Wisconsin Chapter of the American Fisheries Society
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Oral Presentation Abstracts

Keynote Address: Making a difference for your fish and for your publics

Ron Bruch

I was very fortunate to work in the WI DNR Fisheries Management program for 38 years, and also fortunate to have been able to work at literally every level in the program from LTE to Technician to Biologist to Supervisor to Section Chief to Bureau Chief. Although I worked primarily in the eastern half of the state for most of my career, I was able to work statewide in my roles as Section Chief and Bureau Chief, in addition to chairing several statewide Fisheries Work Groups, such as the Sturgeon Team, the Fish Age Task Group, and the Fisheries Outreach Working Group. My keynote remarks will focus on two main areas that I suggest all fisheries professionals in the state are, or should be, dialed in to: 1) professionalism at whatever level you are at or aspire to be at in your career; and 2) The importance of effectively and sincerely working with your "publics" whoever they are.

Fish passage made easier - Working with local units of government to create fish friendly road crossings

Presenting author: Scott Toshner

WI DNR works with local units of government (LUGS) to provide funding, technical and logistical support to restore fish passage on trout streams in Douglas and Bayfield County WI. To date over the past 4 years fish passage has been restored at eight road crossings. Experiences gained in working with Townships and Counties as well as interagency regulatory, legal and finance programs will be shared along with some insights on what success can look like.

Using fin clips to assess brook trout movement through culverts and natural barriers

Presenting author: Nick Brendt

Within the boundaries of the Chequamegon Nicolet National Forest there are 509 road stream crossings across 1400 miles of classified trout streams. Manmade barriers such as failing and perched culverts at some of these crossings can impede fish movement. In addition, natural barriers such as steep plunge pools, waterfalls, and beaver dams can contribute to restricted fish movement. However, opinions vary regarding the size and height of barriers brook trout can successfully navigate. I found little information on brook trout swimming performance in small northern Wisconsin streams as it relates to culvert and natural barrier passage. What barriers can brook trout actually overcome in a small stream? Do brook trout bother to move past these barriers, or can they live successfully with barriers present? Understanding the physical limitations of brook trout can provide insight as to how trout move within a specific stream reach, and can help prioritize culvert replacement on National Forest lands. I tested a quick and low budget means to track brook trout on a small stream to evaluate culvert and natural barrier passage. In August 2019, 357 brook trout from Barney (Archibald) Creek (NW Oconto County) were measured and fin clipped above and below a 3” perched culvert on FS road 2123. The study area was broken into 5 reaches, all of which started and ended at a natural barrier or culvert. Each brook trout was given a reach specific fin clip and was allowed to mix freely for two months prior to recapture. During the October 2019 recapture run, 355 brook trout were sampled and examined for fin clips. In total, we recaptured 11.9% of the clipped brook trout, and found that 68.2% of recaptures stayed within their original clipped reach. Of those recaptured brook trout, 19.9% moved to a different reach past a natural rock plunge, and 11.9% moved through the 3” perched culvert (4.7% upstream, 7.2% downstream). Trout size varied between reaches, giving insight to habitat requirements for large and small trout, with larger trout making more upstream movements. These findings highlight that brook trout in Barney Creek may not need to move much during the late summer to fall if certain habitat requirements are met, and more movement was recorded past natural barriers than a failing perched culvert.

Impact of beaver dams on salmonid populations in Driftless Area and South Shore, WI streams

Presenting author: Kirk Olson
Co-authors: Paul Piszczek

Though few studies have directly evaluated the impact of beaver dams on salmonids in Wisconsin, beaver dams have long been thought to be detrimental to salmonids in the state. One study completed in northeastern Wisconsin found improvements in brook trout density following the removal of beaver dams. In contrast, an expanding body of research from the western US indicates that beaver dams may benefit salmonid populations. We evaluated the impact of beaver dams on salmonids in four Driftless

Area and South Shore, WI streams by comparing populations and movements between free-flowing and beaver impounded reaches. Total salmonid biomass was significantly higher in beaver impoundments. In streams where brook trout were common (n = 3), this difference was primarily the result of greater age I and older brook trout biomass. In a Driftless Area stream, where brook trout were rare (<2% of salmonids by number), the difference was due to greater age I and older brown trout biomass. Salmonid densities were not significantly different between free-flowing and impounded reaches. However, young of the year densities were consistently lower and age I and older brook trout densities were consistently greater in beaver impoundments. In three streams where beaver dam passage was evaluated, we documented passage by all salmonid species in upstream and downstream directions. In two streams, where mark-displacement passage evaluations were completed (n=2), passage over beaver dams in the upstream direction was not significantly different than passage through free-flowing reaches. Beaver impoundments in our study were relatively young (1-2 years old). Observations and aerial photos from one Driftless stream indicated that locations and sizes of beaver dams changed frequently in the absence of active beaver management. Our results suggest that, in some streams, beaver dams may have a positive impact on salmonid populations. These findings also highlight the importance of on-going research examining the impact of beaver dams on salmonid populations statewide.

Coarse woody habitat effects on sport fish behavior

Presenting author: Quinnlan Smith
Co-authors: Gregory Sass and Thomas Hrabik

Coarse woody habitat (CWH) additions have increased in popularity in Midwestern United States lakes, however many of these recent additions have not been treated as deliberate experiments to examine long-term fisheries responses. Past CWH removal studies have shown reduction in fish growth rates, declines in forage fish abundance, and behavioral changes, while short term CWH addition studies have shown improved reproductive output of certain fish species, increased availability and diversity of fish prey, and changes in behavior and habitat use. A long term CWH addition on the undeveloped Sanford Lake in northern Wisconsin began in 2017, with the first results of the experiment aimed at exploring CWH effects on muskellunge (Esox masquinongy), walleye (Sander vitreus), and smallmouth bass (Micropterus dolomieu) behavioral changes. Radio telemetry data from pre-manipulation (2017), and post-manipulation (2018 and 2019) was used to construct a yearly bounded kernel density home range estimate for each species as well as a multi-state lake exchange model to estimate yearly movement changes within the lake. Over the course of the three years, average home ranges significantly increased. Further analysis revealed that season, year, and individual fish species all contributed to the significant home range differences. The multi-state lake model exchange rates between the CWH shoreline, non-CWH shoreline, and offshore zone differed from 2017 to 2018-2019. Fish were modeled to remain in the offshore region of the lake more often during the 2018-2019 seasons, as well as having lower exchange rates from the offshore region to the CWH shoreline in 2018-2019. Results from the first part of this study highlight the importance of considerations with CWH additions to undeveloped systems and potential effects on sport fish behavior with regards to areas where CWH was added.

