North Central Division of the American Fisheries Society

Joint Winter Business Meeting of the Centrarchid, Esocid, and Walleye Technical Committees

3:00 PM, Sunday, February 12, 2023
Sheraton Hotel, Overland Park KS

WTC Chair: Jason DeBoer, jadeboer@illinois.edu
WTC Chair-elect: Logan Zebro, zebrol@lopers.unk.edu
WTC Immediate Past-chair: Lawrence Eslinger, lawrence.eslinger@wisconsin.gov
WTC Secretary: Joe Rydell, joe.rydell@nebraska.gov
ETC Chair: Jordan Weeks, Jordan.weeks@wisconsin.gov
CTC Chair: Will Radigan, wradigan2@huskers.unl.edu

DRAFT Meeting minutes

1. Call meeting to order: meeting was called to order by Jason DeBoer at 3:03 PM
    a. Introductions: attendees around the room introduced themselves and their affiliation (*I neglected to count or send around sign-up sheet*)
2. Agenda additions and approval: no additions were suggested. Jordan Weeks motioned to approve the agenda, Mark Fincel seconded.
3. Approve minutes from 2022 summer business meeting (emailed out prior to meeting): Melissa Wuellner motioned to approve the minutes, Jordan Weeks seconded.
4. Joint summer meeting with CTC/ETC/WTC
    a. Jordan Weeks suggested the meeting be held at the Kemp Natural Resources Station on Lake Tomahawk in Woodruff, WI. Jordan described the facility as "rustic cabins meet new classroom". He will organize, with help from Steve Gilbert and other committee chairs as needed.
    b. The meeting was proposed for June 20-22 2023, based on availability of the facility. This suggestion was met with approval from the attendees.
    c. There will potentially be a largemouth bass removal continuing ed workshop on the afternoon of the first day.
    d. Jordan emphasized there is lodging for 44 people on site, others will have to camp or stay in town. Jordan will explore options.

-- Break into separate tech committees --

5. Percid award
    a. 3 recipients: Logan Zebro (UNK), Logan Cutler (SDSU), Ben Vasquez (UWSP)
    b. WI chapter fully matched the $300 award, Dakota chapter partially matched ($100), NE chapter chose not to match
    c. All three recipients presenting at the conference
6. State and provincial reports

a. Jason mentioned he and Joe had not received MO and IN state reports
b. Jason offered time to anyone who wanted to share anything from their report, no further discussion

7. WTC treasurer's report (Jason DeBoer, for Joe Rydell and Drew Holloway)
    a. Jason presented details about the WTC general/operating fund (expenses, deposits, and balances for calendar year); no further discussion.
    b. John Bruner motioned to approve the treasurer's report, Mark Fincel seconded. Motion approved.
8. Old business
    a. Drew Holloway shared that special issue final bills should be processed soon, and we'll FINALLY have that project put to bed. Dan Isermann mentioned that those authors/groups who paid their own bills already received and paid bills a while ago. Jason DB commented he wants this project finalized before he hands off the reins to incoming chair.
    b. John Bruner gave a few updates and insights about the PERCIS V conference in Czech Republic in Sept 2022, highlighting a few presentations of note:

        PERCIS V – 5th Percid Fish International Symposium

        České Budějovice, Czech Republic, EU September 18-23, 2022
        (https://www.percis-v.eu)

        Five keynote addresses, 54 oral presentations, and 20 posters, all on percids, were presented by the 79 participants from four continents and 29 countries. There were three field trips, one to the Římov Reservoir Monday afternoon (Sept. 19, 2022), and two on Wednesday (Sept. 21, 2022): (1) Český Krumlov: visit to the graphite mine and tour of the historic UNESCO town center; and (2) Třeboň: visit of the Schwarzenberg Tomb and 2-hour boat trip on the Svět Pond.

        The complete Program and Abstract booklet is available at:
        https://ncd.fisheries.org/wp-content/uploads/2022/12/PERCIS-V-Program-Abstracts.pdf

        The Book of Abstracts is available at:
        https://ncd.fisheries.org/wp-content/uploads/2023/01/BookofabstractsPercisV2022.pdf
        (Note that some talks in this Book of Abstracts were not given because the authors were not able to make it to the Czech Republic because of the war in the Ukraine.)

        2 talks are of special interest to fish hatcheries using RAS:

(1.) Fourrier, C., Senff, P., Abd Al Rahim, S., Ledoré, Y., Charpentier, N., Mila, S., and Fontaine, P. Is biculture with tench (*Tinca tinca*) a way to improve growth and physiological status of pikeperch (*Sander lucioperca*) reared in RAS?
(2.) Senff, Paula, Fourrier, C., Abd Al Rahim, S., Grosjean, J., Milla, S., Ledoré, Y., Robin, C., and Fontaine, P. Effects of quercetin and rutin as feed additives on Pikeperch (*Sander lucioperca* L.) in recirculating aquaculture

9. New business
    a. Approval of new WTC chair, Logan Zebro (UNK). Rebecca Krogman motioned to approve Logan, Dan Isermann seconded. Motion approved.
    b. Approval of new WTC chair-elect, Jason Gostiaux (MI DNR). Dan Isermann motioned to approve Jason G., Liz Renner seconded. Motion approved.
    c. PERCIS VI conference. John Bruner had previously suggested this could potentially be held in MI in MI 2024 or 2025, emphasizing Saginaw Bay as a success story. It was mentioned that MI hosted JASM in 2022 and is hosting the National AFS meeting in 2023. Doug Austen suggested having PERCIS VI as a symposium at 2026 AFS in Columbus OH, this was met with general approval and much discussion. The time zone differences with overseas participants was mentioned, and it was suggested to perhaps record or stream online. Doug suggested that interested parties talk to Gary Whelan (who will be AFS president for that meeting) and someone also suggested talking to Joe Conroy OH DNR, who will likely be helping host the meeting.
    d. The Midwest Glacial Lakes Partnership (MGLP) Spring 2023 Webinars:

        Managing for RADical lake change: applying the Resist-Accept-Direct (RAD) framework to support walleye management in Wisconsin

        Description: Managers facing transforming lakes can benefit from considering broader objectives beyond a traditional focus on resisting change. They can also consider whether accepting inevitable change or directing it along some desirable pathway is more practical and appropriate under some circumstances (the RAD framework). Here, we'll introduce the RAD framework and highlight a decision-support tool for the walleye recreational fishery in Wisconsin as an example of how to link the RAD framework to real-world management of a large recreational fishery.
    e. Jason DeBoer mentioned there is a Walleye management and conservation session at Midwest, Monday 1:40pm-4:40pm, in Leatherwood 3
    f. Dan Isermann mentioned a big-scale WAE symposium at National AFS this summer, statewide or basinwide perspectives welcome
10. Adjourn
    a. Dan Dembkowski made a motion to adjourn, Dan Isermann seconded. Meeting was adjourned at approximately 4pm.

Minnesota update to NCD Walleye Technical Committee
Winter business meeting, 2023
Submitted by Dale Logsdon

2023 Walleye Stocking:

193,075,402 fry
92,156 small fingerlings
2,179,667 fall fingerlings
17,547 yearlings or adults

General:

Walleye fishing was generally good across the state this year. However, high waters did cause some flooding in the northern part of the state this spring and poor winter travel conditions due to variable ice thickness and slush has reduced ice fishing opportunities across much of the state this winter. Concern continues to build about the effects of the use of forward looking sonar on the fisheries. A bill to reduce the statewide bag limit of walleyes from 6 to 4 failed in the legislature last year and is unlikely to be proposed again soon because the sponsor of the bill was not re-elected. Many of the staff positions that have been held open the last few years are beginning to be filled and the governor has included substantial funding requests for hatchery and public access improvements in this year's budget.

