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**Oral Presentation Abstracts**

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**Title:** Identifying Recruitment Bottlenecks for Age-0 Walleye in Northern Wisconsin Lakes

**Co-Authors:** Dan Isermann and Gretchen Hansen

**Abstract:** Walleye recruitment (measured as age-0 CPE in fall electrofishing) has declined in several northern Wisconsin lakes, and the reasons for these declines are not known. Our goal was to identify the timing and potential causes of recruitment bottlenecks for age-0 walleyes in northern Wisconsin lakes. In 2014 and 2015, we sampled four walleye lakes with two different recruitment histories: declining natural recruitment (D-NR) and sustained NR (S-NR). Adult walleye were captured in spring using nighttime electrofishing, egg mats were used to verify spawning, towed ichthyoplankton nets, light traps, beach seines, micro-mesh gillnets, and electrofishing were used to capture age-0 walleye throughout their first year of life. Water quality data, zooplankton samples, and panfish diet information were also collected. Walleye spawning was documented on all lakes, but relatively few eggs were encountered on D-NR lakes, which was consistent with lower adult densities. Age-0 walleyes were not captured in D-NR lakes after the early larval stage, while age-0 walleyes were captured at multiple life stages during both years on S-NR lakes. We examined more than 800 panfish diets during periods of peak larval percid abundance, 5 of which contained larval fish, suggesting panfish were not major predators of larval percids on any lake. Temperature and dissolved oxygen were similar for all lakes, although D-NR lakes were clearer. Our research suggests one recruitment bottleneck for age-0 walleye occurs at or before the larval stage in D-NR lakes.

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**Title:** Post-Release Survival and Behavior of Walleye Tagged with Internal Acoustic Transmitters: Do They Sink or Swim?

**Co-Authors:** Christopher S. Vandergoot, Matthew Faust, Richard Krause, Ann Marie Gorman, Charles Krueger, Steven J. Cooke

**Abstract:** Coinciding with advances in acoustic telemetry technology, the studies focusing on the movement and behavior of wild fish have proliferated in recent years. However, there has not been a concomitant increase in the understanding of how the tagging procedure (i.e., collection and surgical process) affects the organism, specifically as it relates to survival and behavior. In 2013 we captured, implanted acoustic transmitters and released 165 walleye into a VEMCO Positioning System (VPS) acoustic array in the vicinity of a spawning shoal in the western basin of Lake Erie. Based on the positions generated from the VPS array, swimming velocities were calculated to evaluate post-release survival and behavior for up to three days post-release. Additionally, we used individual fish detection histories to evaluate post-release survival within three months of release. Using this information we estimated that 77% of the walleye released survived at least three months. Swimming activity was low immediately following release but increased as the time at liberty increased. Thus, researchers should recognize that the tagging procedure may influence short-term behavior of the study fish and that some level of data censoring may be necessary to avoid arriving at erroneous conclusions.

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**Title:** Angler Catch Rates and Catchability of Walleye Using Live and Artificial Baits: Bait Restriction as a Management Tool to Reduce Exploitation?

**Co-Authors:** Austin Noring, Greg G. Sass

**Abstract:** Population specific harvest regulations are becoming increasingly common for managing potentially overexploited Walleye (*Sander vitreus*) fisheries. To achieve or maintain sustainable exploitation rates, estimates of angler catch rates (catch/h) and catchability (q) are needed to monitor changes in fishing effort or harvest rates. We used compulsory creel census data collected a decade prior to (1993-2002) and following (2003-2012) a trophy regulation (1 walleye  $\geq 28$ "") on Escanaba Lake, Wisconsin, to test walleye catch inequalities for anglers using live and artificial baits. For artificial bait anglers catch rates and catchability were significantly lower than anglers using live bait. Anglers using artificial bait also averaged 0.6 hours less angling effort directed towards walleye per trip. Catchabilities of walleye using both bait types increased over time and were significantly greater during the trophy regulation period. Between the pre- and post-regulation periods, the number of walleye anglers decreased significantly and the proportion of anglers using artificial baits increased significantly. Our results suggest angler catchability of walleye in Escanaba Lake is dependent on bait type. Therefore, a live bait restriction may be a viable tool for reducing exploitation in open-access walleye fisheries.

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**Title:** Where the Walleyes are: Estimates of Effort, Catch and Harvest from Wisconsin Angler Diaries

**Co-Author:** Jordan Petchenik

**Abstract:** Creel surveys are an effective way to obtain biological data on sport fish populations from angler catch information, but they are cost-prohibitive to implement at a statewide or even regional level. Surveying anglers by mail is one alternative way to collect information on the relative status of a fishery if they are well-designed and generalized cautiously in light of their potential biases. We conducted an angler diary study on a statewide basis during the 2014-15 license year by sampling a different group of anglers each month. We generated estimates of effort, catch and harvest rates for walleye (*Sander vitreus*) among annual license holders in Wisconsin over a 12-month period. We provide an overview of our results with a particular focus on how a few premiere walleye angling waters can influence attempts to make relative comparisons of walleye angling quality across regions (e.g., north vs. south).

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**Title:** Modeling Movement of Incubating Walleye Eggs Due to Water Movement on Lake Shorelines

**Co-Authors:** Joshua Raabe, Timothy Cross, Peter Jacobson

**Abstract:** Strong winds and associated water movements can negatively influence survival of walleye *Sander vitreus* eggs during incubation through burial, abrasion, and transfer to suboptimal habitat including onto shore, where egg desiccation likely occurs. Recent laboratory studies determined uni-directional, sustained critical water velocities ( $C_v$ 's) capable of moving walleye eggs. However, water movements along lake shorelines are typically multi-directional and not sustained, and their effects on incubating walleye eggs have received limited study. Therefore, our objective was to model walleye egg movements due to water movements along lake shorelines to determine the potential influence of this environmental factor at different spawning sites. We installed velocimeters to measure water movement at four separate spawning locations across three lakes in central Minnesota during the spring 2015 walleye incubation period. Velocimeter measurements (taken continuously for two minutes at half hour intervals) were compared to laboratory  $C_v$ 's and combined with prior estimates of average egg weight to estimate movement on each spawning site. These calculations were repeated to estimate movements of sand, gravel, and cobble. In 2016 we will measure water movements and the movements of substrates and eggs on spawning grounds to compare and improve upon our estimated movements. Our model along with calculated movements will increase our understanding of walleye early life history and allow managers to consider another environmental factor influencing in-lake walleye spawning success.

