90 juvenile fish from these experiments. With these data, we will compare the changes in bacterial community composition to growth outcomes under the different diet-feeding rate regimes. We believe these data will allow us to identify common members of captive bred A. fulvescens gut microbial communities and gain valuable insight into the influence of diet on microbial community composition. These baseline data also will allow us to more critically design experiments that explore the interaction between diet, intestinal microbiota, and fish growth/health in captive breeding programs.

Enhancement of Lake Sturgeon Conservation through Feeding Management

Dong-Fang Deng, UW-Milwaukee
Co-authors: Seunghyung Lee, Song Yang, Shaowei Zhai, Jeffrey Nuese, Brian Shepherd, Fred P. Binkowski

Abstract- Lake sturgeon (*Acipenser fulvescens*), listed as threatened under the State of Michigan's Endangered Species Act, has high ecological and economical values as a native benthivore. A lot of efforts for enhancing stocking have been implemented to restore wild populations. For current stocking programs, lake sturgeon are raised with raw/live feed, which causes stocking programs to be expensive and difficult to maintain due to special care required for managing live feed and decreased control on biosecurity. To address these drawbacks, we aim to replace raw feed with formulated feed and develop a biosecured and sustainable feed management program for the culture of lake sturgeon. A series of feeding trials were conducted to study the effects of different feeds (*Artemia*, formulated feed, combination diet with *Artemia* and formulated feed) and feeding rate on the survival and growth performance of lake sturgeon. Our results showed that early acclimation (from the beginning of exogenous feeding) of lake sturgeon to a formulated feed can improve their acceptance of formulate feed. With the selected formulated feed, the optimal feeding rates for lake sturgeon ranging from 3.6 g to 80 g (body weight) decreased from 7.6 to 3.5%body weight/day. Lipid storage in the whole body of lake sturgeon was significantly ($P<0.05$) influenced by different feeding rates with a lower lipid level in the fish fed at a suboptimal feeding rate. The changes in nutritional status of sturgeon may potentially affect their response to temperature challenges. The results are pending and will be discussed in the presentation.

Application of C and N stable isotopes to track movement of brown trout in the White River, Bayfield County, WI

Kirk Olson, Wisconsin DNR
Co-author: Scott Toshner

Abstract- The White River supports a popular trout fishery and is unique in its remoteness and the extensive amount of undeveloped public land along its length. Over the past 50+ years fisheries managers have dedicated significant resources to protect and improve trout habitat in several small tributaries that are believed to be important spawning and rearing habitats for brown trout which migrate upstream from the mainstem of the White River. The high cost associated with tagging and telemetry studies have prevented fisheries managers from evaluating the hypothesis that brown trout migrate upstream from the mainstem of the White River into smaller tributaries to spawn. In order to evaluate this hypothesis, we collected tissue samples from fish and invertebrates from several headwater and mainstem sites in summer and late fall for C and N stable isotope analysis. We documented decreasing Î´13C signatures of fish from headwater tributaries to the mainstem White River during summer. This result was opposite of patterns typically described in the literature and likely the result of lentic production in headwater spring ponds. Fall sampling in one spring fed tributary revealed that several spawning fish had Î´13C signatures indicative of fish which occupied lower river habitats during summer. One of these fish was larger than any that had been documented in summer electrofishing surveys in the tributary. Since many of our samples were collected during annual trend and rotational monitoring, total cost of collecting and analyzing samples for this project was < $2,500. This work demonstrates that C and N stable isotopes may be used as a cost effective tool for tracking coarse scale movements of trout.