Large lake summaries:

Leech Lake: Walleye gill net catch rates still within management objective ranges. The 2019 and 2021 year classes appearing strong enough to provide quality fishing as long as they are able to continue to recruit to the fishery. Winter fishing potentially increasing with additional resorts now plowing access roads around the lake. Winter creel survey planned for 2023-24.

Lake Winnibigoshish: Walleye gill-net catch rates continue to decline following infestation of the system by Zebra Mussels. Walleye were sampled at rate of 4.6/gill net, which was the second lowest catch rate observed for Winnie but within the typical range for other Minnesota large lakes. Lengths ranged from 8 to 25 inches with a mean length near 15 inches. Size structure was heavily influenced by the strong 2019 year-class. Female spawning stock biomass (SSB) declined to 0.5 pounds per acre, the lowest observed. It is felt that the reduced gill-net catches do reflect a decline in population size but the magnitude of the change may also be impacted by changes in behavior of the walleyes due to the increased water clarity following Zebra Mussel infestation.

Vermilion: Now are the "good ol' days" for Walleye fishing on Lake Vermilion. Gill-net catches have remained above average for the 3rd consecutive year with high numbers of harvestable sized fish. The Walleye population has experienced strong recruitment in the past few years with a very strong 2018 year-class and moderate to strong year-classes in 2019, 2021, and 2022

Mille Lacs: The Mille Lacs Walleye index increased from last year due to a relatively strong input of age 0 WAE caught in the nearshore nets and what appeared to be reduced catchability for

Walleye the previous year; so in all likelihood there actually hasn't been much change in catchable sized Walleye over the last several years. It used to be unusual to see much for age-0 Walleye caught in standard five-panel gill nets; however, it's becoming more commonplace as the age-0 Walleye length frequency distribution has expanded and we now see some of the age 0 fish reaching over 8"(makes them catchable in the 0.75 in. mesh) by the latter part of September. Smaller age-0 Walleye in the fall will be observed under 4" in early September electrofishing and those fish are often in rather poor condition. We often see these wide length frequency distributions when we have plentiful forage and I suspect the larger sized age-0 Walleye are likely taking advantage of earlier growing seasons.

We've had several consecutive seasons of above average levels of age-0 Yellow Perch which are the main forage species for WAE in Mille Lacs. This coincides with highly reduced catch rates of Walleye by recreational anglers as Walleye remain sated. We are observing similar wide length frequency distribution on Yellow Perch and it appears that age 2 and 3 fish average length has increased over time, such that we are now seeing increases of Yellow Perch over 9" that should be becoming more appealing to recreational anglers.

Lake of the Woods: Catch rate was 12.8/net with a 3-year average of 12.4/net, which is below the management objective of 14/net. Below average gill net catches largely driven by weak to moderate year-classes produced in 2017, 2019 and 2020. Preliminary juvenile assessments indicate average year-classes in 2021 and 2022. Sauger catch rate was 16.2/net this past fall with a 3-year average of 21.5/net and exceeds management objective of 16/net.

Red Lake: Gill net catch rates remain high with lots of young fish in the population. Spawning stock biomass is toggling between our surplus and optimal conditions, both of which allow for regulations that provide good harvest opportunities. The age-0 catch rate in seine hauls was very strong, and it looks like 2022 may be the strongest year class in a decade.

Cass Lake: Meeting or exceeding most management plan goals except recruitment. The strong 2018 year class is carrying the fishery with modest support from adjacent year classes. However, good numbers of quality-sized fish being caught. The 2021 year class is average but not large enough to harvest yet. The age-0 catch rate in 2022 was record low.

Rainy Lake: The walleye fisheries are looking good on both Rainy and Kabetogama. However, we saw record flooding on Rainy and the Namakan Reservoir (Namakan, Kabetogama, Sand Point and Crane Lakes) in 2022 which impacted some of our spring sampling. The overall walleye catch rate on Rainy increased from less than 5 per net in 2021 to just under 7 per net in the fall 2022 survey, driven mostly by a good catch of fish from the 2021 year-class. These fish were in the 7-8" length groups during fall 2022 netting. We also saw above average numbers of fish from the 2019 year-class which were in the 10-12" length ranges.

Kabetogama: The overall walleye catch rate from fall 2022 sampling was near the long-term median at 8.3 per net. Kabetogama has seen consistent walleye recruitment in recent years, and there is an abundance of smaller fish in the system right now ranging from 8-12". Many of the smaller fish are from the 2020 year-class which were caught in above average numbers in 2021 and 2022.

DNR Research:

Dale Logsdon, Loren Miller, and Steve Shroyer - 2022 fry stocking represented the fourth paired-stocking into eight lakes to evaluate performance of Lower Mississippi strain walleye fry to that of the more easily obtainable Upper Mississippi strain. This year's data continue to indicate higher survival of the Lower Mississippi stain walleyes in southern Minnesota lakes. Cost analysis indicated that although the Upper Mississippi strain fry were substantially cheaper to stock, the increased survival of the Lower Mississippi strain resulted in a lower cost-per-return of stocked Lower Mississippi strain Walleye during fall electrofishing.

Loren Miller - Fine-scale genetic structure was examined for Walleye in the Big Sandy system, tributary to the Mississippi River, in conjunction with an Iowa State/MNDNR telemetry study. Walleye populations in two headwater lakes were each moderately genetically distinct despite being only about 10 and 30 km away from the Big Sandy Lake population. Unfortunately, the acoustically-tagged fish from different areas of Big Sandy Lake and its inflowing tributaries were all similar so we could not test for associations between genetic groups and movement patterns

Beth Holbrook and Bethany Bethke – Data is being analyzed from a collaborative three-year project to evaluate Yellow Perch growth, sex, and maturity from 28 lakes across Minnesota, including repeated sampling on seven lakes. A broad size range of Yellow Perch were collected using boat electrofishing and small mesh gill nets to complement larger fish captured in standard surveys. Early analyses indicated that in most lakes in this study, Yellow Perch matured at small sizes and young ages, with females maturing on average at 100 mm and 2 years and males maturing on average at 65 mm and 1 year. Yellow Perch captured in boat electrofishing matured larger and older than fish captured with small mesh gill nets, although these differences were small compared to the differences between lakes. A meta-analysis was also conducted using standard survey data from 1,200 lakes and indicated that the maximum length of Yellow Perch has declined statewide over the past 25 years. The project is expected to be completed by May 2024.

University of Minnesota Research:

Papers published:

Mahlum, S, K Vitense, H Corson-Dosch, L Platt, PJ Schmalz, M Treml, and GJA Hansen. 2023. Connecting habitat to species abundance: the role of light and temperature in the abundance of walleye in lakes. Canadian Journal of Fisheries and Aquatic Sciences.| dx.doi.org/10.1139/cjfas-2022-0109

Krabbenhoft, CA, SA Ludsin, EA Marchall, RR Budnik, ZL Almeida, CL Cahill, HS Embke, ZS Feiner, PH Schmalz, MJ Thorstensen, MJ Weber, MR Wuellner, and GJA Hansen. *In press*. Synthesizing professional opinion and published science to build a conceptual model of walleye recruitment. Fisheries.