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**Title:** Balancing Angler Bag and Size Limits to Control Angler Harvest of Walleye in the Wisconsin Ceded Territory

**Abstract:** Despite being effective in managing adult walleye exploitation, public input suggested that a stable bag limit of 3 walleye/day was preferable, even if more restrictive size limits were then required to control angler harvest. Using existing creel survey data from the Wisconsin ceded territory I investigated the potential impact to walleye harvest numbers if 2-fish daily bag limits were to be raised to 3-fish daily bag limits. Expected increases in harvest due to increased bag limits were shown to be dependent upon the harvest regulations (size limits) currently in place and ranged from 0 to 14 percent. I evaluated various restrictive angling regulations and their potential to offset the impacts of increased bag limits. Addition of a '1 fish over 14 inch' harvest restriction to lakes that currently have no size restrictions on walleye harvest could largely offset the increased harvest expected from increased daily bag limits. Addition of '1 over' regulation components evaluated (1 > 18, 20, 22, 24, 26 or 28") to other existing regulations would have negligible impact on harvest numbers. Numerous potential protected slot limits (20-24, 20-26 and 20-28") were evaluated for addition to the existing 15" minimum size regulation, finding that addition of a 20-24 inch protected slot would result in a 13-14 percent reduction in angler harvest and offset impacts of increased harvest expected from increased daily bag limits. More restrictive size regulations are expected to offset increased harvest in at least 67% of mixed fishery waters in the ceded territory; Lakes where increased harvest would be expected are those that currently have no minimum size restrictions, indicating population characteristics that should tolerate increased harvest pressures.

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**Title:** Quantifying Coastal Wetland – Nearshore Linkages in Green Bay, Lake Michigan

**Co-Authors:** Patrick Forsythe, Christopher Houghton, Gary Lamberti, Katherine O'Reilly, Donald Uzarski, James Student, Martin Berg

**Abstract:** Coastal wetlands provide habitat for a majority of Great Lakes fish species at some life history stage, and are especially important for transient littoral sportfish, which periodically use wetlands to feed and spawn. Movement of fishes between coastal wetlands and nearshore areas trophically links the two habitats, and this linkage has not been thoroughly described for Lake Michigan. Using a variety of methods, this study assesses the trophic linkage between coastal wetlands and nearshore habitat to determine its importance to sportfish. Fish and invertebrate communities from both habitats were sampled at seven sites around Green Bay, Lake Michigan to assess habitat use and energy flow. At each site, water samples from coastal wetland and nearshore areas were analyzed for trace element concentrations and dissolved inorganic carbon (DIC). Results indicate that there are sufficient differences to distinguish between wetland and nearshore habitats. Trace element concentration differences indicate that otolith microchemistry can be used to estimate habitat usage throughout the life of these fish. The distinction in DIC between habitats indicates stable carbon isotope analysis of fish tissues should show wetland contribution to secondary production. Inferences about coastal wetlands and nearshore trophic linkages may be drawn following full analysis, potentially including habitat and community based predictive models. Resulting insights will be useful to streamline multi-species management objectives.

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**Title:** Use of Net Pens in Stocking Chinook Salmon into Lake Michigan

**Co-Author:** Bradley Eggold

**Abstract:** In 2013 Wisconsin legislation was changed to allow the use of net pens to rear fish in the Great Lakes and tributary rivers. A net pen is a cage made of a rigid frame and mesh material used to confine fish in a specific stream or harbor. Some Michigan DNR net pens have shown an increase in survival and imprinting of Chinook salmon (*Oncorhynchus tshawytscha*) to their stocking locations. In 2015 fishing clubs in Port Washington and Racine began using net pens, and a fishing club in Kenosha used an existing rearing station with the same guidelines as those established for net pens. Chinook fingerlings were stocked into the pens by Wisconsin DNR, and volunteers assumed the care and feeding responsibilities until the fish were released two weeks later. Wisconsin DNR will be monitoring their survival and contribution to the fishery over the next several years through coded wire tag recoveries from the fish. The presentation will highlight the successes and challenges of the first year of cooperator use of net pens.

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**Title:** TDO3, The Temperature at which Dissolved Oxygen is 3 mg/l, a Possible Metric for Assessing Coldwater Habitat Quality in Wisconsin Two-story Lakes

**Abstract:** A relatively small number of Wisconsin lakes support coldwater fisheries in their deeper waters. These so-called two-story lakes are threatened by eutrophication and climate change. However, current water quality standards, which treat water temperature and dissolved oxygen separately, do not adequately characterize coldwater habitat suitability in these lakes. A combined water temperature-dissolved oxygen metric, TDO3, the water temperature in the water column at which dissolved oxygen is 3 mg/l during the summer, has been developed for Minnesota two-story lakes. I used data from 137 two-story lakes to test the utility of this metric in Wisconsin. TDO3 values ranged from 4.6-22.1°C with a median of 9.8°C. Lakes with cisco (*Coregonus artedii*) had significantly lower TDO3 values than lakes from which cisco had been lost, although there was extensive overlap. Cisco catch per effort was also significantly negatively correlated with TDO3, but the relationship was noisy. In some lakes TDO3 values remained fairly stable within and among years, but in other lakes they varied substantially in response to seasonal and annual weather fluctuations. TDO3 appears to have promise as a measure of coldwater habitat quality, but more data are needed to develop effective standardized sampling protocols.

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**Title:** Recognizing Spatial Patterns in Young of the Year Walleye Recruitment in a Large Flowage in Northern Wisconsin; a Pilot Approach for Prioritizing Habitat Improvement Projects.