McGee Lake Brook Trout Fishery - 10 Years after Hitting the Reset Button

David Seibel, Wisconsin DNR

Abstract- McGee Lake is a 23-acre spring pond with a native, naturally reproducing brook trout population. The Wisconsin Department of Natural Resources purchased the property surrounding the lake in 1968. The fishery of this large spring pond has been managed for quality trout fishing since. In the mid 1990s, largemouth bass and hybrid sunfish were illegally introduced to the lake. Despite liberal bass harvest regulations and intensive removal efforts, the largemouth bass population was severely limiting trout reproduction, survival, and fishery potential. Bass were consuming virtually every trout produced and natural reproduction could no longer sustain the trout fishery. We then started stocking large fingerling trout in hopes of maintaining a trout fishery but quickly realized this was just an expensive bass feeding program. To maintain a trout fishery of any kind, the spring pond had to be renovated. In November 2006, rotenone was applied to McGee Lake to completely kill all fish and start trout management anew. The project was considered a brook trout restoration project so wild trout genetics were used to reestablish a population. Six large adult brook trout from 14 to 17 inches were fyke netted from the lake prior to the rotenone treatment, kept alive at a decommissioned state fish hatchery, and stocked back into McGee Lake following detoxification. Also, 645 1.5-10.4 inch brook trout from McGee Creek were field transferred into the spring pond in summers 2007 and 2008 to restart the population. McGee Creek originates at the outlet of McGee Lake and is a high quality naturally reproducing brook trout stream. Prior to and following the renovation, the brook trout fishery has been managed for quality fishing opportunities with a 12 inch minimum size limit, daily bag limit of 2, and artificial lures only regulations. While the population was rebuilding, all fishing was suspended through the 2010 season (4 years). Trout electrofishing surveys and population estimates have been done annually every October, after the angling season ends, since 2008. Data analyses show that, in hindsight, we probably could have opened the fishery after just 2 years of closure without doing the population harm. Data will be presented showing that McGee Lake is once again a top quality brook trout angling destination.

Beaver Control an Effective Method to Maintain Trout Populations in Low Gradient Streams

Max Wolter, Wisconsin DNR

Abstract- Brook and brown trout are popular sportfish in Wisconsin and draw a considerable amount of management interest. Trout populations in streams face a variety of environmental challenges including rising water temperature, degradation of spawning habitat, and loss of habitat connectivity. Excessive damming by beaver can exacerbate these environmental challenges by further warming water, silting over spawning areas, and destroying connectivity. The Wisconsin DNR contracts the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) to manage beaver and remove dams on select trout streams across the state. We evaluated the apparent success of APHIS beaver control in Sawyer and southern Bayfield counties. Trout recruitment and adult abundance were compared between nine predominantly class-1 and class-2 trout streams that are currently enrolled in the APHIS beaver control program and nine other class-1 and class-2 streams where beaver activity was noted by biologists but no official control program was in place. Trout recruitment was measured as young-of-year trout (<4 inches for brook trout, <5 inches for brown trout) per mile of stream surveyed using WDNR baseline monitoring techniques. Adult abundance was compared using the same techniques but including all trout larger than young-of-year. Recruitment ($P<0.01$) and adult abundance ($P=0.04$) were both significantly higher on waters where beaver control programs were in place. Many trout streams without a beaver control program have seen an apparent loss of native trout altogether. These results demonstrate the effectiveness of professional beaver control programs, particularly in small, low-gradient streams that can be easily colonized by beaver.

Diel and Seasonal Movements of Brook Trout in the Little Plover River, Wisconsin

T. J. Hein, UW-Stevens Point
Co-authors: Joshua K. Raabe, Douglas Zentner

Abstract- Brook trout *Salvelinus fontinalis* movements in response to fluctuating water temperature and flow has received limited study, especially in small streams. The Little Plover River in Portage County, Wisconsin is a second-order, class-1 brook trout stream that has experienced fluctuating water levels in recent years, including dry reaches with dead brook trout observed. Water levels have remained stable or elevated since we began our study, so our objectives were to determine if brook trout movements differed daily or seasonally. Trout were sampled at various locations using backpack electrofishing in fall of 2015 and spring and fall of 2016. Individuals exceeding 120 mm in total length were implanted with a PIT tag. Paired PIT antennas were installed at five sites throughout the river to passively detect movements of tagged individuals from March 2016 through January 2017. Detection data were filtered to examine diel (one detection / 15 min) and seasonal (one detection / site / day) movements. Brook trout diel activity was primarily nocturnal during spring through early fall, but in late fall to winter shifted to more detections during the day. The number of individuals detected overall and that passed multiple sites (i.e., migrated) was noticeably higher in the fall than other seasons. Brook Trout may have changed their movements in the fall to gain a competitive reproductive advantage. Our results increase knowledge of brook trout movements and spawning behaviors, and we plan to continue the study to learn about responses to different environmental conditions.