Willard, JD, JS Read, S Topp, GJA Hansen. V Kumar. 2022. Daily surface temperatures for 185,549 lakes in the conterminous United States estimated using deep learning (1980–2020). Limnology and Oceanography Letters, 7(4), 287-301. doi: 10.1002/lol2.10249

Associated data release (predicted surface temperatures for all lakes in US):

J Willard, JS Read, SN Topp, GJA Hansen, and V Kumar, 2022, Data release: Daily surface temperatures for 185,549 lakes in the Contiguous United States estimated using deep learning (1980-2020): U.S. Geological Survey, https://doi.org/10.5066/P9CEMS0M

Hansen, GJA, J Ruzich, CA Krabbenhoft, H Kundel, S Mahlum, CI Rounds, AO Van Pelt, LD Eslinger, DR Logsdon, DA Isermann. 2022. It's complicated and it depends: A review of the effects of ecosystem changes on Walleye and Yellow Perch populations in North America. North American Journal of Fisheries Management 42:484-506. doi:10.1002/nafm.10741

Boehm, HI, DA Isermann., MJ Ermer, LD Eslinger, GJA Hansen, DE Logsdon. 2022. Special Section Overview: Effects of Ecosystem Change on North American Percid Populations. North American Journal of Fisheries Management, 42(3), 477-483. http://dx.doi.org/10.1002/nafm.10791 10.1002/nafm.10791

Results from projects not yet published:

- Using historical data from Minnesota, we have shown that walleye recruitment to the first fall declines in the presence of invasive zebra mussels. We are working on publishing these results.
- Walleye and yellow perch in lakes invaded by zebra mussels rely more heavily on nearshore, littoral resources than those from uninvaded lakes. We are working on publishing these results.
- Food web shifts associated with zebra mussel invasion are also linked to higher mercury concentrations in both walleye in yellow perch. We are working on publishing these results.

Ongoing projects related to walleye/yellow perch:

- We are continuing to collate fish relative abundance and growth data from state agencies in the Midwestern US. We are building a workflow for combining, filtering, and summarizing these data and plan to release them this year.
- We are developing models to predict fish responses to warming temperatures that incorporate physiological tolerance and observational data.
- We are embarking on a new project focused on walleye "bright spots" - places where walleye populations are doing well and demonstrating resilience to changing conditions, in order to learn how to manage for resilience.

University of St. Thomas Research:

Title: Factors Driving Isotopic Niche Size and Niche Overlap in Yellow Perch (*Perca flavescens*)

Understanding patterns of trophic niche overlap in fish communities is important because trophic redundancy stabilizes food webs. Stable isotopes δ13C and δ15N can be converted into percent littoral carbon and trophic position, respectively, and used to estimate isotopic niche size of species A, niche overlap of species A on other species, and niche overlap of other species on species A. Our previous work showed Yellow Perch (*Perca flavescens*) have the largest isotopic niche overlap on other species and the second largest niche size of all species tested. However, perch niche size varied ten-fold and niche overlap threefold among lakes. We hypothesized niche overlap of perch on other species is positively related to perch niche size. We also hypothesized that perch niche size is driven by ontogenetic changes in diet, such that

populations with greater range in body size would exhibit the largest niches. Alternatively, perch niche size could be driven by food web effects such as average trophic position. We studied 14 Minnesota lakes and results showed perch niche overlap on other species was positively related to perch niche size. Perch niche size, however, was unrelated to mean, range, or standard deviation of perch length. Instead, niche size was inversely related to perch mean trophic position. Lastly, perch mean trophic position was positively related to hypolimnetic dissolved oxygen levels. Yellow Perch niche size and niche overlap on other species is thus driven by lake effects on food webs, and not by ontogenetic changes in perch foraging. Therefore, lake physical environments can influence patterns of fish trophic overlap and food web stability.

Title: Parallel trophic responses in predators across ecosystems: support for the ecosystem size and accessibility hypotheses

Understanding similarities and differences in trophic ecology of top predators in ecosystems is crucial given their importance for stabilizing food webs. Ecosystem size has been shown to influence trophic characteristics of predators, but the degree to which habitat quality alters ecosystems size -trophic relationships is less clear. Walleye (*Sander vitreus*) and Northern Pike (*Esox lucius*) are top predator fish species coexisting in many North American lakes, but similarities and differences in their trophic ecology across lakes are poorly know. We sampled Northern Pike and walleye from 14 Minnesota (USA) mesotrophic – eutrophic lakes and used δ13C and δ15N to estimate littoral carbon and trophic position, respectively. We also used littoral carbon and trophic position to estimate isotopic niche size of both species and niche overlap between species in each lake. Trophic ecology was distinctly different between the two species across lakes, with northern pike using more littoral carbon, having lower trophic position, a larger isotopic niche, and having greater niche overlap on walleye than vice versa. However, each species showed pronounced variability across lakes. Subsequent analysis showed the two species differed but paralleled each other across lakes as littoral carbon use, trophic position, variability in littoral carbon and trophic position, and niche size were all positively related between species across lakes. Lastly, the parallel responses across lakes were driven by presence of zebra mussels increasing use of littoral carbon, warmer and more oxygenated hypolimnion increasing trophic position, and lake size reducing niche size in both species. Our results provide evidence key factors can drive similar trophic responses in top predators, suggesting ecosystem features may influence ecosystem function by influencing multiple top predators in a similar way. They also support the habitat accessibility and ecosystem size hypotheses for trophic position, where unfavorable habitat conditions can reduce trophic position and alter ecosystem size-trophic position relationships.

Bemidji State University Research:

Title: Diet Patterns and Niche Overlap of Muskellunge and Co-occurring Piscivores in Minnesota Lakes

Kamden C. Glade, Brian R. Herwig, Tyler D. Ahrenstorff, Jeffrey R. Reed, Andrew W. Hafs North American Journal of Fisheries Management (In Press)

Muskellunge Esox masquinongy, Northern Pike E. lucius, Walleye Sander vitreus, and Largemouth Bass Micropterus salmoides are popular sport fish that often co-occur in aquatic systems. Although numerous studies have investigated interactions among these species, the simultaneous evaluation of diet patterns and niche overlap among all four species has not been conducted. Our experimental design aimed to quantify diet overlap among Muskellunge and other piscivores, while lakes without Muskellunge were also sampled to compare the diets of other piscivores in their presence or absence. Diets of piscivores from 10 Minnesota lakes were collected via gastric lavage and quantified using an index of relative importance. Diets of individual species were compared among seasons and length categories, and among-species comparisons were also conducted by season and relative to Muskellunge presence using permutational multivariate analysis of variance (PERMANOVA). Muskellunge consumed a wide range of prey, whereas Northern Pike and Walleye diets consisted primarily of Yellow Perch Perca flavescens and centrarchids. Largemouth Bass consumed more invertebrates, especially crayfish Faxonius spp. No species exhibited seasonal diet shifts, but diets were different among length categories for all species except Walleye. Although NMDS ordinations indicated shared prey use, PERMANOVA results indicated diets of Muskellunge and Largemouth Bass were most different from each other and other piscivores across all seasons. Conversely, Northern Pike and Walleye diets were similar regardless of season or Muskellunge presence. Finally, lake- scale habitat variables were correlated with piscivore diets and Yellow Perch abundance was correlated with Walleye diets. Our results indicate that while Muskellunge, Northern Pike, Walleye, and Largemouth Bass can co-exist in a variety of lakes, populations of important prey and habitat variables should be examined before management actions (e.g., stocking) are implemented to ensure adequate prey availability
and competition among these piscivores is not increased to the detriment of existing fisheries.