Competition for pelagic niche space: reintroducing native cisco to control invasive rainbow smelt

Presenting author: Joseph Mrnak
Co-authors: Jake Vander Zanden, Noah R. Lottig, and Greg G. Sass

Invasive rainbow smelt Osmerus mordax negatively affect ecosystems that they colonize, primarily through competitive and predatory interactions with native species. Negative effects include shifting food

webs, altering zooplankton communities, and the decline or extirpation of native cool- and cold-water fishes (e.g., yellow perch Perca flavescens, walleye Sander vitreus, cisco Coregonus artedi). Rainbow smelt invaded Crystal and Sparkling lakes (Vilas County, WI) during the 1980s and quickly became the dominate pelagic forage fish. Despite several eradication efforts, rainbow smelt have remained a component of these food webs. However, current rainbow smelt stock sizes are near all-time lows according to LTER monitoring. This provides an opportunity for whole-lake biomanipulations to shift native species composition back to its non-invaded state, with the potential to limit the negative effects of rainbow smelt and increase ecosystem resilience. We plan to stock cisco into Crystal (yellow perch, cisco vs. rainbow smelt; competition) and Sparkling lakes (yellow perch, walleye, cisco vs. rainbow smelt; competition/predation) to test for the potential to control and(or) eradicate this invasive species. We hypothesize that these biomanipulations will lead to depensatory effects whereby the rainbow smelt stock size will be insufficient to negatively affect the native food web. We plan to conduct these biomanipulations during Fall of 2020.

Cisco body morphology, relative weight redundancy, and oxythermal habitat relationships in Wisconsin inland lakes

Presenting author: Tim Parks
Co-authors: James Church, John Lyons, Dan Isermann, Greg Sass, Jeffrey Kampa, and Martin Jennings

Cisco (Coregonus artedi) exhibit substantial variation in body morphology across populations in North America. Understanding cisco body morphology is important, since their form may be a symptom of environmental conditions and possibly used as an indicator of habitat suitability. We used standard geometric morphometric techniques to assess cisco body shape variation of 17 lake populations in Wisconsin during 2013. We then evaluated body form associations with environmental factors and cisco relative weight. Principle components and cluster analysis revealed lake-specific forms varying from deep- to narrow-bodied cisco morphotypes. Cisco morphotypes strongly corresponded to water temperature at which dissolved oxygen reached 6 mg/L in a vertical profile (TDO6). TDO6 was positively associated with the deeper-bodied morphs, indicating that the deeper-bodied morphs were associated with poorer quality oxythermal habitat. Furthermore, cisco relative weight was highly redundant with body form variation. Our results provide insight about the use of cisco morphotypes as indicators of coldwater habitat quality and the alternative use of relative weight to characterize cisco morphotypes.

Piscivore stocking alters a historic trophic cascade

Presenting author: Ben Martin
Co-authors: Jake Walsh, Jake Vander Zanden

Trophic cascades can occur both naturally and through supplemental management actions (i.e. stocking). In analyzing almost 40 years of water clarity, zooplankton, and fish data from Trout Lake in Vilas County, Wisconsin, we've found that recent lake trout stocking created an alternate trophic cascade state. The lake's cascade history can be broken into three periods 1) cisco dominated 2) lake trout dominated and 3) spiny water flea disruption. The cisco dominated cascade occurred from 1981-2006 where the lake's pelagic food web had lower lake trout and daphnia abundances, and higher cisco and phytoplankton abundances. The lake trout dominated period of 2007-2014 had higher lake trout and daphnia abundances, and lower cisco and phytoplankton abundance. However, the lake's pelagic food web has since been disrupted by the invasion of spiny water flea in 2014 and they have recently risen to significant abundances. According to other studies, cisco undergo an ontogenetic shift in diet in the

presence of spiny water flea, where they transition from daphnia to spiny water flea around 200-250mm. During the cisco dominated periods, cisco average (182mm) and interquartile range (51mm) was smaller than that of the average (209mm) and interquartile range (84mm) of cisco lengths during the lake trout dominated period. Therefore, a cascade state dominated by cisco would have especially high predation on daphnia from both cisco and spiny water flea, whereas a lake trout dominated cascade would have less predation pressure on daphnia and more predation on spiny water flea from larger cisco. Bearing in mind how the cascade state influences cisco size structure could be important to managing the lake in its novel state.

Fish community response to whole-lake Centrarchidae removal in a north temperate lake

Presenting author: Holly Embke
Co-authors: Stephen Carpenter, Daniel Isermann, Alyssa Andersen, Giancarlo Coppola, Jake Vander Zanden

Centarchidae spp., a warm-adapted group of fishes including basses and sunfishes, has increased in recent decades in Wisconsin. Concurrently, declines in cool-adapted species, including Walleye (Sander vitreus), have occurred but the cause is not understood. Multiple factors have been associated with these declines, including rising lake temperatures, habitat degradation, harvest, and species interactions. To quantify the role that competition and/or predation between increasing centrarchids and the rest of the fish community plays, we are conducting a whole-lake experiment to remove centrarchids from an experimental lake in northern Wisconsin while measuring the response of all other fish species. In 2018 and 2019, ~200,000 centrarchid individuals were removed, while species-specific length-at-catch and catch-per-unit-effort (CPUE) were measured. Yellow Perch size-at-catch and CPUE have increased, while the response of other species has been varied. Some previously high abundance species, including Bluegill and Pumpkinseed, have experienced relatively no change, emphasizing the resilience of this taxa. We will continue removing centrarchids in 2020 and monitoring these populations. This information will be used to inform an understanding of the conditions necessary to support self-sustaining fish populations given global environmental change.