Brook trout movements in the West Branch of the Wolf River, Wisconsin

Emma Easterly
Co-authors: Daniel Isermann and Joshua Pyatskowit

Abstract- The portion of the West Branch of the Wolf River (WBWR) that resides within the Menominee Indian Reservation is classified as a class I trout stream with naturally-reproducing brook trout. Little is known regarding movement of brook trout within this section of the WBWR and seasonal movements could have important implications for management. The objectives of this study are to determine if: 1) brook trout in this section of the WBWR utilize multiple river segments during the year; 2) a large percentage of brook trout enter the Bass Lakes and the Neopit mill pond as a refugia during winter, but eventually return to the river, and 3) brook trout are moving through two locations where two dams were recently removed. Brook trout will be captured by barge electroshocking during the fall of 2016 and spring of 2017. All brook trout ≥ 120 mm in length will be implanted with a passive integrated transponder (PIT) and antenna deployments at multiple locations will be used to detect and describe trout movements. Observed movements during the fall of 2016 suggest brook trout freely move throughout the stream and that seasonal use of lacustrine habitat may occur. Information obtained from the project will help tribal biologists in managing the brook trout population.

Using archival tags to measure thermal habitat use by Brown Trout during summer: a case study on the Namekagon River, Wisconsin

Matthew Mitro, Wisconsin DNR
Co-authors: Max Wolter, Joanna Griffin

Abstract- Fisheries biologists routinely use temperature data loggers to record hourly water temperatures in streams during summer. Data loggers record the ambient temperature where the data logger is located, but we do not know if such recorded temperatures are necessarily representative of temperatures experienced by trout, which may move to find suitable habitat when thermally stressed. We used surgically-implanted temperature archival tags to record hourly water temperatures experienced by Brown Trout *Salmo trutta* in the Namekagon River. We captured and tagged 11 Brown Trout in a wadeable section of the Namekagon River downstream of Seeley, Wisconsin in May 2016 and installed 4 data loggers at intervals along 11.7 km of the river. In September we recaptured 7 trout, of which 5 had retained their tags. Temperatures recorded by the archival tags were similar to temperatures recorded at a fixed site. The maximum daily mean water temperature was 23.7°C and the maximum daily maximum was 25.5°C. For 1 to 63 day intervals, maximum n-day mean and n-day maximum temperatures were on average 0.9°C and 1.1°C below thermal tolerance limits for trout in Wisconsin streams. Archival tags may be useful for studying trout thermal habitat use and its effects on growth and maturation.

Use of Regional Regression Curves for Bankfull Stream Geometry to Assist with Stream Assessment Restoration and in Eastern Wisconsin

Neil O'Reilly, UW-Milwaukee

Abstract- Regional regression curves for bankfull width, depth, cross-sectional area, bed slope and planform are important tools to help guide engineers and ecologists in determining stable conditions for steam restoration projects. While the literature includes curves developed for large regions of the world, experts agree that curves that have been developed for a local regional are more effective. This presentation outlines the development of regional regression curves for Eastern Wisconsin by a team from the University of Wisconsin – Milwaukee utilizing data from the U. S. Geological Survey.