Title: Comparisons of Walleye Fecundity Before, During, and After Rehabilitation of the Red Lakes Fishery

Kamden C. Glade, Anthony J. Kennedy, Benjamin J. Miller, Benjamin D. Erb, Andrew L. Thompson, and Andrew W. Hafs Journal of Fish and Wildlife Management (In Review)

The Red Lakes, Minnesota, supported a substantial Walleye Sander vitreus fishery from the early to mid- 20th century, but experienced a major crash in the late 1990s. The population has since rebounded following a successful inter-agency recovery program and now supports valuable commercial and recreational fisheries. The variation in population densities associated with the collapse and subsequent recovery in the Red Lakes Walleye population provides a rare opportunity to study potential changes in relative fecundity (eggs/kg of body mass) under varying rates of exploitation: overexploited (1989 data), recovering (2004 data), and recovered (2017 data). Female Walleye were collected spring 1989 (n=30) in the Blackduck and Tamarac rivers and spring 2004 (n=30) and 2017 (n=30) in the Tamarac River. Results indicate relative fecundity was significantly lower in 2017 (50,768, SD=10,266) than in 1989 (58,216, SD=6,211) and 2004 (61,964, SD=7,472). We hypothesize differences in relative fecundity among fishery states

were due to differences in Walleye population abundances caused by varying exploitation rates in the years leading up to fecundity estimates.

Title: Interactions Between Rusty Crayfish Invasion and Yellow Perch Population Dynamics in North-Central Minnesota Lakes

Kendra L. Fink, Kamden C. Glade, Brian R. Herwig, Bethany J. Bethke, Andrew W. Hafs

In recent years there have been changes in percid populations in Minnesota, likely due to combined effects of invasive species, shoreline development, and changes in local climate. New sampling techniques are being used to better assess changes in these populations, though it is still unknown to what extent each of these variables affect fish population dynamics. Yellow Perch Perca flavescens are an important game fish and prey species for many piscivorous fish like Walleye Sander vitreus and Northern Pike Esox lucius. They spend much of their post-larval life in littoral areas, where they consume small fish and invertebrates and use benthic structures for shelter and reproduction. rusty crayfish Orconectes rusticus are a regulated invasive species and have the potential to outcompete native crayfish and decrease macroinvertebrate and small minnow populations though predation and habitat destruction. These changes to vegetation and prey assemblages in aquatic systems can lead to shifts in energy flow and, subsequently, altered growth, condition, and maturity of native fish species. It is unknown the degree of impact rusty crayfish invasion has on Yellow Perch population dynamics. In this study, we investigated potential effects by sampling 150 Yellow Perch from 14 lakes across north central Minnesota. Of those lakes, half are infested with rusty crayfish and all support healthy Yellow Perch populations. Total length, weight, sex, maturity status, age, and brief diet composition of sampled perch will be documented. Hypothesized interactions include an increase in growth, condition, length at 50% maturity (L50) and maximum size (Lmax) of Yellow Perch populations in lakes infested with rusty crayfish compared to populations in lakes without rusty crayfish. This could be driven by an increased availability of a nutrient-rich, and relatively easy, prey source to perch who exceed gape limitations, yet decreased habitat and resources for juvenile perch.

Title: Spatial and Temporal Variability of Mercury in Upper and Lower Red Lake Walleye

Tyler Orgon, Andrew Hafs, Carl Isaacson, Shane Bowe, Mark Brigham

Mercury is a global pollutant that is released into our environment by natural and anthropogenic processes resulting in extensive studies of mercury cycling in aquatic ecosystems, and the issuance of human-health- based fish-consumption advisories. We examined total mercury concentrations in Walleye Sander vitreus from Upper and Lower Red Lakes, located in north central Minnesota, between 2019 and 2020. Sampled Walleye (n = 265) ranged from 158 to 610 mm in total length from an age range of 0 to 16 years. Mercury concentrations within the Red Lakes ranged from 0.030 mg/kg to 0.564 mg/kg ($\bar{x}$ = 0.179 ± 0.105 mg/kg; $\bar{x}$ = mean ± sd, all

fish-mercury concentrations expressed in wet-weight). The best supported model for predicting mercury concentrations in Red Lake Walleye included the independent variables: length, age, sex, and lake basin. This model indicated that basin is an important predictor variable for estimating mercury concentrations between Upper and Lower Red Lake Walleye (Figure 1; $\bar{x}$ = 0.215 ± 0.117 and 0.144 ± 0.077 mg/kg, respectively), and also suggests that individuals who rely on fish for subsistence should target ≤ 400 mm Walleye from Lower Red Lake (Figure 2). The observed differences in mercury concentrations could be linked to wetland area, fish growth rates, and physicochemical parameters between the two basins. After adjusting for length as a covariate, Upper and Lower Red Lake exhibit fish-mercury concentrations comparable to other large lakes within the region. Given that our results illustrated a significant difference in fish-mercury concentrations between basins, future pollutant monitoring efforts should treat Upper and Lower Red Lake as separate lakes and not assume that data from one basin can apply to the other. This will be important over a longer time scale as ecosystems respond to changes in mercury emissions and other environmental changes.

Production

This was a good year for Walleye production across Michigan and helped some management units get lakes back in rotation, which had not received Walleye since prior to the COVID-19 pandemic. In total, the Michigan DNR stocked approximately 4.7 million spring fingerling Walleye. Additionally, over 17,000 fall fingerling Walleye were also stocked. It is important to reiterate Walleye rearing in Michigan is a joint effort between hatchery and field staff. Primarily, the respective field units raise Walleye in ponds after eggs are collected, fertilized, and hatched by hatchery personnel. Therefore, environmental conditions can certainly create strong and lean years. It was a big relief to fulfill stocking requests for some lakes that were still influenced by production limitations due to COVID.

Research

Several Walleye research endeavors are underway, with a new project beginning in 2022. In conjunction with the Michigan DNR, the Great Lakes Acoustic Telemetry Observation System initiated a new acoustic telemetry study in Saginaw Bay Lake Huron during the spring of 2022. The goal of this study is to identify if reef or shoreline spawning aggregations of Walleye occur in Saginaw Bay. Historically, "bay" spawning populations existed however, the extent of these populations is currently unknown. Researchers caught Walleye in the bay proper with the assistance of local fisherman and implanted acoustic transmitters into the abdomen. In addition to deploying acoustic receivers in Saginaw Bay tributaries (e.g., Tittabawassee, Cass, Flint, and Shiawassee), acoustic receivers were deployed throughout the bay to help identify spawning aggregations in successive years. The results of this work will assist fishery managers understand stock contribution of this important Great Lakes fishery.

Other research focused on Walleye is occurring on the Lake Michigan side of the State, as well as Lake Superior. The Marquette Fisheries Research Station provided samples from Walleye spawning stocks and the fishery in Michigan waters of Lake Superior as part of a Lake Superior wide Walleye genetics project entitled "Determining stock structure and habitat usage of Lake Superior Walleye to inform management and restoration" being led by Jared Homola from UWSP. Furthermore, collaboration continues to occur with Dan Isermann, Dan Dembkowksi and others on acoustic telemetry and diets of Walleyes in Green Bay.

Recent Publications

Whitinger, J.A., Zorn, T.G. and Gerig, B.S. 2022. Stable isotope signatures and displacement patterns of Walleye change following establishment of dreissenid mussels in a Lake Michigan embayment. North American Journal of Fisheries Management. https://doi.org/10.1002/nafm.10733

Zorn, T. G., and D. R. Kramer. 2022. Changes in habitat conditions, fish populations and the fishery in northern Green Bay, Lake Michigan, 1989-2019. North American Journal of Fisheries Management. https://doi.org/10.1002/nafm.10715

Management

Michigan DNR – Fisheries Division finalized and published the Management Plan for Walleye in Michigan's Inland Waters. The overarching goal of this plan is to protect, conserve, and adaptively manage Walleye populations to maximize ecological benefits and angler satisfaction derived from healthy Walleye populations and fisheries. The plan can be found in its entirety at this website, https://www.michigan.gov/dnr/managing-resources/fisheries/Walleye.