**Co-Authors:** Dan Oele, Luke Loken, Vince Buttita

**Abstract:** Understanding spatial distributions of chemical, physical, and biological components of aquatic food webs provide valuable information to lake managers. Moreover, identifying specific habitat types or particular areas within a system that function above or below management goals help to prioritize management efforts. Recently, multiple user groups expressed interest in habitat augmentation projects on the Turtle Flambeau Flowage (13,500 acre flowage in northern Wisconsin) to promote young of the year (YOY) Walleye (*Sander vitreus*) recruitment. However, each group had conflicting beliefs on the type and location of habitat projects to be implemented. To reach consensus on future habitat projects, we attempted to address: 1) Is Walleye recruitment on the Turtle-Flambeau Flowage homogenous? and 2) Does YOY walleye recruitment relate spatially to different types of physical habitat or physical limnology?

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**Title:** Electrofishing Catchability of Juvenile Muskellunge in Northern Wisconsin Lakes

**Co-Authors:** Daniel Isermann and Timothy Simonson

**Abstract:** To assess the effectiveness of muskellunge stocking, biologists conduct electrofishing surveys in fall to estimate catch per effort (CPE) and relative contribution of stocked fish. Inherent assumptions of this sampling are that wild and stocked fish have equal probability of capture and that changes in CPE reflect changes in actual abundance. However, capture rates of age-0 muskellunge tend to be low for both wild and stocked fish, making it difficult to determine if electrofishing catch is a meaningful predictor of actual abundance. The goal of our study was to determine the effectiveness of electrofishing for capturing individual age-0 muskellunge by determining locations of stocked fish released into two lakes in northern Wisconsin. All stocked fish received a fin clip and at least 40 fish per lake were inserted with radio transmitters. All fish were released at a single boat ramp on each lake, which followed standard Wisconsin Department of Natural Resources (DNR) protocols. Stocked muskellunge with transmitters were tracked weekly for one month after release. Fish were also sampled weekly using standard Wisconsin DNR electrofishing methods that included a single boat following single line transect around the shoreline of each lake. Comparing known locations of radio-tagged fish to the area sampled by the electrofishing boat revealed that most of the sampling effort was expended outside the area where stocked fish were located. Our initial results suggest that the majority of hatchery fish remained in the vicinity of the release location, with fish moving a max distance of 0.4 – 0.7 km on average away from the release location within four weeks of being stocked. Based on these results, biologists will be able to improve sampling protocols to evaluate muskellunge stocking success by stratifying sampling effort so that more time is spent sampling where the fish are located.

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**Title:** Understanding Muskellunge Growth Using PIT-tag Recapture data in Lakes in Northwestern Wisconsin

**Co-Authors:** Jeff Kampa, Gene Hatzenbeler, and Martin Jennings

**Abstract:** The use of passive integrated transponder (PIT) tags allows managers to obtain incremental length measurements for estimating fish growth for species like muskellunge *Esox masquinongy* without having to sacrifice fish to obtain traditional size at age information from hard boney structures. In Wisconsin, the majority of PIT-tagged muskellunge growth information comes from individuals of unknown age. A lack of muskellunge age information can be a major limitation when assessing certain dynamic rate functions, but fortunately managers are still able to evaluate and compare fish growth using incremental length data. The purpose of this study was to evaluate growth of PIT-tagged muskellunge and demonstrate some useful methods for evaluating muskellunge growth in the absence of age data. Growth data was derived from 476 PIT tag recapture events occurring in 14 Northwestern Wisconsin lakes during fyke net, electrofishing, and volunteer angling surveys from 2006 to 2015. We estimated relative incremental growth rates  $[(\Delta TL/TL_{Initial}) / \Delta \text{ years}]$  by sex, waterbody, and size class for each lake. We also estimated ultimate length or  $L_{Inf}$  for each population using Ford-Walford graphical methods. Female incremental growth rates showed substantial inter-lake variation at the 20-30" size class and gradually less inter-lake growth variation at the 30-40" and 40-50" size classes. Male incremental growth rates showed a similar inter-lake growth pattern at the 20-30" and 30-40" size classes, but no data were available to describe growth patterns at the 40-50" size class. Ford-Walford plots estimated female  $L_{Inf} = 44.8 \pm 1.9''$  ( $\pm 1$  SE;  $n= 80$ ) and male  $L_{Inf} = 38.4 \pm 0.8''$  ( $n=159$ ) for all lakes. Female  $L_{Inf}$  varied from 28.6-45.4" among lakes, whereas male  $L_{Inf}$  varied 36.2-40.4". Overall the ultimate lengths for female and male muskellunge were comparable to those in other Wisconsin

growth studies. Some  $L_{Inf}$  estimates for individual lakes were likely biased, due to low sample sizes and inadequate representation of fish size structure. Nonetheless, ultimate lengths revealed insights about muskellunge growth potential in Northwestern Wisconsin lakes without the sacrifice of fish to obtain unbiased age data. Additionally, information on incremental growth rates provided a more detailed perspective about the amount of growth occurring at different size classes among populations.

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**Title:** Trends in Muskellunge Fishing Tournaments in a North Central Wisconsin County

**Abstract:** Muskellunge fishing tournaments are very popular among anglers. Throughout the 1990's and early 2000's muskellunge tournaments in Lincoln County in North Central Wisconsin grew in popularity. Muskellunge tournaments in Lincoln County peaked in 2007 and have since declined. There were no muskellunge fishing tournaments in Lincoln County in 2014 and 2015 for the first time since at least 1994 when tournaments in Wisconsin first required a permit. From 1995 through 2015, 56 muskellunge tournaments were analyzed. These 56 tournaments included 3,578 anglers fishing 674 tournament hours for a combined total of over 1.5 million angler-hours. A total of 276 34-inch and larger muskellunge were registered during these tournaments. On average, it took 5,604 angler-hours for tournament anglers to register a muskellunge, which equates to 4.9 muskellunge registered per tournament or one muskie for every 13.0 tournament anglers. Average length of muskellunge registered was 39.8 inches. There was about a four-inch difference in average length of registered muskellunge between tournaments that registered fish over 34 inches (38.8" average) and those that only registered muskellunge over 40 inches (43.0"). Mean length of registered muskellunge increased over the years from about 38 inches in the early 2000's to about 39 inches in the early 2010's. From 1995 to 2013, a subset of the 40-inch and larger muskellunge registered, showed no increase in the average length. Mean length of 40-inch and larger fish registered remained stable through the years at about 43 inches. Netting surveys on both Lake Mohawksin and Rice Reservoir have indicated that the muskellunge populations have decreased, though not statistically significantly, over time from the early 2000's to the late 2000's and early 2010's. Over these same time periods, size quality has increased on both bodies of water, both in terms of netting surveys and tournament angler catches. The decrease in