Long-term trends in Production, Biomass and P/B for Cisco in Trout Lake, Wisconsin

Timothy Parks, Wisconsin DNR
Co-authors: Andrew Rypel

Abstract- We estimated and described long-term trends in annual production, biomass, and P/B ratios for cisco (*Coregonus artedi*) in Trout Lake, Wisconsin. Production statistics were based on hydroacoustic and vertical gillnet data collected 2001-2015 as part of the north-temperate lakes, long-term ecological research grant (i.e., NTL-LTER) administered by the National Science Foundation through UW-Madison. For each sampling year, acoustic size data from cisco targets were assigned predicted ages and weights using mean-length-at-age and length-weight regression models. Predicted cisco ages, weights, and population estimates were then used to apportion and estimate biomass and production across various cohorts. Production estimates were based on the instantaneous growth method. Across all years, annual cisco production, biomass and P/B estimates ranged 0.6-30.2 kg/ha/y, 1.2-39.7 kg/ha, and 0.4-0.9 /y, respectively. Annual production calculations were overwhelmingly dominated by age-0 individuals, suggesting young-of-year cisco recruitment is central to driving production rates over time. Time series models revealed a significant declining trend in cisco production ($F = 8.23$, $R2 = 0.39$, $P = 0.01$) and biomass ($F = 6.34$, $R2 = 0.33$, $P = 0.03$). Environmental conditions such as oxythermal habitat were temporally stable in Trout Lake and showed no apparent relationship with temporal patterns of cisco production and biomass. However, Lake trout (*Salvelinus namaycush*) CPUE in vertical gillnets was significantly and inversely related to cisco production ($r = 0.75$, $P < 0.01$) and biomass ($r = 0.75$, $P < 0.01$). We suggest that stocking rates of lake trout (17.3 fish/ha) combined with survival of stocked lake trout fingerlings could be contributing to declining cisco production and biomass in Trout Lake.

Population Trends of Northern Sunfish in the Lower Mukwonago River Wisconsin, from 2003-2015

Derek Sallman, Wisconsin Lutheran College
Co-authors: Robert C. Anderson, John Lyons

Abstract- The northern sunfish (*Lepomis peltastes*) is a threatened species in the state of Wisconsin. The Lower Mukwonago River below the low-head dam at Phantom Lake in Waukesha County is one of the few places where they still thrive. Previous analyses of northern sunfish length data (1994 - 2002) from this section of the river indicated a declining trend in recruitment. This study assessed the northern sunfish population from 2003-2015 using length data collected during Wisconsin DNR annual electrofishing surveys in this same river section. Since 2003, the northern sunfish population below Phantom Lake has not declined but rather showed somewhat repetitive and predictable fluctuations in length categories. Years 2003, 2009, 2011, 2012, and 2014 were similar ($p>.05$) with the majority of individuals in the 50-70 mm size range. Three of these years (2003, 2009, and 2014) were followed by length distributions that were centered around larger fish than the previous year, suggesting that the majority of younger fish grew into the next length category. The 2005-2007 distributions were also similar to each other with an intermediate size range (70- 90mm). The largest mean size distributions occurred in 2004, 2008 and 2010, although 2010 also showed some younger individuals. The northern sunfish population in the Lower Mukwonago River from 2003-2015 seems to no longer be in decline and instead has a variable but generally constant population with regular recruitment. However, given the threatened status of this species and the vulnerable nature of the habitat in the lower Mukwonago River, continued efforts to manage this watershed carefully are encouraged.

Genetic Assessment of Seven Fish Species Above and Below the Prairie du Sac Dam

Jenna Ruzich, Wisconsin Cooperative Fishery Research Unit
Co-authors: Wes Larson, Keith Turnquist, Nathan Nye, David, Rowe

Abstract- The Prairie du Sac dam is the last impassable structure on the Wisconsin river before convergence with the Mississippi river. 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 objective of our project is to determine if genetic structure and/or differences in diversity exist 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 (*Acipenser fulvescens*), walleye (*Sander vitreus*), sauger (*Sander canadensis*), smallmouth bass (*Micropterus dolomieu*), flathead catfish (*Pylodictis olivaris*), shorthead redhorse (*Moxostoma macrolepidotum*), and quillback carpsucker (*Carpiodes cyprinus*). 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 diversity and population structure was evaluated for each species using a minimum of eight microsatellites. 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.