A new Walleye and Yellow Perch Management Plan is being developed for Saginaw Bay. Beginning in 2015, Walleye harvest regulations were liberalized to reduce the Walleye population and reduce predation pressure on Yellow Perch. Currently, the Yellow Perch population remains depressed, and the Walleye population has swelled to over 9 million. Possibly, this is a compensatory response to the efforts to reduce the population size and the Walleye population is resisting by generating very large year classes. The full extent of the Saginaw Bay Walleye recovery may not yet be revealed, and the bay's Walleye population may still be showing what it is capable of. Likely the liberalized harvest regulations will continue under the new management plan, but expectations and sustainability criteria may change.

Michigan DNR is in the process of developing protocols to evaluate recruitment and stocking success. The internal Walleye Committee is currently in the process of drafting the protocols, so would greatly appreciate feedback from other states regarding what has been useful for their evaluations. Methods being considered are spring mark-recapture surveys using trap and fyke nets and electrofishing, multiple gear types via Michigan DNR's status and trends inland lakes program conducted in early summer (~May-June), and fall shoreline electrofishing to target juveniles.

Michigan DNR and the MSU Quantitative Fisheries Center used fisheries assessment and stocking data to determine important biotic and abiotic factors that contribute to Walleye production, natural and artificial (i.e., stocking), throughout the state. This work was drafted into a manuscript entitled "Biotic and abiotic factors that influence Walleye recruitment in stocked lakes in Michigan" and was submitted to the NAJFM. Michigan DNR also provided data for the UWSP project led by Dan Isermann that is focused on evaluating stocking success at a regional level.

IL WTC Report, February 2023, submitted by Jason DeBoer INHS

Qihong Dai and Cory Suski, University of Illinois

We did a lab study to quantify how warmwater fish (largemouth bass), coolwater fish (walleye) and prey (fathead minnows) vary in their response to short duration heat waves associated with climate change. The temperature parameters used came from in-situ monitoring of tributaries of the Kaskaksia River, and consisted of 1-h exposures of fish to 30 degrees and looked at metabolic rates, swimming abilities and response to prey items. He found that walleye had pronounced declines in aerobic scope, swimming abilities and their response to prey items after just a 1-h heatwave exposure, and these responses were largely absent in largemouth bass, which maintained performance. This study provides a possible mechanism by which largemouth bass can outcompete walleye and expand their range northwards as heatwaves will result in a decline in performance for walleye.

Jeremiah Haas, Constellation Nuclear

Walleye production was poor for us in 2022. The 90-degree temps in May put a beating on our canal water temperatures. We only produced a little over 16,000 advanced fingerlings in 2022, unfortunately. Fall electrofishing stock assessments in the tailwaters showed poor YOY production of walleye in Pools 13-15, so mother nature may have struggled as well.

Our big news is we installed a new RAS system in December, similar to ones at the Rathbun Iowa Hatchery. This was installed to replace our natural water walleye production. We hope to run parallel programs in 2023, with the discontinuance of the spray canal program once we know the RAS is operating as expected. With it, we should have much better consistency in our production as well as the flexibility to produce alternate crops of fish with them.

Sarah King, Illinois Natural History Survey

General Objective: Collect and analyze demographic information for Walleye, Sauger and their hybrids in Lake Bloomington, Charleston Side Channel, Clinton Lake, Dawson Lake, Lake Decatur, Evergreen Lake, Homer Lake, Lake Mattoon, Lake Paradise, Paris East Lake, Paris West Lake, Lake Shelbyville, and Weldon Springs Lake to assess age-related metrics by June 30, 2023.

We continue to collaborate our sampling efforts and data collection with IDNR and Kaskaskia biological station to survey our targeted lakes in the spring (using fyke nets and night DC EF) and in the fall (using fyke nets). We began by conducting QA/QC of our data and the IFish Data Portal to ensure accurate data on both platforms. In doing so, we were able to enter cool water fish age data into the IFish Data Portal from previous years and update survey data. We have been able to keep up with data entry into the portal so that all age data that has been entered.

As we collected an adequate sample size, we began to compare the age estimates between otoliths and dorsal spines of Saugeye caught in Dawson Lake (N=125) and Evergreen Lake (N=142). Length at age curves were constructed for both males and females within each waterbody. Age bias plots were also constructed to detect any bias between otolith and dorsal

spine age. There was little variation between otolith and dorsal spine ages, however, dorsal spines tended to underestimate the age of older Saugeye relative to otolith age.

To validate annuli growth in otoliths and dorsal spines, we examined Walleye and Saugeye from lakes stocked with fish that were immersion marked with oxytetracycline (OTC) in 2019. We used a UV light source under a compound microscope to look for OTC in otoliths and sectioned dorsal spines. No positive marks have been detected to date. Data collection is ongoing for this component of the project.

Age-length keys were created for Walleye, Sauger, and Saugeye populations using consensus-aged fish to visualize growth trends across populations. For most populations, keys were created using whole dorsal spine ages, but if otolith age data was available, we also created a key based on otolith ages. When possible, keys were separated by sex as well. There was a distinct difference in growth curves between males and females regardless of which structure was used to make the curve (example in Figure 1). Data collection is ongoing for this component of the project and will expand into the Fox Chain o' Lakes in fall 2023.

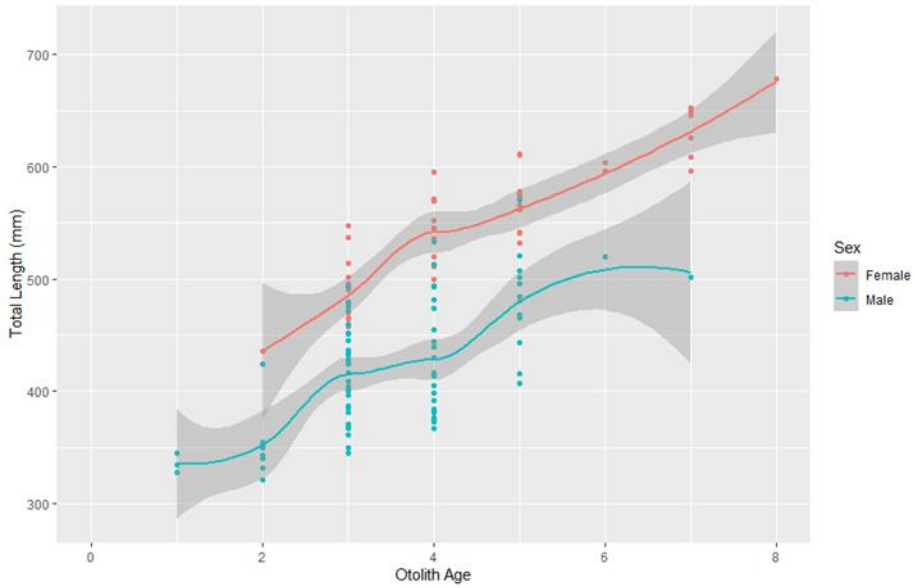


Figure 1: Total length at otolith age for Saugeye captured in Evergreen Lake (N=141). Shaded area represents 95% CI.

Seth Love, Illinois DNR

- 810,810 Walleye stocked into District 8 Lakes (half of those were fry stocked into Monster Lake)
- 4,230 Saugeye fingerlings stocked into Lake Chaminwood (cooperatively managed lake owned by Will County Forest Preserve District).
- Monster Lake (Mazonia SFWA) had an approved Walleye regulation change, from the statewide regulation (14" Minimum Length Limit, 6 Fish Daily Creel) to a site-specific 18-24" Protected Slot Length Limit (4 Fish Daily Creel, only 1 Over 24").