population size seems not to have affected tournament angler catches as their catch rates have increased over time and both netting survey and angler catches show an increase in muskellunge size quality. One tournament which took place from 1995-2004 consisted of 2 days and 15 or 16 hours of tournament fishing. All the other tournaments were one-day events and averaged 10.0 hours of fishing over all of the 19 years studied. Trends in the number of muskellunge tournaments and average number of anglers per tournament showed an increase from 1995 to a peak in 2007 and a steady decline since 2010. Similar trends in muskellunge tournament numbers were seen at the statewide level also: a decreasing trend from 1994-99, an increasing trend from 1999-2007, and then another decreasing trend from 2007-15. Downward trends in muskellunge tournaments and tournament anglers since 2010 has occurred despite increases in tournament catch rates and the average size of registered muskellunge which may signify that "muskie angler burnout" or "muskie tournament saturation" has occurred. Continuing to follow trends in Wisconsin muskellunge tournaments may show that tournament numbers and participation may run in streaks.

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**Title:** Influence of Temperature and Flow on Recruitment of Smallmouth Bass in Southwestern Wisconsin Streams

**Co-Authors:** John Lyons, Paul Kanehl

**Abstract:** Recruitment plays a fundamental role in structuring fish populations and is influenced by many abiotic and biotic variables. Identifying the abiotic variables that influence recruitment patterns in fish populations is crucial to understanding, assessing, and managing those populations. Populations of Smallmouth Bass from seven streams in Southwest Wisconsin have been sampled intensively since 1989. Scale samples were collected and catch per effort (CPE) data was calculated during each year of the study. Beginning in 2010, crews collected water temperature and streamflow data annually. Stream temperatures and flow characteristics were assessed to determine how changes in these variables influence Smallmouth Bass populations. Regression tree analyses, using the randomForest package in the R statistical program, were used to determine the importance of stream temperature and flow variables on recruitment of age-0 Smallmouth Bass from 2010-2015. July mean temperatures explain the majority of variation in CPE of Smallmouth Bass populations from 2010-2015. Temperature may be more influential than previously thought; however, six years of data may not be sufficient to fully explain what and how environmental variables affect riverine Smallmouth Bass populations in Southwestern Wisconsin.

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**Title:** Into the Breach: Progress of the Recovery of the Fishery of Lake Delton Following Catastrophic Emptying of the Lake in June 2008

**Abstract:** Lake Delton is a 249-acre impoundment of Dell Creek in northeastern Sauk County, Wisconsin. The lake has a maximum depth of 16 feet, approximately 6 miles of shoreline, is heavily developed, and was formed by a dam built in 1927. In early June of 2008, a 500-year flood event caused Lake Delton to overtop its banks and breach the narrow strip of land lying between the lake and the Wisconsin River. A new drainage channel was formed, the lake drained completely, and the existing fishery was eliminated. The breach was repaired during the summer of 2008 and a chemical fish eradication treatment (rotenone) occurred in December 2008 to eliminate nuisance fish species from remnant puddles and the portion of Dell Creek flowing over the lake bed. The dam was closed and re-filling began in concert with the rotenone treatment. Initial re-stocking efforts commenced during the spring of 2009. Forage fish were stocked in April and May, small fingerling walleyes in June, and black crappies, bluegills, largemouth and smallmouth bass, channel catfish, and large fingerling walleyes were stocked in September and October. Walleye stockings have occurred annually through the present day. Electrofishing surveys were conducted from 2009 through 2013 to monitor the recovery of the fishery, and a comprehensive survey occurred in 2014. Gizzard shad were successfully eliminated by the chemical treatment, but common carp and yellow bass were not. Northern pike were not stocked prior to 2013, but by 2014 Lake Delton had built up an adult northern pike population of 1.3 fish/acre with good size structure (RSD-26 = 60, RSD-34 = 14). These fish were naturally produced upstream in Mirror Lake and escaped through the Mirror Lake Dam into Lake Delton. Female northern pike averaged 33.8 inches at age 5, with the largest measuring 41.1 inches. Stocking of walleyes above state-recommended rates has not produced a significant adult fishery; the population estimate in 2014

was 0.4 walleyes  $\geq$  15 inches/acre. Competition for forage has led to slow walleye growth, and escapement via the dam appears to be substantial based on tag returns from anglers. Black crappies were nearly 6.5 times more abundant in 2014 than in years prior to the breach based on electrofishing catch rates. They also grow much more slowly post-breach when compared to pre-breach survey data, and currently dominate the panfish catch. Largemouth and smallmouth bass numbers and population size structure have showed steady improvement, the fish grow relatively fast (LMB MAL14 = 4.9 years), and natural reproduction of both bass species is occurring.

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**Title:** The Utility of Genomics for Fisheries Management: Lessons from Pacific Salmon

**Abstract:** Recent advances in DNA sequencing technology have facilitated an explosion in the amount of data available to fisheries geneticists. This genomic revolution has the potential to greatly improve fisheries management. However, the integration of genomic data into management and conservation has been relatively slow. During my PhD, I worked closely with management agencies to find ways to apply genomic data to the conservation and management of Pacific salmon. Here, I will provide an overview of my PhD research and discuss how the genomic tools that I applied to Pacific salmon may be used to improve fisheries management in Wisconsin and the Great Lakes Region. I will also talk about my vision for the future of genetics-based research at the Wisconsin Cooperative Fishery Research Unit in Stevens Point.