Effects of bullhead removals in four northern Wisconsin lakes

Presenting author: Logan Sikora
Co-authors: Justin VanDeHey, Gregory Sass, Gregory Matzke, and Michael Preul

Bullheads Ameiurus spp. are found throughout much of the United States and are an understudied species. Although limited information has been published on Black A. melas and Yellow Bullheads A. natalis, it has been shown that Bullheads can dominate the biomass in some north temperate lakes resulting in predominantly warm water fish communities. Recently, recruitment and abundances of coolwater species such as Walleye Sander vitreus and Yellow Perch Perca flavescens have been declining in some northern Wisconsin lakes. These declines, coupled with high Bullhead densities, led fisheries biologists from the Wisconsin Department of Natural Resources and the Mole Lake Band of Lake Superior Chippewa to conduct Bullhead removals on four northern Wisconsin lakes. Removal of Black and Yellow Bullheads from these lakes resulted in substantial changes in the fish community. Naturally reproduced age-0 Walleye relative abundance increased in Lake Metonga and Patten Lake following the removal of Bullheads. Additionally, survival of stocked Walleye increased in Crane and Pickerel lakes following Bullhead removals resulting in higher relative abundance of age-0 and age-1 walleye. Subsequently, adult Walleye abundance has increased or at least remained steady in all study lakes. Significant declines in Bluegill Lepomis macrochirus and increases in Yellow Perch and Black Crappie

Pomoxis nigromaculatus were also observed following Bullhead removals further illustrating a shift from warm to coolwater dominated fish communities. Our observations suggest that removal of Bullheads from high density populations can increase recruitment and abundance of sport fishes and change fish community composition.

Developing a dual-purpose GTseq panel for stock discrimination and parentage analysis in walleye

Presenting author: Kristen Gruenthal
Co-authors: Wesley Larson, Matt Bootsma, Loren Miller, and Greg Sass

Previous genetic research on walleye has provided important information that has been used to manage this iconic species. However, currently available tools (e.g. microsatellites) do not provide high power for parentage or stock discrimination. Here, we leveraged RADseq to identify high-resolution markers and designed a GTseq panel incorporating 600 of these markers. This new panel represents a valuable resource for future walleye studies, and we will discuss current and potential future applications for the panel. Additionally, we will discuss our refined understanding of patterns of population structure and conservation units in walleye that was facilitated through the panel development process.

Assessing abundance of centrarchids and juvenile yellow perch in northern Wisconsin lakes with different walleye recruitment histories

Presenting author: Ethan Brandt
Co-authors: Daniel A. Isermann and Daniel J. Dembkowski

Walleye recruitment has declined in many northern Wisconsin lakes that historically supported natural recruitment. As Walleye recruitment has declined, adult Largemouth Bass abundance has increased. Possibly, increased abundance of adult Largemouth Bass also indicates that abundance of all centrarchids has increased, but standard sampling gears used by the Wisconsin Department of Natural Resources do not effectively sample fish < 100 mm total length (TL). These small centrarchids may interact with larval Walleye through predation or competition. Yellow Perch are another important component of these fish communities, yet data needed for indexing trends in perch recruitment is not available because targeted sampling is not conducted. Consequently, the goals of this project are to identify gears that sample centrarchids and Yellow Perch < 100 mm TL and to determine if current and historical relative abundance estimates for centrarchids and juvenile Yellow Perch are related to Walleye recruitment history. I completed one sampling season during late summer 2019 and will sample additional lakes in late summer 2020 using mini-fyke nets, cloverleaf traps, standard boat electrofishing, micromesh gill nets, and electrofishing from a boat using a hand-held probe. We will also assess the validity of a qualitative approach for estimating abundance of small centrarchids using observations made by netters while boat electrofishing. We will develop composite indices of centrarchid and juvenile Yellow Perch abundance and determine if those indices vary among lakes with different Walleye recruitment histories. Finally, we will use historical data collected from a sample of lakes to assess whether centrarchid abundance at that time was related to subsequent Walleye recruitment history.

Dispelling common misconceptions about tribal spearing in Wisconsin

Presenting author: Tom Cichosz

Since court reaffirmation of tribal spearing rights in the early 1980s, six Ojibwe Bands have routinely been spearing fish in off-reservation waters throughout northern Wisconsin. Many misconceptions surround the level of tribal harvest that occurs, as well as the relative impact of tribal spearing on the affected fisheries. I'll explore ten misconceptions about tribal spearing commonly expressed by members of the angling public and present data, discussion and photographic evidence to contrast reality with perception.

An overview of fisheries genetics in Wisconsin: leveraging new technologies to improve fisheries management and address long-standing ecological questions

Presenting author: Wes Larson
Co-authors: Kristen Gruenthal

Over the past four years, the Molecular Conservation Laboratory at UW-Stevens Point has transitioned from more traditional approaches, such as Sanger sequencing and microsatellites, to genomic approaches that have allowed us to answer new questions and better answer existing ones. Here, I will provide an overview of some of our past and current research as well as outline some potential future research topics that could leverage the genetic tools we have created. In particular, I will discuss our research developing conservation units for brook trout, assessing state and private stocking in musky, and using eDNA to monitor species diversity in Wisconsin lakes and rivers. I will also discuss potential future research topics including evaluating survival of stocked fish using high-throughput SNP panels and investigating fisheries induced evolution with genome resequencing.