• Have yet to formally analyze data, but Heidecke Lake Spring Muskie and Fall community surveys appeared to provide desirable Walleye data (good size distribution, good relative abundance, etc).

Tristan Widloe, Illinois DNR

Twenty-nine Walleye broodfish collected below the Wilmington Dam on the Kankakee River, were transferred to the Lasalle Hatchery in March 2022. Average length of broodstock was 540 mm (21 in). The largest Walleye collected was a female measuring 632 mm (25 in).

Three locations on the Kankakee River (Aroma Park, downstream Kankakee Dam, downstream Wilmington Dam) were stocked with 86,752 Walleye fingerlings in late May/early June 20222. An additional 22,688 fingerlings were stocked in the Iroquois River in Watseka in May 2022.

Boone LaHood, Illinois DNR

East Fork Lake (Richland County): Walleye fingerlings are stocked annually (approximately 30,000 per year). The catch rate for the 2022 spring gillnetting survey was 21 per net-night. The fall 2022 electrofishing catch rate was 14 per hour. Survey catch rates and angler reports seem to suggest that the population has improved in recent years and is doing well.

Forbes Lake (Marion County): Saugeye fingerlings are stocked annually (approximately 30,000 per year). Catch rates in the spring gillnetting surveys and fall electrofishing surveys have historically been low. However, spring and fall Wr values are typically very good and anglers report being able to target them.

Sam Parr Lake (Jasper County) and Borah Lake (Richland County): Starting in spring of 2023, annual saugeye fingerling stockings (approximately 9,000 per year in Sam Parr Lake and 6,900 in Borah Lake) have been requested. These small lakes have abundant shad forage bases and also contain dense populations of small black and white crappies.

Nerissa McClelland, Illinois DNR

In 2022, the IDNR State Fish Hatchery System stocked over 10.3 million sauger ranging in size from 0-1.4" into the upper Peoria, Starved Rock and Marseilles pools of the Illinois River.

Mike Garthaus, Illinois DNR

ILLINOIS DEPARTMENT
OF NATURAL RESOURCES
DIVISION OF FISHERIES

SUPPLEMENTAL SURVEY

COUNTY: DeWitt
T 19N R 2E S 12
Direction from nearest town:
2.5 miles southeast of Clinton

Date of Inspection: 3/24/22

Name of Water: Weldon Springs Lake Owner: State of Illinois
Address: Weldon Springs State Park Phone: 217/935-2644
R.R. 2 Clinton, IL 61727
Person Contacted Charlie Montgomery Identification Site Sup.
Address Phone

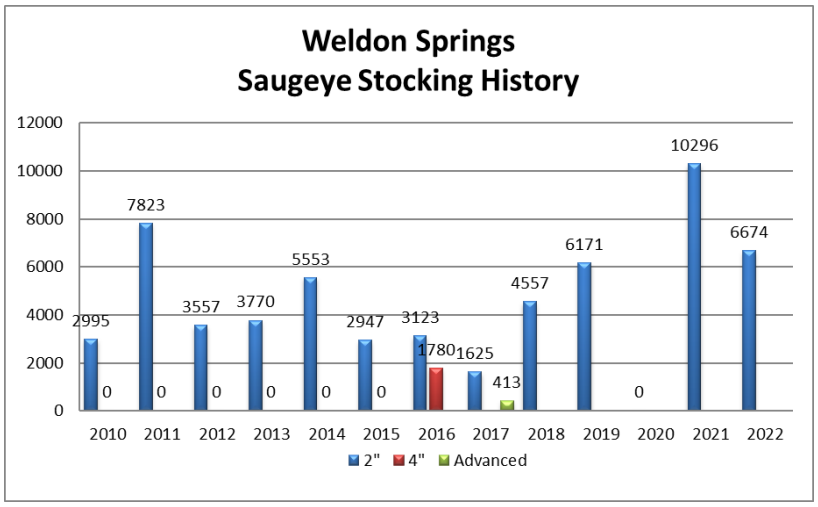
Water Classification: State XX Public ___ Organizational
Commercial ___ Private ___ Stream

Survey Initiated By: District Fisheries Biologist
Water Size: 29.4 Acres or _____ Miles.
Date of Last Inspection: 10/26/17
Purpose of Survey: Saugeye Survey

In 2022, the lake was surveyed using three, 15-minute DC electrofishing stations. From 2012 to 2015, the lake was divided into two sampling areas and each area was sampled at night for 0.5 hours using DC electrofishing. Two netters were utilized during all surveys.

Saugeye

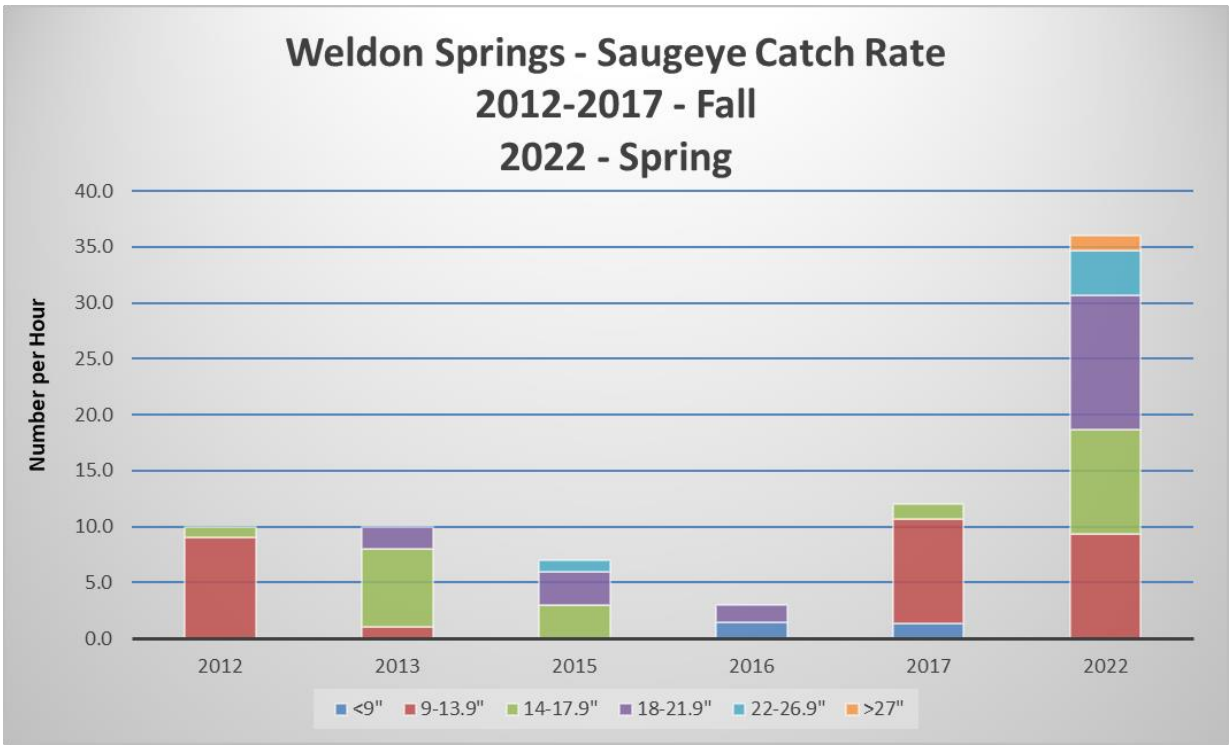
Saugeye were first stocked into the lake in 2010. The requested stocking rate is 45 per acre resulting in 1,305 saugeye. All of the saugeye stockings have been above the requested rate. The original stocked request was for 2" saugeye but 4" saugeye were requested in 2016. The hatchery does not raise fingerling Saugeye and only 2" Saugeye are available, so the hatchery stocks above the requested rate. No Saugeye were stocked in 2020 because of COVID restrictions.