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**Title:** Estimating Genetic Diversity Levels and Sampling Effort Required for Wisconsin's Walleye Propagation Program

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

**Abstract:** Conservation of genetic resources is a vital component of Walleye Sander vitreus management in Wisconsin. Maintaining genetic diversity is especially important within the propagation program. Due to the increase in production of extended growth fingerlings (6-8" in length) from state and private hatcheries, the Wisconsin Department of Natural Resources (WDNR) has requested assistance to better understand the genetic implications of their current propagation methods. Therefore, the objectives of our research were to (1) compare the genetic diversity within Wisconsin's feral Walleye broodstock with genetic diversity levels in other wild, naturally recruiting, Wisconsin Walleye populations; and (2) determine if levels of inbreeding, effective population size, and the probability of spawning related individuals differed between fish collected with different gears (electrofishing and fyke netting) and varying levels of sampling effort. During 2015, fin clips were collected from Walleye in two lakes throughout the spawn. Genetic diversity within the broodfish was comparable to other northern Wisconsin Walleye populations, however, results suggest that effort should be increased to obtain larger numbers of broodfish to increase diversity within progeny. Results also suggest that broodfish should be sampled over a larger portion of the spawn to capture more genetic diversity within the populations. Results from this research will be used develop a genetic broodstock management plan which includes standardized collection techniques, including both numbers and sex ratios for the broodfish, spawning and rearing techniques, and fish distribution protocols. This will ensure the WDNR is operating using the best possible management practices.

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**Title:** Genetic Heritage of Lake Trout in Lake Michigan

**Co-Authors:** Charles R. Bronte, Brian L. Sloss, Wendylee Stott, S. Dale Hanson

**Abstract:** Lake Trout (*Salvelinus namaycush*) restoration efforts in the Great Lakes have relied on the propagation and stocking of various strains of Lake Trout. Lake Trout are successfully reproducing and recruiting in Lake Michigan at low levels suggesting continued progress toward restoration goals. Previously stocked Lake Trout primarily contribute to the observed natural recruitment, and determining which strains have been successful will help guide future stocking efforts. Eight hatchery strains are potentially contributing to the observed Lake Michigan Lake Trout recruitment: Seneca Lake, Lewis Lake, Green Lake, Marquette, Apostle Island, Isle Royale, Klondike Reef, and Parry Sound. Our objectives were to 1) identify a subset of previously developed microsatellite markers that reliably delineate strain of origin for the eight Lake Trout strains stocked into Lake Michigan, and 2) determine if the same subset of genetic markers and reference data are capable of diagnosing the genetic heritage of interstrain crosses. A total of fifty previously developed microsatellite loci were used to genotype approximately 350 Lake Trout from five reference strains to date. Thirty of the fifty loci with the largest global  $F_{st}$  values were found to reliably delineate each strain with Bayesian admixture analysis using the program STRUCTURE. For each of the 5 pure parental strains and all possible combinations of F1 interstrain crosses (e.g., Seneca Lake x Lewis Lake; 15 total crosses), 1,000 individuals were simulated using the program HybridLab ( $N = 15,000$  simulated individuals). Tests of accuracy and precision will be discussed on the correct classification of all simulated pure and F1 interstrain crosses assessed with mixed stock analysis using the programs ONCOR and STRUCTURE. These reference data will be used to assess genetic heritage of wild caught Lake Michigan Lake Trout sampled

from 2003-2014 to evaluate the reproductive success of the Lake Trout strains used for restoration.

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**Title:** Walleye Stock Characteristics in Green Bay

**Co-Author:** Steven Hogler

**Abstract:** Green Bay supports one of the most prominent recreational fisheries for walleyes in North America. Management of this fishery is complicated, because walleyes spawn in many locations and the fishery contributions of these different locations are not known at this time. Furthermore, it is not known whether these stocks are discrete or if they differ in relation to stock dynamics and demographics. Our objective was to determine if growth, age structure and fecundity varied among walleyes collected during 2015 spawning runs on the Peshtigo, Oconto, Fox, and Menominee Rivers. Walleyes were collected by electrofishing, measured (total length; TL) and dorsal spines were removed for age estimation. Subsamples of fish (N = 50) were also sacrificed for otoliths and fecundity estimation. Our work is part of an ongoing, collaborative effort to learn more about the walleye fishery in Green Bay.

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**Title:** Wisconsin Department of Natural Resources' Response Framework for Invasive Species

**Abstract:** In 2015 the Wisconsin Department of Natural Resources' Department Invasive Species Team (DIST) developed a new framework to aid resource managers responsible for responding to newly discovered populations of invasive species across the state. This framework was adapted from the department's "Rapid Response Framework for Aquatic Invasive Species" to apply to terrestrial, wetland, and aquatic species, and gives department staff directions for responding in a thorough, professional, and effective manner to the many challenges that result from new invasions. This talk will give participants an overview of the response procedures discussed in the new framework, and discuss how department and partner staff members are utilizing these procedures to guide the current round goby response efforts in the Lake Winnebago system.

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**Title:** Improving Wisconsin's Aquatic Invasive Species Monitoring Strategy  
**Co-Authors:** Alex Latzka, Scott Van Egeren, Catherine Hein, Michael Shupryt

**Abstract:** The Wisconsin Department of Natural Resources (DNR) aquatic invasive species (AIS) monitoring program recently completed a 5-year project to collect baseline data and evaluate the rate of AIS spread within the state. We also completed a pilot projects on 100 streams throughout the Lake Michigan basin to help inform site selection for early detection AIS monitoring on streams. Results from these projects on lakes and streams will inform the AIS monitoring strategy with the aim of improving early detection enabling early responses.

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**Title:** Preventing Alien Invasions: Wisconsin's Invasive Species Law Updates

**Abstract:** The State of Wisconsin revised its invasive species identification, classification, and control rule (chapter NR 40, Wis. Admin. Code) in 2015, following a three-year effort that involved numerous stakeholders and affected industries. First enacted in 2009, the law seeks to prevent ecological and economic impacts associated with invasive species by prohibiting and restricting the introduction, possession, transfer, and transport of certain plants and animals. The intent is to provide a comprehensive, science-based system that prevents invasive species from becoming established in Wisconsin and prevents already-established species from spreading within the state. Significant changes to the law include: delisting two species, listing 49 new prohibited and 32 new restricted species, split-listing (prohibited/restricted) two species, changing the regulated status of five species, and creating a phase-out period for restricted plants to minimize impacts to the nursery industry and facilitate compliance. Other changes clarify rule language and streamline implementation. The Department of Natural Resources can authorize transport, possession, and transfer of regulated species through permits in certain situations. A summary of permitting activity under the law will be provided. The law also requires certain preventative measures. The fisheries management community can help implement this law in a variety of ways. What one needs to do varies depending on the type of work and activities. Resources for complying with ch. NR 40 will be provided.