Using genetics to evaluate survival and growth of Leech Lake strain muskellunge stocked in Wisconsin lakes

Presenting author: Tommy Hill
Co-authors: Wes Larson and Kristen Gruenthal

Stocking of muskellunge Esox masquinongy is common throughout Wisconsin supporting fisheries that could not be sustained through natural reproduction. Most muskellunge stocked in Wisconsin derive from native broodstock, but progeny of non-native broodstock have been stocked in some locations. Muskellunge derived from Leech Lake, Minnesota, have been stocked in at least four locations in Wisconsin: Lake Wissota, Petenwell Lake, Castle Rock Lake, and Lake Monona. Leech Lake muskellunge were stocked because they are thought to grow larger than native muskellunge from Wisconsin. However, a pilot study, which used genetics to assign muskellunge caught in Lake Wissota to their strain of origin, found that survival of Leech Lake muskellunge was poor. To determine if stocking of Leech Lake muskellunge in other Wisconsin systems resulted in similar survival rates, we genotyped muskellunge at 13 microsatellite loci and assigned fish to their strain of origin using previously collected data. Additionally, we used length and age data to explore growth rates of Leech Lake strain muskellunge stocked in Wisconsin lakes. Our research will lead to a better understanding of strain-specific survival and growth rates in muskellunge.

Experimental demonstration of catch hyperstability from habitat aggregation, not effort sorting, in a recreational fishery

Presenting author: Colin Dassow
Co-authors: Alex Ross, Olaf Jensen, Greg Sass, Brett van Poorten, Chris Solomon, Stuart Jones
The relationship between angler catch rates and fish abundance can contribute to or hinder sustainable exploitation of fisheries depending on whether catch rates are proportional to fish abundance or are hyperstable. We performed a whole-ecosystem experiment where fish abundance was manipulated and paired with weekly angler catch rate estimates from controlled experimental fishing. Catch rates were hyperstable (β=0.47) in response to changes in fish abundance. By excluding effort sorting (i.e., catch rates remaining high because less-skilled anglers leave the fishery as abundance declines), our experiment isolated the influence of fish aggregation as a driver of hyperstability. Spatial analysis of catch locations did not identify clustering around specific points, suggesting that loose aggregation to preferred habitat at the scale of the entire littoral zone was enough to maintain stable catch rates. In our study, general, non-spawning, habitat preferences created loose aggregations for anglers to target, which was sufficient to generate hyperstability. Habitat preferences are common to nearly all fishes and widely known to anglers, suggesting that many harvest-oriented recreational fisheries can be expected to exhibit hyperstability.

Maintaining trophy potential of riverine smallmouth bass populations in the upper Midwest: An assessment using the Menominee River, Wisconsin-Michigan, as a model

Presenting author: Daniel Isermann
Co-authors: Daniel Dembkowski, Michael Donofrio, Joshua Schulze, and Joshua Raabe

Many rivers in the upper Midwestern USA support smallmouth bass fisheries that provide excellent opportunities to catch fish ≥ 457 mm total length, but quality angling opportunities often attract angler effort. Fish in these rivers likely grow slow and modest increases in fishing-related mortality have the potential to reduce the availability of trophy fish. However, information on the population dynamics of riverine smallmouth bass populations is often lacking. The Menominee River supports high-quality fisheries for smallmouth bass that attract anglers from across North America and the popularity of these fisheries has continued to increase. Our objectives were to determine if smallmouth bass population characteristics, including exploitation, varied among three riverine impoundments on the Menominee River and if the current 356-mm minimum length limit is adequate for maximizing opportunities to catch smallmouth bass ≥ 457 mm total length. Growth, natural mortality, and angler exploitation rates of smallmouth bass were similar among the three river segments. Based on dorsal spines, age structure of smallmouth bass in electrofishing samples was dominated by fish between the ages of 4 and 8 and maximum ages ranged from 12 to 15 among river segments. However, ages estimated from dorsal spines routinely underestimated otolith ages for smallmouth bass. Within 13 months after tagging, anglers reported catching 42 of the 684 smallmouth bass we tagged (6%) and uncorrected annual exploitation rates ranged from 0 to 4% among river segments. Model results suggest that increasing the current minimum length limit does not appear to be warranted at this time. Conversely, if annual exploitation rates of increase to levels ≥ 10%, a 457-mm minimum length limit may provide greater opportunities for catching bass ≥ 457-mm total length when compared to 356- and 406-mm minimum length limits.

Effect of density reduction on growth, condition, and size structure of brown trout *Salmo trutta* in Spearfish Creek, South Dakota

Presenting author: Nathan Jaksha
Co-authors: Justin VanDeHey, Jake Davis, and Jeremy Kientz

Stream-dwelling salmonids often exhibit density-dependent growth due to shortages in prey availability. Spearfish Creek, within the Black Hills of South Dakota, supports a Brown Trout Salmo trutta population displaying density-dependent growth. Lack of larger Brown Trout in Spearfish Creek is of concern for anglers and fisheries managers. While various means exist to improve Brown Trout size structure one method to reduce density is mechanical removals. Our objective was to determine if removal of Brown Trout resulted in increased growth, condition and size structure in Spearfish Creek. In 2016, Brown Trout biomass was reduced by 50% at seven sites in Spearfish Creek. All remaining fish (> 100 mm) received PIT tags to monitor growth rates between experimental and control sites. First year analyses indicated improved growth rates of adult Brown Trout in removal sites. Further annual sampling (2017-2019) of Spearfish Creek allowed for recapture of PIT tagged Brown Trout and additional implantation of additional PIT tags. Growth parameters were estimated from recaptured fish using the Fabens growth model. Faster growth coefficient rates (K and ω) were observed in the reference sites and larger maximum theoretical lengths ($L\infty$) were estimated for experimental sites. Body condition (relative weight) and size structure (proportional size distribution) were similar between reference and experimental reaches. Bioenergetics modeling estimated total consumption (g/d) was similar between reference and experimental reaches. Lack of improvements in growth, condition, and size-structure in the experimental sites may indicate that the single removal effort may have not been effective in improving long-term growth in Spearfish Creek, SD. Management of Brown Trout within Spearfish Creek should focus on increasing removal efforts (either % removed or frequency of removals) to determine if successive removals are effective in improving long-term growth.