Healthy Lakes: Where the (Applied) Science Meets the Shore

Pamela Toshner, Wisconsin DNR
Co-authors: Dave Ferris, Patrick Goggin, Amy Kowalski, Jane Malischke, Tom Onofrey, Carroll Schaal & Shelly Thomsen

Abstract- The Wisconsin Lakes Partnership recently launched Healthy Lakes - a statewide initiative promoting five simple and inexpensive best practices for lakeshore properties. National and state research continuously shows habitat stress to be a major threat to our lakes, and lakes with poor habitat are more likely to also have poor water quality. Furthermore, we better understand how social marketing can drive people's attitudes and behaviors in regards to lakes. Healthy Lakes integrates natural and social science into terms and actions the general public can understand while providing technical and funding assistance to install fish sticks, native plantings, diversions, infiltration projects, and rain gardens. Environmental outcomes are small and cumulative, as intended, but quite extraordinary to individual property owners. Participation results are exceeding expectations- both in numbers and geographic distribution, and inspiring project partners to share our vision of a new lakeshore norm in the future.

Effects of 2, 4-D herbicide treatments used to control Eurasian watermilfoil on fish and zooplankton in northern Wisconsin lakes

Nick Rydell, Wisconsin Cooperative Fishery Research Unit
Co-authors: Daniel Isermann, Justin VanDeHey, John Kubisiak, Kevin Gauthier, Scott Van Egeren

Abstract- Eurasian watermilfoil (EWM) *Myriophyllum spicatum* is one of the most problematic invasive macrophytes in the United States. Eurasian watermilfoil spreads easily and often displaces native aquatic plants, causing economic and ecological damage. Dichlorophenoxyacetic acid (2, 4-D) herbicides are widely used to control EWM and have been used since the 1950â€™s. However, little is known regarding the effects of 2, 4-D on zooplankton and fishes outside of laboratory experiments. Our objectives are to determine if 2, 4-D treatments affect: 1) the abundance, diversity, and size structure of fishes at different life history stages; 2) feeding, survival, and growth of larval fish, and 3) diversity, abundance, and size of zooplankton. This study will be conducted on six lakes in northern Wisconsin over a three year period, including a pre-treatment, treatment and post-treatment year. During the treatment year (i.e., 2016), three lakes served as reference systems, while three lakes received a whole lake 2, 4-D herbicide treatment. Information collected during this study will aid managers in determining the use of 2, 4-D treatments for whole lake manipulations.

Growth, condition, health, costs and post-stocking survival of Muskellunge reared using two different methods

Justin VanDeHey, UW-Stevens Point
Co-authors: Michael Vaske, Dan Dembkowski, Brian Sloss, Tim Simonson and Rich Klett

Abstract- Muskellunge *Esox masquinongy* are commonly reared on natural prey in hatcheries. However, this method is expensive and introduces biosecurity risks. Formulated feeds (pellets) are now being used by some agencies, however concerns exist regarding the size and post-stocking survival of pellet-reared Muskellunge. Our objectives were to (1) determine if size, condition, and health at stocking differed between age-0 Muskellunge reared solely on natural prey (minnow only; MO) and those reared intensively on pellets and finished extensively on minnows (minnow finished; MF), and (2) determine relative costs of rearing and survival of stocked Muskellunge reared using the two different techniques. During 2013-2016, fingerling Muskellunge were reared, marked, and stocked into 6 to 23 lakes annually throughout Wisconsin. A total of 11,334 MO and 21,075 MF fingerlings were stocked during the study. Across all years, size and condition at stocking was significantly higher for MO fish compared to MF fish ($P<0.01$ for all comparisons). Health metrics (qualitative assessment) were similar for both treatments across years. Nighttime boat electrofishing catch rates were used to asses short-term (2-6 weeks) post-stocking survival. A total of 698 MO (8.7%) and 756 MF (5.0%) fingerlings were recaptured. Mean relative survival across all lakes and years (for all paired stockings) was 1.44 MO to every 1.00 MF fish. Rearing costs were approximately 36 to 57% higher for MO fish compared to MF fish. Formulated feeds may be a viable method if the cost to rear more individuals (to offset reduced survival) is less than the cost to rear fish on natural prey and hatcheries have available rearing space and infrastructure.