Density and Size Structure

From 2012 to 2017, the Saugeye targeted night survey was conducted in the fall. The original intent of the fall surveys was to assess stocking success. The fall surveys tend to underrepresent the larger Saugeye.

The 2022 survey was conducted at the end of March and resulted in the highest catch rate ever obtained for Saugeye at Weldon Springs. Size structure was also good, and all size ranges were represented – except for less than 9" but the Saugeye might have grown out of that size range. The Saugeye fishery looks great and future targeted surveys should be conducted in the spring.



Future Management

Saugeye will continue to be stocked each year and a spring electrofishing survey will be conducted.

In an attempt to increase catch rates and improve the saugeye fishery, the regulation was changed on April 1, 2016 to a 15 inch minimum length limit with a 3 per day harvest limit and only one saugeye over 20 inches. This regulation is working to maintain a great Saugeye fishery.

SPECIES: SAUGEYE
LAKE: WELDON SPRINGS
COUNTY: DEWITT
ACRES: 29.4
GEAR: ELECTROFISHING - DC - FALL

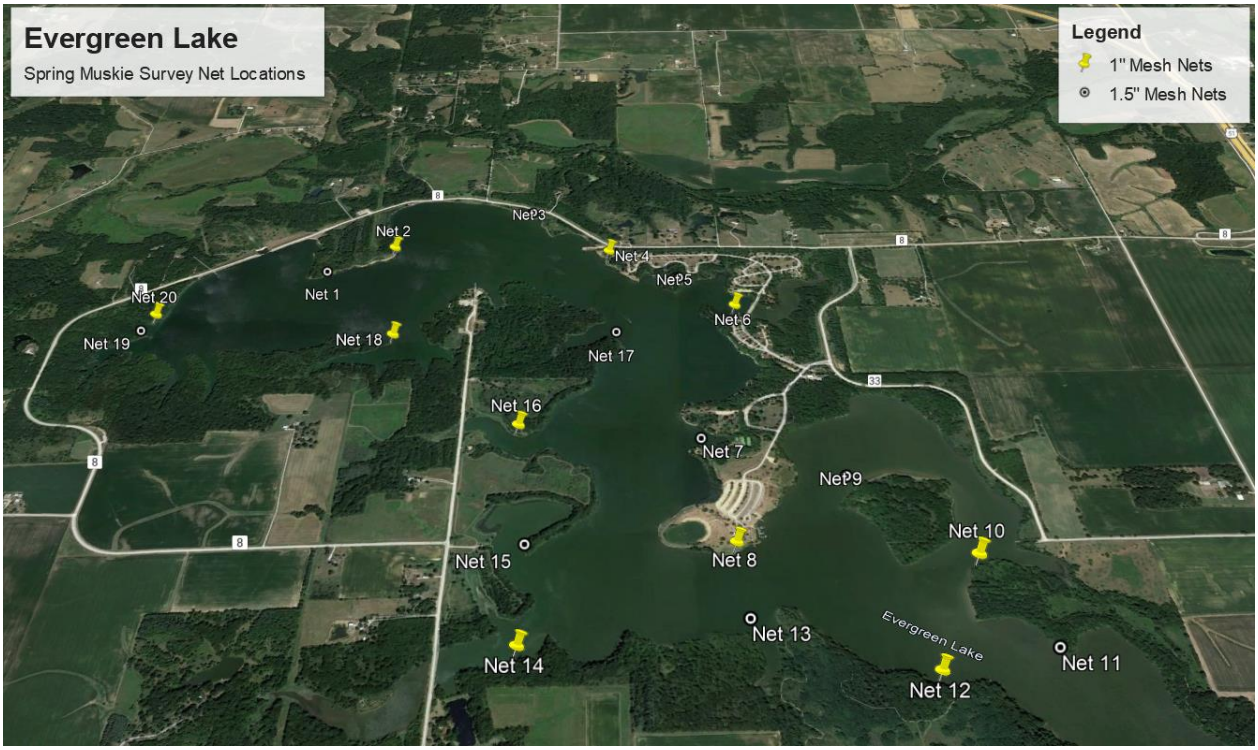
										Relative Weight								
YEAR	TOTAL NUMBER AND CPE			<S <230 <9"	S-Q 230-349 9-13.9"	Q-P 350-459 14-17.9"	P-M 460-559 18-21.9"	M-T 560-689 22-26.9"	>T GE690 >27"	Average Relative Weight	S-Q 230-349 9-13.9"	Q-P 350-459 14-17.9"	P-M 460-559 18-21.9"	M-T 560-689 22-26.9"	PSD	RSD-P	RSD-M	EFFORT
2012	NO.=	10		0	9	1	0	0	0									
	CPE=	10.0		0.0	9.0	1.0	0.0	0.0	0.0	80	79	84			10	0	0	1
	%			0	90	10	0	0	0									
2013	NO.=	10		0	1	7	2	0	0									
	CPE=	10.0		0.0	1.0	7.0	2.0	0.0	0.0	74	79	75	69		90	20	0	1
	%			0	10	70	20	0	0									
2015	NO.=	7		0	0	3	3	1	0									
	CPE=	7.0		0.0	0.0	3.0	3.0	1.0	0.0	82		82	84	75	100	57	14	1
	%			0	0	43	43	14	0									
2016	NO.=	2		1	0	0	1	0	0									
	CPE=	3.0		1.5	0.0	0.0	1.5	0.0	0.0				96		100	100	0	0.67
	%			50	0	0	50	0	0									
2017	NO.=	9		1	7	1	0	0	0									
	CPE=	12.0		1.3	9.3	1.3	0.0	0.0	0.0		87	79			13	0	0	0.75
	%			11	78	11	0	0	0									
2022	NO.=	27		0	7	7	9	3	1									
	CPE=	36.0		0.0	9.3	9.3	12.0	4.0	1.3		104	95	99	104	73	46	12	0.75
	%			0	26	26	33	11	4									
Average		13.0		0.5	4.8	3.6	3.1	0.8	0.2	78.7	87.3	83.0	87.0	89.5	64.3	37.2	4.3	

2022 - Spring

ILLINOIS DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISHERIES
SUPPLEMENTAL SURVEY

Evergreen Lake
Owner: City of Bloomington
Lessee: McLean County Parks and Recreation
Water Classification: Public Coop
Water Size: 926 acres
Date of Inspection: 3/29/22
Purpose of Survey: Saugeye & Muskie survey

Two different fyke net designs were used during the 2021 and 2022 fyke netting surveys. The 1" mesh fyke nets were 4' x 6' with 2 frames per net followed by (n = 5) 36" diameter hoops, and 1 throat on first hoop. The 1.5" mesh fyke nets were 4' x 6' with 2 frames per net followed by (n=6) 30" diameter hoops, and 2 throats. In 2021, 40 net-nights of effort was used. Ten nets of each type were run for one net-nights totaling 20 net-nights of effort in 2022. Severe weather prevented us from running nets a second day in 2022.
Frame nets were first utilized in 2002 to assess these fisheries. The standard net size for this survey has been the 1.5" mesh fyke net. Sites with 1" mesh nets in 2021 were switched to 1.5" mesh nets in 2022 and vice versa for the 1.5" mesh nets. The map shows the 2022 net locations.