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**Title:** Zooplankton Response to Asian Carp Harvesting in Illinois River Backwaters

**Co-Author:** Andy Casper

**Abstract:** Since Asian carp (*Hypophthalmichthys nobilis* and *Hypophthalmichthys molitrix*) have arrived in the Illinois River, they appear to have a major negative impact on zooplankton. In an effort to protect the Great Lakes by keeping the Asian carp population low and thus to reduce the pressure on the electric barrier, the Illinois DNR has contracted ten commercial fishing crews to conduct regular Asian carp removals. The objectives of this study are to understand the zooplankton ecological response to the reduction of Asian carp and thus determine the effectiveness of Asian carp harvesting for ecosystem recovery. The fishing crews harvested bimonthly at select backwaters of the upper reaches of the Illinois River. The hypothesis is that zooplankton, a major food source for Asian carp and other fish, may respond positively to the harvesting. Although zooplankton have recovered from other types of disturbances in different ecosystems, it is not known how zooplankton might respond to planktivore harvesting in a large river system. Zooplankton samples were collected over four months at ten backwaters during the summer of 2015. The macrozooplankton community was primarily copepod nauplii followed by cladocerans and copepods. I will compare the zooplankton community structure between a spectrum of Illinois River backwaters with harvesting of Asian carp at different frequencies and intensities.

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**Title:** Biological Aspects of the 316b Rule

**Abstract:** The 316b Rule requires a quantification of impingement and entrainment losses. The WDNR will play a major role in reviewing these studies. In this paper, I will describe how these studies should be conducted and what the Rule does and does not require. I will also describe selected problematic issues associated with the Rule. Some of these include the timing, duration, and intensity of entrainment sampling; problems caused by the level of taxonomic resolution available for ichthyoplankton; "fragile" species; entrainment survival; mussels; and establishment of the size of the at-risk population. I will use data and examples from two plants we are studying on the Mississippi R near La Crosse to illustrate these points.

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**Title:** The Up's and Down's of Water Level Management on the Chippewa Flowage

**Abstract:** The Chippewa Flowage is a 15,000 acre impoundment of the Chippewa River located in Sawyer County that was filled in 1920. As a storage reservoir for hydroelectric power generation the Chippewa Flowage experiences widely fluctuating water level conditions, particularly through winter. Recently, drought conditions changed water level management and concurrent declines in walleye recruitment were observed. These changes prompted interest in studying historical trends in walleye recruitment compared to water level management schemes and elicited interest in designing overwinter drawdowns that would optimize walleye recruitment success. Analyses of past water level management revealed a positive trend between maximum winter drawdown depth and walleye recruitment on the Chippewa Flowage. However, that pattern was confounded by several other variables. Further analyses were completed for similar reservoirs including the Turtle-Flambeau Flowage and Lake Wissota which produced mixed results. Planned overwinter drawdowns on the Chippewa Flowage in 2013 and 2014 similarly produced mixed results and highlight the nuances of managing water levels to optimize components of the fishery.

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**Title:** Predator/Prey Ratio Analysis for Chinook Salmon and Alewife in Lake Michigan

**Co-Authors:** Clark, R., B. Breidert, C. Bronte, R. Claramunt, J. Dettmers, B. Dickinson, R. Elliott, M. Holey, M. Jones, M. Kornis, C. Madenjian, S. Robillard, M. Tonello, I.Tsehaye, D.Warner, M.Williams, G.Wright

**Abstract:** The predator/prey ratio analysis for Chinook salmon and alewife in Lake Michigan is a recently developed approach to summarize lake-wide data, evaluate predator/prey balance, and provide guidance for fisheries management decisions. This ratio is derived by dividing total lake-wide biomass of Chinook salmon by total lake-wide biomass of alewives. The ratio is fairly simple to interpret (i.e., a high ratio indicates too many predators with insufficient prey; a low ratio indicates too few predators with surplus prey), while underlying methods are comprehensive and use statistical catch at age models that incorporate datasets from several agencies. Lake Michigan's Chinook salmon/alewife ratio reached an all-time high in 2013, which strongly indicates an unbalanced ecosystem (i.e., insufficient prey), corresponds with other lake-wide observations (i.e., low Chinook salmon body weights), and supports management actions implemented in 2013 to reduce Chinook salmon stocking lake-wide by 50%. The predator/prey ratio analysis is a new and focused approach to evaluate balance between a dominant top predator (Chinook salmon) and its primary prey (alewife), will provide guidance for future stocking decisions, and should help achieve overall management goals of a balanced and diverse fishery within Lake Michigan's complex and dynamic ecosystem.

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**Title:** Stocking 'Wild' Brook Trout: Does Filial Generation Matter?

**Abstract:** The Wisconsin DNR's 'wild' trout stocking program was designed to produce and stock trout derived from eggs of wild parentage. Previous studies have shown these first filial generation (F1) trout to exhibit survival rates 2-4 times greater than trout derived from domestic broodstock. Program constraints eventually led to the production of second filial generation (F2) trout to supplement F1 trout production. I used annual paired stockings of about 500 F1 and 500 F2 Brook Trout *Salvelinus fontinalis* in Tenny Spring Creek, Wisconsin, in 2011-2013 to evaluate the effect of filial generation on apparent survival and growth. Filial generation and cohort were identified by fin clips at the time of stocking, and recaptured trout were tagged with PIT tags to generate capture histories for survival analyses in program MARK. Model analyses indicated apparent survival rates 2-3 times greater for F1 versus F2 Brook Trout in the first year following release and no significant difference in apparent survival thereafter. There was also a cohort effect with progressively lower apparent survival rates in successive years of stocking. Model analyses also indicated significantly greater apparent survival rates for wild Brook Trout, which progressively increased in numbers over the course of the study. There were no significant differences in growth of F1 versus F2 Brook Trout. These results suggest F1 and F2 Brook Trout should not be treated as equivalents in regards to management expectations of post-stocking survival in streams.