Using parentage analysis to investigate the spawning and recruitment dynamics of walleye in a small northern Wisconsin lake

Wes Larson, Wisconsin Cooperative Fishery Research Unit
Co-authors: Keith Turnquist, Greg Sass

Abstract- Supplementation and management strategies for walleye are based on a variety of assumptions about the spawning and recruitment dynamics of the species. For example, large females are protected with slot limits and preferentially used as broodstock because they are thought to produce disproportionately more offspring than smaller fish. However, this assumption has never been directly tested. Additionally, minimum size limits are implemented to protect fish that have recently reached maturity, but it is unclear how many offspring the fish in this size range produce. The overall goal of this research is to use genetic parentage analysis to directly test multiple assumptions related to walleye spawning and recruitment dynamics. Our study site is Sanford Lake, a small 90-acre lake on the Dairyman's property in northern Wisconsin. Adult walleye were captured by fyke netting in spring 2015 and 2016 (N = 427), and young-of-year walleye were capture in 2016 using electrofishing (N = 128). We genotyped these fish and used parentage analysis to determine the parents of each juvenile. In this talk, I will present preliminary results from the parentage analysis.

Female walleye size structure and recruitment on Escanaba Lake, Wisconsin, 1957-2015

Stephanie Shaw, Wisconsin DNR
Co-authors: Greg Sass

Abstract- The length of female fishes is related to fecundity and egg quality, which are factors that may influence survival and recruitment of juveniles to a fishery. However, female size structure is not commonly included when analyzing recruitment and juvenile survival rates. Walleye, Sander vitreus, are an important gamefish managed with length and harvest based regulations. Thus, understanding whether changes in size structure may influence juvenile survival and recruitment can be useful to management. The Escanaba Lake, Wisconsin walleye dataset includes long-term data (1957-2015) on adult female spawning stock structure and recruitment. Our objectives were to: 1) evaluate female spawning stock and annual egg production as alternative measures of "stock" for the Ricker recruitment relationship; and 2) test for potential relationships between juvenile walleye survival and reproductive output of different size classes of adult female walleye. An index of female spring spawning stock (female fyke net catch) and an index of annual egg production (fyke net catch at age x fecundity) explained more variation in the Ricker stock-recruitment model (female spawning stock R2 0.07; egg production R2 0.09) compared to adult stock abundance (R2 0.02). In years where 50% or more annual egg production was contributed by one size group (e.g., 15-18 in, 19-22 in, > 22 in), mean recruit abundance and mean juvenile survival (egg to fall recruitment) tended to increase with increasing size group, although not significantly. Alternatively, there was no relationship between heterogeneity (Shannon diversity index) in age or size structure and recruit abundance or juvenile survival.