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

Presenting author: Jasmine Johnson
Co-authors: Daniel Isermann, Daniel Dembkowski, and Ryan Koenigs

Lake sturgeon (Acipenser fulvescens) spawn in multiple tributaries of the Lake Winnebago system but the relative contribution of recruits from these tributaries to annual spearing harvest is not known. Otolith microchemistry is often used to determine natal origins of fish, but pectoral fin rays provide a non-lethal alternative sampling method. The efficacy of using microchemistry in calcified structures for determining natal origin has not been evaluated for lake sturgeon. Thus, the objectives of our study are to: 1) determine if otolith microchemistry can be used to assign lake sturgeon to specific rivers where spawning occurs; 2) determine if chemical signatures are consistent between otoliths and fin rays; 3) determine if contribution to spearing harvest varies among rivers; and 4) estimate abundance of larval sturgeon among spawning locations. Microchemistry of calcified structures will be assessed via laser ablation inductively-coupled mass spectrometry. Larval and juvenile fish will be collected downstream of spawning locations in four rivers. Chemical signatures from these juveniles will allow us to determine the extent to which we can discern among fish originating from the four rivers. Chemical signatures from adult fish harvested by spearers will be used to determine the contribution of different spawning locations to overall harvest.

Evaluation of methods for estimating age and growth of lake sturgeon *Acipenser fulvescens*

Presenting author: Aaron O'Connell
Co-authors: Ryan Koenigs and Dan Isermann

Pectoral fin rays are currently the preferred structure used to estimate the age of Lake Sturgeon (Acipenser fulvescens). Previous research has shown that ages estimated via fin rays underestimate true age of Lake Sturgeon ≥ 14. Age estimates from otoliths were previously reported as valid for Lake Sturgeon, but difficulties in otolith availability, collection, and processing have resulted in little to no comprehensive work. Mark-recapture based growth modeling has been used to estimate growth parameters when age estimates from calcified structures are inaccurate, imprecise, or structures are difficult to collect. We are evaluating multiple different techniques for estimating age and growth of Lake Sturgeon including: use of sectioned pectoral fin rays, use of otoliths prepared via alternative sectioning methods, and the Fabens mark-recapture growth model. Results indicate only 13% of sectioned otoliths are readable. Further, of otolith sections that were readable, precision of age estimates among three readers was lower than precision of ages estimated using pectoral fin rays. Von Bertalanffy growth functions were created for each reader and structure and were compared to the Fabens mark-recapture based growth curve using likelihood ratios tests.

Catch-and-release in inland recreational fisheries: Meeting manager and angler expectations or shooting ourselves in the foot?

Presenting author: Greg Sass
Co-authors: Stephanie L. Shaw

Catch-and-release (CR) has become a pervasive practice and "social norm" with anglers for some inland recreational fisheries. This practice has been promoted for fish conservation and to meet angler and manager desires of greater fish abundances, angler catch rates, and trophy growth potential. We reviewed catch-and-release in north-temperate inland recreational fisheries over time and documented the subsequent responses of fish populations to the practice in catch rates, recruitment, abundance, size structure, growth, and trophy potential primarily focusing on black bass Micropterus spp., muskellunge Esox masquinongy, walleye Sander vitreus, and panfish (sunfishes Lepomis spp., crappies Pomoxis spp., yellow perch Perca flavescens). Our review suggested that angler and manager desires may not be met when fisheries are almost exclusively CR, CR may create situations where managers are unable to structure fish communities to meet such desires, and CR can cause imbalances in fisheries managed for multiple species. Because CR may be one of the biggest challenges facing inland recreational fisheries management in the 21st century and beyond, we provide recommendations and future research considerations aimed to alleviate concerns identified from our review to better balance fisheries, meet angler and manager desires, and to keep fisheries within a safe operating space.

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

Presenting author: Jared Krebs
Co-authors: R. Sheffer, D. Dembkowski, S. Hogler, J. Raabe and D. Isermann

Green Bay and its tributaries support a world-class fishery for trophy muskellunge that attracts anglers from across North America. The lower Fox River and Green Bay muskellunge population is largely supported by stocking because natural recruitment is limited, possibly due to habitat limitations. While previous work has identified potential spawning locations, it is unknown whether muskellunge hatch at

these locations and habitat attributes associated with successful hatching have not been determined. Our objectives are to 1) determine if habitat conditions explain selection of spawning locations, and quantify the availability of suitable muskellunge spawning habitat in tributaries of lower Green Bay, 2) characterize general muskellunge movement patterns, 3) determine proportion of muskellunge spawning in tributaries to lower Green Bay or Green Bay proper, 4) determine if muskellunge return to stocking locations to spawn, and 5) determine if muskellunge display high site fidelity, returning to the same locations to spawn in consecutive years. We are identifying spawning sites of tagged muskellunge (N = 60) using radio and acoustic telemetry and conducting spawning habitat surveys. Initial results suggest that several habitat variables are related to the probability that muskellunge will deposit eggs at a specific location, approximately 60% of adult muskellunge in Green Bay spawn in tributaries, most fish return to stocking locations to spawn, and most fish exhibit site fidelity among years.