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**Title:** Prioritizing Brook Trout Habitat Restoration in the Lake Superior Basin

**Co-Authors:** Jason Ross, Michele Wheeler, Paul Piszczek, Mark Brouder, and Anna Varian

**Abstract:** Recent models of future stream water temperature in Wisconsin are reason for concern for brook trout populations in the state. The abundance and distribution of brook trout in tributaries to Lake Superior is already greatly reduced. Through efforts by the Wisconsin Lake Superior Landscape Restoration Partnership brook trout team, we developed criteria to rank and prioritize brook trout restoration efforts in subwatersheds (HUC 12 level) in the Lake Superior basin of Wisconsin. Our criteria include climate change projections of future stream temperature status, brook trout management priorities by the State, Tribes, and Lake Superior fishery management agencies, watershed association involvement, and a recently completed evaluation of brook trout population status and distribution. We ranked each of the 105 subwatersheds in the basin based on our criteria to help agencies prioritize brook trout conservation and restoration areas. Focusing restoration in priority areas with considerations of future changes in climate is integral to the sustainability of brook trout and other cold water fish species.

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**Title:** Natural Recruitment Assessment of Class 2 Trout Streams: Mill Creek System

**Co-Author:** Gene Van Dyck

**Abstract:** There have been large increases in the abundance of brown trout *Salmo trutta* in Wisconsin in the past 50 years. Several changes may have led to these increases including: improvement in agricultural practices and land use, stream habitat improvements, wild trout propagation, fishing regulations, and angler attitudes. This study used a modification of Wisconsin DNR baseline monitoring rotation schedule to evaluate the current trout stream classification of Class 2 streams in the Mill Creek watershed, Richland County, and the need for supplemental stocking. The baseline monitoring schedule was adjusted so that all 6 year rotation streams were grouped by watershed. Three year and 12 year streams were also aligned with the 6 year rotation. This allowed for the suspension of all supplemental stocking of Class 2 streams within the watershed the year prior to evaluation. We assumed that any yearling fish sampled in the following year must be the result of natural recruitment. A total of 35 sites on 14 streams were sampled between June 17 and August 20 in 2013. Levels of natural recruitment, as measured by abundance of yearling trout, and levels of natural reproduction as measured by abundance of young of the year trout were assessed. Many of the Class 2 locations showed higher recruitment than Class 1 locations. However several of these sites also had no evidence of natural reproduction. Two streams showed low recruitment and reproduction but did have above average adult abundance. One stream had high reproduction, but no yearlings or adults. We discuss these results and the implications for modifying trout stream classifications and modification of baseline rotation sampling to answer targeted management questions.

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**Title:** Comparison of Lake Sturgeon Growth Rates Estimated from Fin Rays and Mark-recapture

**Co-Authors:** Janice Kerns, Daniel Isermann, Mike Donofrio, Ed Baker

**Abstract:** Pectoral fin rays are commonly used as a non-lethal method for estimating age of lake sturgeon *Acipenser fulvescens*. While fin rays generally underestimate age of older lake sturgeon, fin rays could provide useful estimates of growth rate for younger fish within a population. Our objective was to determine if lake sturgeon growth rates estimated from fin rays were similar to growth rates observed from recaptures of lake sturgeon tagged with passive integrated transponders (PITs). Lake sturgeon were sampled in 2012-2013 via electrofishing on the Menominee River, where the Wisconsin and Michigan Departments of Natural Resources maintain a long-term PIT tagging program. Parameters from a von Bertalanffy growth model were used to describe growth rates estimated from fin rays (range of fin ray ages = 4 to 34). For recaptured fish, growth rates were quantified as change in length during time at large. Preliminary results suggest growth rates estimated from fin rays (mean = 1.18 in/yr) are substantially higher than rates observed from PIT tag recoveries (mean = 0.47 in/yr). This difference is consistent with underestimating lake sturgeon age from fin rays. Differences in growth rates between the two methods were inversely related to lake sturgeon total length, suggesting that fin ray growth estimates were more reliable for larger ( $\geq 50$  in), older lake sturgeon, only because these fish were growing very slowly. Fin rays are probably not useful for estimating growth rates of lake sturgeon and we suggest that continued use of mark-recapture with PITs offers the best method for describing growth and survival in most lake sturgeon populations.

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**Title:** Effects of 2, 4-D Herbicide Treatments Used to Control Eurasian Watermilfoil on Fish and Zooplankton in Northern Wisconsin Lakes

**Co-Authors:** Dr. Daniel Isermann, Dr. Justin VanDeHey

**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 or eradicate EWM and have been used in Wisconsin since the 1950'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, three lakes will serve as reference systems, while three lakes will receive 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.

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**Title:** A Portfolio of Wisconsin's Northern Pike Fishery

**Co-Authors:** Paul Cunningham, Zach Lawson, Andrew Rypel, and the Northern Pike Team

**Abstract:** Natural resource professionals rely heavily upon fishery demographics such as age, growth, density, and size-structure metrics to manage populations. In Wisconsin, this information is often collected at the county level with priority given to individual lakes with highly desirable Walleye and Muskellunge populations. Though Northern Pike are often considered secondary fisheries, their ecological importance and angler's desire to catch them make them an important component of Wisconsin's sportfish portfolio. However, summarization of key fishery demographics for Northern Pike has been relatively slow. Enhanced information about the range of fishery opportunities (consumptive vs trophy waters) would allow management and marketing of Wisconsin's pike fishery at broader spatial scales and could be tailored to a variety of needs including helping anglers decide where to fish or aiding in regulatory decisions. We've summarized nearly every Northern Pike entered into the Fisheries Management Database in the last twenty years using R and organized these data at multiple spatial scales ranging from individual lakes to ecoregion in Arcmap. We present preliminary results for average size expectation and maximum size potential for each lake in the state and demonstrate the utility of this approach for a subset of counties as examples.