An Ice Fishing Guide Reporting System for Green Bay

Scott Hansen, Wisconsin DNR

Abstract- An unprecedented sport fishery for lake whitefish emerged on Green Bay during the 2007 ice fishing season and annual harvest estimates since have been as high as 190,000 fish. Green Bay has a long history of commercial whitefish fishing, thus a shared fishery has developed; and along with that, a certain level of controversy. Guides have responded strongly to this new fishery and are likely accounting for a substantial component of the harvest. Although the WDNR's longstanding Green Bay ice creel survey adequately estimates sport fishing dynamics, there is concern it does not proportionally capture guided trip harvest and effort. A considerable amount of effort was invested initially in collecting voluntary information from guides through mail and on-ice surveys as well as a guide reporting pilot project. Beginning the 2017 ice fishing season, a formal Green Bay ice fishing guide reporting program was implemented (through statute). Guided trip data are required not only for lake whitefish but also for walleyes, yellow perch and other non-rough fish species. Data collected from this survey will enhance the accuracy of the whitefish sport harvest estimate input in our statistical catch at age model and will help in making other management decisions to guard against the risk of overfishing in Green Bay. Historically there has been considerable interest from the public and sport/commercial groups in the development of a guide reporting system, not only for Green Bay, but statewide guiding activities as well.

Characterizing the Joint Tribal Spearing and Angling Walleye Fisheries in the Ceded Territory of Wisconsin

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

Abstract- Continual assessment of the joint tribal spearing and angling walleye fisheries in the Ceded Territory of Wisconsin is critical for the sustainability of this economically and culturally important resource. Key to these assessments is an understanding of harvest demographics, catch and harvest efficiency, and relationships between catch, harvest, catchability, and stock size in each fishery. We evaluated the: 1) length-frequency distributions of harvested walleye; 2) mean length of harvested walleye; 3) mean harvest per lake; 4) mean catch (CPUE) or harvest (HPUE) rate per lake; and 5) the relationship between CPUE and HPUE and 6) the catchability coefficient (q) versus adult walleye density for both fisheries in all lakes with available data and a subset of more frequently sampled lakes during 1990-2015. The size structure of harvested walleye in both fisheries was similar, with the mean length only differing by 13 mm. In populations primarily sustained by natural reproduction, anglers harvested significantly more walleye per lake (about 850 walleye/lake versus 200 walleye/lake). Tribal spearfishers had significantly higher harvest rates per lake (17 walleye/hr) compared to angler catch and harvest rates (0.25 and 0.06 walleye/hr, respectively). For both fisheries, an asymptotic model best explained the CPUE and HPUE versus adult walleye density relationship. Lastly, q was greater at lower adult walleye densities in both fisheries and the tribal spear fishery was more efficient. Given the asymptotic relationship between CPUE and HPUE and adult walleye density, along with a general agreement to manage walleye at ≥ 7.4 adults/ha in naturally reproducing populations, our results suggest that maintaining adult walleye densities at or above the asymptotic inflection point (10-15 walleye/ha) will result in a sustainable fishery that also maximizes tribal and angler harvest. Adult walleye densities below the inflection point may result in a less resilient walleye fishery, if effort is not self-regulating, and may fail to satisfy tribal and angler demands.

Expanded Assessment of Recruitment Bottlenecks for Age-0 Walleye (*Sander vitreus*) in Northern Wisconsin Lakes

Jason Gostiaux, Wisconsin Cooperative Fishery Research Unit
Co-authors: Hadley Boehm, Daniel Isermann, Joseph Hennessy, and Gretchen Hansen

Abstract- Previous research we conducted provided sampling protocols for age-0 walleye at different stages during their first year of life and suggested a recruitment bottleneck was occurring at or before the larval stage in lakes with declining walleye natural recruitment. In 2016, we used these sampling protocols on 13 northern Wisconsin lakes with two different recruitment histories (declining = D-NR, sustained = S-NR) to determine if the timing of a recruitment bottleneck was consistent among D-NR lakes. We also determined if abiotic and biotic metrics differed between lakes with different recruitment histories. Age-0 walleye were collected after the larval stage in six of seven S-NR lakes and but were not observed at any stage in the remaining S-NR lake. Age-0 walleye (N = 8) were collected after the larval stage (fall electrofishing) in only one of six D-NR lakes. Our first year of data suggests a recruitment bottleneck occurs at or before the larval stage in some, but not all D-NR lakes. Furthermore, walleye fry stocking on Lac Vieux Desert did not appear to circumvent this bottleneck.