Post-release movement of lake trout in Lake Michigan

Presenting author: Matthew S. Kornis
Co-authors: Theodore J. Treska and Charles R. Bronte

Movement among interconnected regions is an important component of understanding and assessing fisheries stocks. In Lake Michigan, native lake trout have been the focus of rehabilitation efforts since the 1960's and are also harvested by tribal commercial fishers in the 1836 Treaty waters that cover most of the Michigan shoreline. Updated movement data are needed for stock assessment models within Treaty and non-Treaty waters, and for efforts to understand the genetic origins of wild lake trout recruits. Since 2010, all hatchery lake trout released in Lakes Michigan and Huron have received a coded-wire tag with information on their year class and stocking location. We analyzed returns of coded-wire tagged lake trout from these mass-marked year classes (2010 – present) to the recreational fishery and in spring gill net assessment surveys to develop a new movement matrix for lake trout in Lake Michigan. Although lake trout occasionally moved long distances, the majority of lake trout were recovered in the management unit where they were stocked or in adjacent units < 100 km from the stocking location. Lake trout stocked on one shoreline of the lake rarely moved to the opposite shoreline. Fish stocked at offshore locations, including the Southern Refuge, Northern Refuge, and Julian's Reef, dispersed more widely and to both shorelines when they moved, although 36 – 56% of fish remained in the two refuges where they are protected from exploitation. Nonetheless, fish from these three offshore locations comprised the majority (66%) of hatchery lake trout harvested by anglers, owing to greater returns per unit stocked than lake trout stocked nearshore. Evaluation of coded-wire tagged lake trout from the 1990s and early 2000s suggest dispersal may increase with age, and thus a re-evaluation of movement is planned for 2025 when mass-marked fish will be older.

Polygenic inheritance of differential lipid content between siscowet and lean lake trout

Presenting author: Peter Euclide
Co-authors: Wes Larson, Andy Jasonowicz, Shawn Sitar, Crystal Simchick, Greg Fischer, and Rick Goetz

The detection of genetic variants associated with phenotype is often confounded by neutral population structure in wild populations. This is the case for lake trout (Salvelinus namaycush) in Lake Superior in which three distinct morphotypes, lean, siscowet, and humper, show relatively low genetic differentiation among types compared to geography. However, previous research of lean and siscowet lake trout reared under identical conditions demonstrated that differences between morphotypes does have a genetic basis. To investigate the genetic basis for lake trout type, we evaluated the associations between one of the

strongest phenotypic differences between siscowet and lean lake trout, lipid content, and 32,285 restriction-site-associated sequencing (RAD-seq) SNP genotypes. Analysis was conducted separately on four experimentally reared lake trout crosses (lean x lean; lean x siscowet; siscowet x lean; siscowet x siscowet) reared under identical conditions for four years. By evaluating genetic associations within F1 lake trout hybrids, we were able to identify SNPs putatively linked to lipid content while controlling for strong neutral genetic structure associated with spawning site and family structure. Of these, several low-effect loci were found that appear to have an additive effect with lipid content. Our results suggest that differences between morphotypes is likely complex - with low effect genes spread across the genome.

Otolith microchemistry: A tool to identify the natal origins of larval lake whitefish

Presenting author: Lydia Doerr
Co-authors: Patrick Forsythe, Christopher Houghton, Scott Hansen, Kevin Pangel, and Andrew Ransom

Despite the ecological and economic importance of Lake Whitefish in the Great Lakes, much remains unknown regarding life history at the larval stage and the contribution of individual stocks. The ability to identify the natal origins of particular populations could aid Lake Whitefish management by improving stock delineation. The capture of larval Lake Whitefish in the four major Green Bay tributaries (Fox, Menominee, Peshtigo, and Oconto Rivers) not only indicates the re-establishment of potamodromous stocks but raises questions regarding key sources of production for the Green Bay Lake Whitefish metapopulation. Larvae collected during pelagic drift in 2017-2018 were used to examine if otolith microchemistry can be used to accurately determine natal origin. The chemical signatures conserved in larval otoliths allowed for the differentiation of larvae collected from riverine and open water locations. Enhancements in the understanding of larval natal origins will facilitate management at a stock specific level.

Lake trout and cisco restoration, and rainbow smelt dynamics in Long Lake, Phelps, Vilas Co, WI

Presenting author: Ron Bruch
Co-authors: Fred Binkowski

Long Lake near Phelps, WI is an 886-acre oligotrophic lake in which the WI DNR since 2005 has been attempting to establish a self-sustaining population of a unique inland strain of lake trout. The brood source is a native lake trout population in nearby Black Oak Lake from which eggs were taken and yearlings reared for stocking into Long Lake in 2005, 2012, 2013, 2017, 2018. Long Lake is also one of the several dozen inland lakes in northern WI into which rainbow smelt have been illegally introduced. Smelt, likely introduced in the 1990s, dominate the cold-water fish forage community in Long Lake and locals are concerned about the impact of smelt on the lake's fish and aquatic community, especially on walleye and cisco reproduction. The Long Lake of Phelps Lake District entered into a series of research agreements with the University of Wisconsin-Milwaukee School of Freshwater Science (UWM SFS) from 2016 to 2020 to: 1) rear and stock cisco into Long Lake; 2) determine the status/dynamics of the smelt population; and 3) determine if stocked lake trout are surviving and eating smelt and determine where lake trout may be attempting to spawn. Results to date: 1) in fall 2017, 10000 fin clipped extended growth fingerling cisco (mean TL 178 mm), reared at UWM SFS from eggs collected from North Twin Lake (Vilas Co) were stocked into Long Lake; subsequent summer/fall gill net surveys were able to capture native cisco (ages 9-22, 280-380 mm TL) at every hypolimnion set throughout the lake; cisco age estimates indicated cisco may be producing year classes during smelt domination in the lake; 2) smelt were collected using otter trawls and age and growth data indicate the population, while comprised of fish from nearly annual year classes up to age 7, is dominated by slow growing, small fish (most less than 110

mm) with gravid females as small as 83 mm found; smelt total annual mortality rates were estimated at 67%; 3) during 2017-2019, 13 lake trout were captured via angling and gill nets, in which sonic and/or radio tags surgically were implanted; no trout from 2005 nor 2012 were captured indicating those stocking events may have been failures; captured trout were growing fast and maturing in 5 years, eating smelt, and were found to be utilizing two rocky points in the lake during the 2018 and 2019 fall spawning seasons; sonic tags provide depth and body core temp of the trout tagged which allowed documentation of surface finning, sinking to spawning depths, and spawning bout behaviors. Sonic tag data also indicated a high mortality rate of tagged lake trout possibly from angler by-catch of trout while summer trolling deep for walleye.