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**Title:** Modified von Bertalanffy Growth Function to Estimate Age to Reach a Critical Length

**Co-Authors:** Daniel A. Isermann

**Abstract:** Critical points in a fish's life (e.g., age at maturity or recruitment to fishery) are often defined for management purposes. Understanding the time required for a fish to reach these critical points ( $t_r$ ) is important, as this time is directly related to growth rates and cumulative mortality. Consequently, estimates of  $t_r$  are vital parameters in yield-per-recruit and dynamic pool models. Values of  $t_r$  that are based on defining a critical length ( $L_r$ ; e.g., mean length at recruitment) are often estimated by fitting a traditional von Bertalanffy growth function (VBGF) to estimate  $L_\infty$ ,  $K$ , and  $t_0$ , and then solving for  $t_r$  (i.e., age) for a specified value of  $L_r$ . While this method produces a valid point estimate of  $t_r$ , interval estimates and statistical comparisons of  $t_r$  among groups cannot be directly obtained. We derive a simple modification of the VBGF that produces a direct estimate of  $t_r$ , while still providing direct estimates of  $L_\infty$  and  $K$ . We demonstrate the utility of this new function by fitting the function to length and age data observed for Lake Whitefish (*Coregonus clupeaformis*) sampled from two locations in Lake Michigan. We recommend using this modified VBGF because it can be simply adjusted to directly estimate values of  $t_r$ ,  $t_0$  or  $L_r$  (if  $t_r$  is specified).

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**Title:** Spatial Variation in Mercury Contamination of White Suckers: Source Tracking and Pathological Implications

**Co-Authors:** Dr. Peter McIntyre, Dr. James Hurley, Dr Joel Hoffman, Dr. Vicki Blazer, Dr. Evan Childress, Dr. David Krabbenhoft, Dr. Runsheng Yin, Ryan Lepak, Dan Oele, Ellen Hamann

**Abstract:** White suckers (*Catostomus commersonii*) are widespread, long-lived fish that are targeted in subsistence fisheries and used as sentinels of pollution impacts on the Great Lakes. We surveyed tissue mercury concentrations in white suckers across 12 sites in Lake Michigan and one from Lake Superior, and analyzed tumor incidence from five of them to assess the pathological implications of heavy metal pollution. Mercury concentrations and tumor incidence varied substantially both within and between fish populations. To understand the basis for the observed variation in mercury concentration, we used mercury stable isotopes to differentiate among watershed and industrial inputs of mercury into Lake Michigan. Initial results show differences in mercury signatures of fish residing near similar watersheds and an effect of tumor presence on mercury concentrations. Our work suggest that spatial surveys of both concentrations and isotopes of mercury are important for designing effective control strategies, and may also elucidate the basis for fish pathologies and other ecosystem consequences of contamination.

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**Title:** Environmental Drivers of Black Bass Abundance and Growth: a Proposed Classification System

**Co-Author:** Jonathan Hansen

**Abstract:** Understanding environmental drivers of fish community composition and abundance of key species is a central goal of fisheries ecology and management. We developed statistical models to predict relative abundance and growth of largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieu*) bass in Wisconsin lakes from lake-specific environmental conditions. Water growing degree days derived from a thermodynamic simulation model of water temperatures was the strongest predictor of both species; largemouth abundance was higher in warm lakes and smallmouth abundance was higher in cool lakes. Additional predictors included landscape position, lake area, maximum depth (smallmouth only), and Secchi depth (largemouth only). Non-linear threshold responses between predictors and the abundance of both species suggested that lakes could be classified into discrete categories. We generated a classification system for each bass species by splitting each predictor at threshold values (i.e., where “high” vs. “low” relative abundance was predicted) and examining all possible combinations of the resulting binary classes. We collapsed classes where no biologically significant differences in abundance or growth were observed. We propose six lake classes for largemouth bass and five for smallmouth bass and present normal ranges of relative abundance and growth rates for each. This system of classification can be used to set expectations and regulations specific to lake class and management goal. Based on projected changes in growing degree days, we present expected future changes in lake class membership. By quantifying current and future expected fisheries potential of individual lakes, management can be designed to protect resilient systems and adjust expectations and goals in places where fish community changes are likely.

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**Title:** Upper Mississippi River Restoration: Bluegill and largemouth bass response over the past 25 years to habitat restoration at Bertom and McCartney Lakes.

**Co-Authors:** Dave Heath and Pat Short

**Abstract:** While many water resources provide a multitude of uses, few have been officially recognized by congress as both a nationally significant navigation system and nationally significant ecosystem. The Upper Mississippi River (UMR) received this designation with authorization of the Environmental Management Program (EMP) in WRDA 1986. EMP, now referred to as UMR Restoration (UMRR), is a partnership program where multiple river management agencies are involved in project identification, selection, design, implementation, project assessment and systemic monitoring of the ecosystem's health. The most visible results of the UMRR are the 55 large scale Habitat Rehabilitation and Enhancement Projects (HREPs) affecting over 100,000 acres of floodplain habitat on the Mississippi and Illinois Rivers. One of Wisconsin's first HREPs is located downstream of Cassville, Wisconsin. The Bertom McCartney HREP, completed in 1991, was designed to restore centrarchid backwater over-wintering habitat primarily through the dredging of over 300,000 cubic yards of sediment from 7 backwater pockets. Post project monitoring shows a significant increase in CPUE of age 1+ bluegill and largemouth bass within the project area. However, the response in individual backwater pockets were not uniform. Dredged areas most protected by flow showed the most significant increases in CPUE, while pockets occasionally subjected to flows did not show consistent populations of target species. This lack of response is likely due to cold water flows (< 1 deg. C) entering into the pockets during years when Mississippi River flows are above average, which potentially affect survival of YOY and adult target species.

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**Title:** Exploitation and Population Size of Black Crappie in Lake Dubay  
**Co-Author:** Jake Thompson

**Abstract:** We calculated angler exploitation rates and population size for black crappie in Lake Dubay, Portage County, Wisconsin. Black crappie  $\geq$  228mm were tagged with Floy FD-68B tags during the period April 21 to 29, 2014. Exploitation rate was estimated using angler tag returns from May 1, 2014 to April 30, 2015. Tag and recapture during the survey period were used to estimate the population size. A subsample of otoliths was used to determine black crappie growth and develop a catch curve used to estimate population parameters. Annual exploitation was estimated between 0.20 to 0.23 after adjustments for tagging mortality and non-reporting. This study provided information on fish movement as well, which allowed us to characterize and evaluate various segments of the fishery.