Genetic structure in five fish species from a fragmented river is driven primarily by existing habitat heterogeneity rather than isolation by a dam

Presenting author: Becky Gehri
Co-authors: Daniel Zielinski, Kristen Gruenthal, and Wesley Larson

The fragmentation of river systems by dams can have a genetic impact on fish populations due to reductions in gene flow and subsequent genetic drift. However, genetic structure within a system can exist naturally at small scales, and the degree of this historical differentiation varies among systems and species. Therefore, the interaction between natural and anthropogenic influences on population genetic structure can be complex and difficult to understand. We investigated five native species with varying life histories, generation times, and migratory behaviors: white sucker (Catostomus commersonii), yellow perch (Perca flavescens), walleye (Sander vitreus), smallmouth bass (Micropterus dolomieu), and rock bass (Ambloplites rupestris) in the lower Boardman River in Michigan, which is fragmented by the Union Street Dam. The objective of our study was to determine if the populations of these five fish species above and below the Union Street Dam are significantly differentiated and/or show differences in diversity. We collected fin clips from fifty fish above and below the dam for each species, extracted DNA, and used RAD sequencing to examine differences in population structure and diversity. We also simulated different migration rates over the lifespan of the dam to assess if our results were consistent with dam effects or better explained by natural historic genetic structure. Our results suggest that for most of our study species, habitat heterogeneity is a stronger driver of genetic differentiation compared to fragmentation effects of the Union Street Dam.

Food web interactions among walleyes, lake whitefish, and yellow perch in Green Bay, Lake Michigan

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

Green Bay supports important fisheries for walleyes, lake whitefish, and yellow perch and these species likely interact in a variety of ways. A better understanding of these interactions is needed to guide management decisions. Specifically, there are concerns that high walleye abundance could negatively influence abundance of lake whitefish and yellow perch, primarily through predation. Consequently, we integrated an intensive assessment of walleye diet compositions with bioenergetic modeling and statistical catch-at-age models to determine if walleye predation could influence the recruitment potential of lake whitefish and yellow perch. Our 2018 results suggest that the contribution of lake whitefish and yellow perch varies at spatial and temporal scales, and bioenergetics modeling scenarios indicated that walleye predation was likely sufficient to limit the recruitment potential of yellow perch but not lake whitefish.

Assessing relative changes in yellow perch and walleye abundances in Green Bay

Presenting author: Iyob Tsehaye
Co-authors: Steve Hogler, Tammie Paoli, and Lucas Koenig

Based on fishery-dependent and survey data, yellow perch and walleye populations in Green Bay have shown varying trends in abundance over the last couple of decades, with walleye numbers increasing and yellow perch numbers declining. Using-catch-at-age models, we assessed the population dynamics of these species, reconstructing historical population abundances and estimating fishery and population parameters. To characterize feeding interactions among these species, we used results of diet analysis conducted over the last couple of years in collaboration with the USGS, Wisconsin Cooperative Fishery Research Unit, UW-Stevens Point. Model abundance estimates show that the walleye population in southern Green Bay has been continuously increasing over the last couple of decades. By contrast, whereas young-of-year yellow perch numbers remained generally stable, the adult abundance declined sharply over the last 2–3 decades, suggesting the presence of recruitment bottlenecks for the yellow perch population. Results from diet analyses showed that round gobies, alewife and gizzard shad accounted for the largest proportions of walleye diet (>30%), and yellow perch comprised 0-10% of walleye diet depending on the location in Green Bay. Based on regressions, there was a strong negative relationship between yellow perch and walleye abundances, with the percentage of explained variance approaching 85%. Although correlation does not necessarily mean causation, these results are consistent with a hypothesis that walleye predation represented a major impediment to yellow perch recruitment in some parts of the Great Lakes. Bases on our results, although yellow perch account for a relatively small proportion of walleye diet in Green Bay, the large walleye population vs. yellow perch may still amount to a considerable predation pressure on the yellow perch population.

Estimating mortality of lake sturgeon in the Lake Winnebago system using traditional age-based approaches and capture-recapture models

Presenting author: Jeremiah Shrovnal
Co-authors: Daniel Dembkowksi, Ryan Koenigs, Joshua Raabe, Daniel Isermann

The lake sturgeon population in the Lake Winnebago System (LWS) supports a culturally and economically important spear fishery. Harvest from the spear fishery is closely monitored and managed by the Wisconsin Department of Natural Resources (WDNR) through use of a safe harvest cap system that limits exploitation to 5% or lower. Harvest caps for males and adult females are based on mark-recapture estimates of population abundance that are adjusted for natural mortality rate. The current estimate of instantaneous natural mortality rate (M = 0.055) was estimated using a statistical catch at age (SCAA) model formulated using corrected ages estimated from fin rays. Correction is required because fin ray age estimates are not accurate for older fish. Mark-recapture methods can also be used to estimate mortality rates and the WDNR marks Lake Winnebago lake sturgeon captured in annual assessments with passive integrated transponders (PITs). Recapture of fish tagged with PITs provides information that can be used to estimate apparent survival and mortality rates using capture-recapture models. The primary objectives of our research are to determine if: 1) total and natural mortality rates are similar among estimation methods that rely on corrected fin ray ages or mark-recapture and 2) potential differences in natural mortality rates among estimation methods would affect safe harvest caps for the spear fishery. The goal of this research is to provide WDNR biologists with suggestions on estimating mortality rates of lake sturgeon to improve management of this important fishery.

Digging deep: A look at the shovelnose sturgeon population in the lower Chippewa River

Presenting author: Joseph Gerbyshak

Shovelnose Sturgeon had been historically documented as one of the most abundant gamefish in the lower Chippewa River system, but fisheries surveys in 1999 and 2000 captured only a handful of individuals indicating the population was likely at a very low level. The population decline triggered a closure of the hook and line fishing season for Shovelnose Sturgeon in the lower Chippewa River system in 2004. From 2006-2011, a series of Shovelnose Sturgeon population estimates were conducted on a 4.5 mile stretch of the Chippewa River known as the Meridean Slough, located between Eau Claire and Durand, and those abundance estimates ranged from 1,317 to 1,677 fish. In 2019, a Shovelnose Sturgeon abundance estimate was conducted on the same 4.5 miles stretch of river known as the Meridean Slough and these data show encouraging results. Six electrofishing sampling events took place between June 11th and June 26th where 1,160 individual Shovelnose Sturgeon were captured. Electrofishing catch rates were as high as 71 fish per mile and a Schnabel population estimate generated an abundance of 7,691 (C.I. +/- 1,654) fish. Fork lengths ranged from 16.5 inches to 32.1 inches with an average fork length of 26.5 inches. Ages were estimated for a subsample of fish via cross-sectioning pectoral fin rays and the age estimates ranged from 6 to 15 years of age. Seventy-two Shovelnose Sturgeon were recaptured in 2019 from previous surveys, and growth rates appear to be almost negligible based on differences in initial length compared to recaptured length despite being at large for 8-13 years. Shovelnose Sturgeon appear to be on the rebound in the lower Chippewa River and there are plans to conduct this survey again in the coming years to further monitor this population.

Experimental angler preference survey

Presenting author: David Rowe
Co-authors: Dan Oele and Robert Holsman

An important first step in management of recreational sport fisheries is to establish goals. Ideally these goals are developed with stakeholder input not solely from biological criteria and/or manager preferences. Collecting stakeholder input is not straightforward. Various approaches including public meetings, visioning sessions, online surveys tend to attract only the most motivated stakeholders. This often results in processes that collects biased information. Mail surveys can be more representative of a larger population but again rely on willingness to complete and return the survey. The WDNR Fitchburg Fisheries Team is planning to conduct “on the water” angler preference surveys to try and better understand the preferences of anglers actively participating in local fisheries. In planning for this survey several questions were developed to assess angler preferences for different recreational fishery goals by species where the foci varied from a harvest-oriented fishery where fish size was not important, quality-oriented fishery where size was important and with reduced harvest, and trophy management where fish size should be maximized and harvest very limited. We also wanted to test several questions regarding angler’s motivation to go fishing. These questions were turned into a short one-page experimental questionnaire we tested at the 2019 Wisconsin Fishing Expo, in Madison Wisconsin. Show attendees completed 328 questionnaires. We will present the survey results which confirm some of our previous understanding of angler preferences and motivations, but also challenge some. We will discuss the ability of the survey questions to assess angler preferences and recommendations for “on the water” angler preference surveys.

Bois Brule River creel survey: A mixed-method approach

Presenting author: Paul Piszczek
Co-authors: Ericka Massa and Kirk Olson

For decades, creel surveys have been conducted in Wisconsin using traditional DNR staff-angler interactions in the field, which included angler interviews and vehicle counts necessary to estimate angling pressure. Working to modernize and experiment with alternative methods for creel surveys, we coupled the traditional approach with trail cameras on the iconic lower Bois Brule River, known for its seasonal runs of Steelhead, Brown Trout, and Coho Salmon from Lake Superior. Total catch and harvest were estimated from both the traditional creel survey (i.e., angler interview-based pressure, catch, and harvest rates) and remote cameras (i.e., camera-recorded angler pressure). The most prominent finding in our survey relative to this combination of methods was the consistently higher pressure and higher proportions of residency observed with the cameras versus the traditional creel. Pressure and residency varied seasonally, however, for each method. The traditional creel method estimated approximately 50,000 angler-hours annually whereas camera methods estimated over 70,000 angler-hours. Both estimates were comparable to the nearly 68,000 angler-hours estimated in a 1990 survey using multiple creel clerks. The difference between the two estimates was not unexpected, as traditional creel methods do not necessarily capture all angler pressure, and camera-based methods upwardly bias angler hours due the camera's inability to exclude non-fishing time. Although harvest varied among species, Steelhead harvest varied the least, perhaps due to a conservation ethic associated with the species. This survey demonstrated the utility of using trail cameras to offset some of the labor associated with traditional creel surveys.

Volunteer angler lake sturgeon tagging project

Presenting author: Zach Mohr
Co-authors: Joseph Gerbyshak

A volunteer angler lake sturgeon tagging project started in 2019 on the lower Chippewa River. Data gained from this project will yield more information about the movement and growth of lake sturgeon in this complex river system. Four volunteer anglers obtained a Scientific Collectors Permit, were trained in the proper tagging technique and outfitted with floy tagging equipment. Volunteer anglers tagged 100 individual lake sturgeon between 6/28/19 and 9/30/19, along with multiple recaptured lake sturgeon observed by the volunteer anglers during the 2019 sampling season. The average total length of lake sturgeon captured by volunteer anglers was 35.8 inches, with the longest fish measuring 60.5 inches and shortest fish measuring 16.3 inches. Due to the difficulty of sampling lake sturgeon from the Chippewa River, angling has been one of the most effective methods of capture and has potential to capture sizes of lake sturgeon that are underrepresented in routine sampling events. The WDNR plans to continue volunteer led lake sturgeon sampling in the future.

Using parentage analysis to investigate the spawning and recruitment dynamics of walleye

Presenting author: Levi Simmons
Co-authors: Wes Larson and Gregory Sass

Conservation 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, slot limit regulations are regularly 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. By leveraging a new marker panel for Genotyping-in-Thousands by sequencing (GT-seq) methodology, we aim to elucidate reproductive success and reproductive skew of thousands of walleye with high accuracy and at a reasonable cost. Here, I will present preliminary data from Escanaba and Sanford Lakes; two lakes in northern Wisconsin.