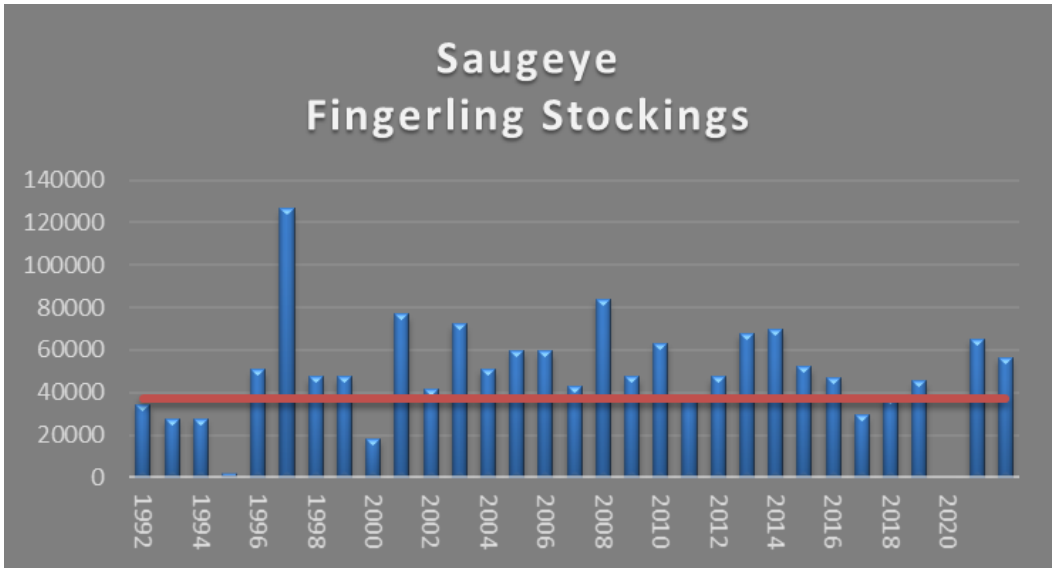
Regulation

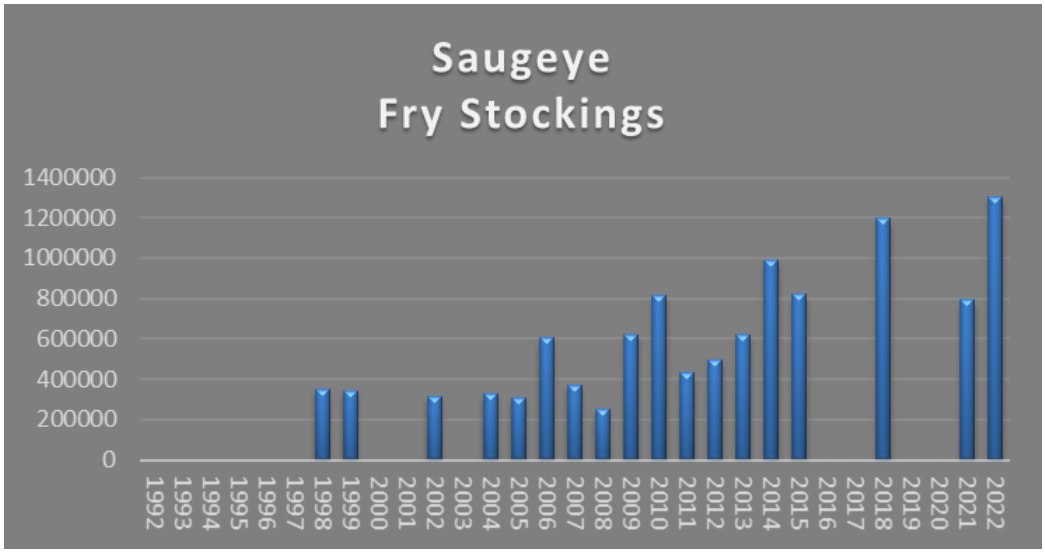
Saugeye 18" minimum length limit and 3 per day harvest limit. (April 1, 2015)

Saugeye

Stockings

Saugeye were first stocked into the lake in 1992 as part of a study for the North Central Division of the American Fisheries Society. The study was planned for five years, making 1996 the last year. Saugeye have been stocked every year since 1992 and has resulted in a very good fishery. The annual requested stocking is 37,040 (40 per acre).





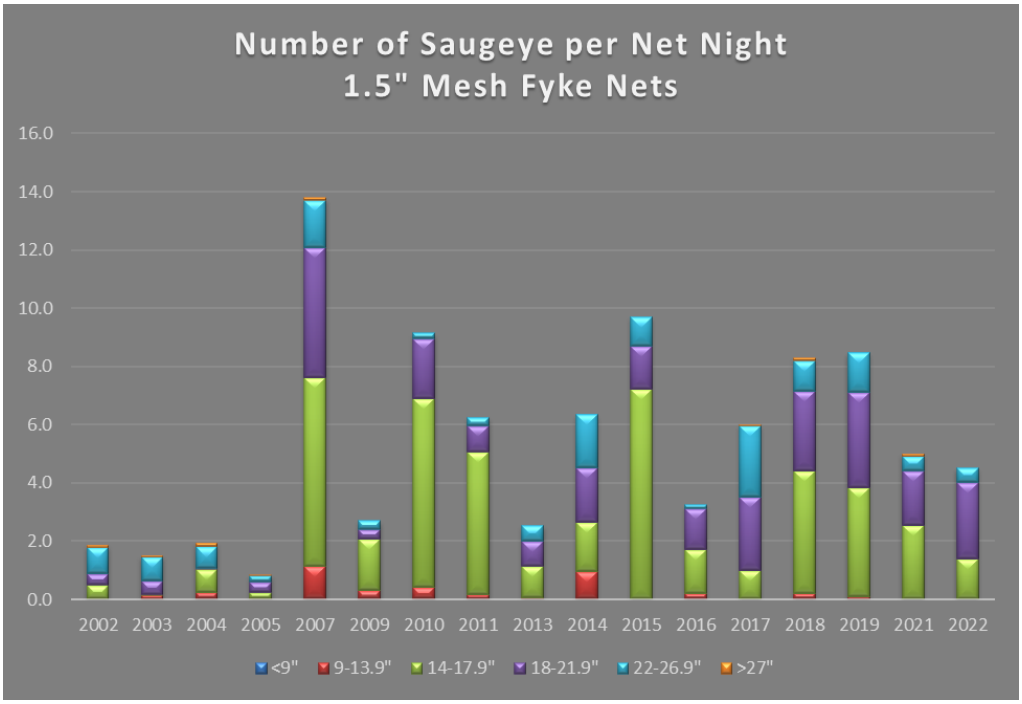
Density

Since the nets have 1.5" mesh, the nets fail to collect smaller saugeye, but the nets catch a larger number of big Saugeye than fall nighttime electrofishing. Netting surveys have been a poor indication of young year classes for Saugeye but were a good indication of legal-sized fish. No Saugeye have been collected less than 9 inches during the spring netting surveys.

In 2015, the catch rate was 9.7 per net-night and declined to 3.3 per net night in 2016. In 2015, the regulation was changed from a 14" minimum length limit and 6 per day harvest limit to an 18" minimum length limit and a 3 per day harvest limit. In 2018, the catch rate increased to 8.3 per net-night and the catch rate changed very little in 2019. Catch rate declined in 2021 but remained stable in 2022. The missing 2020-year class might be playing a role in the decrease.

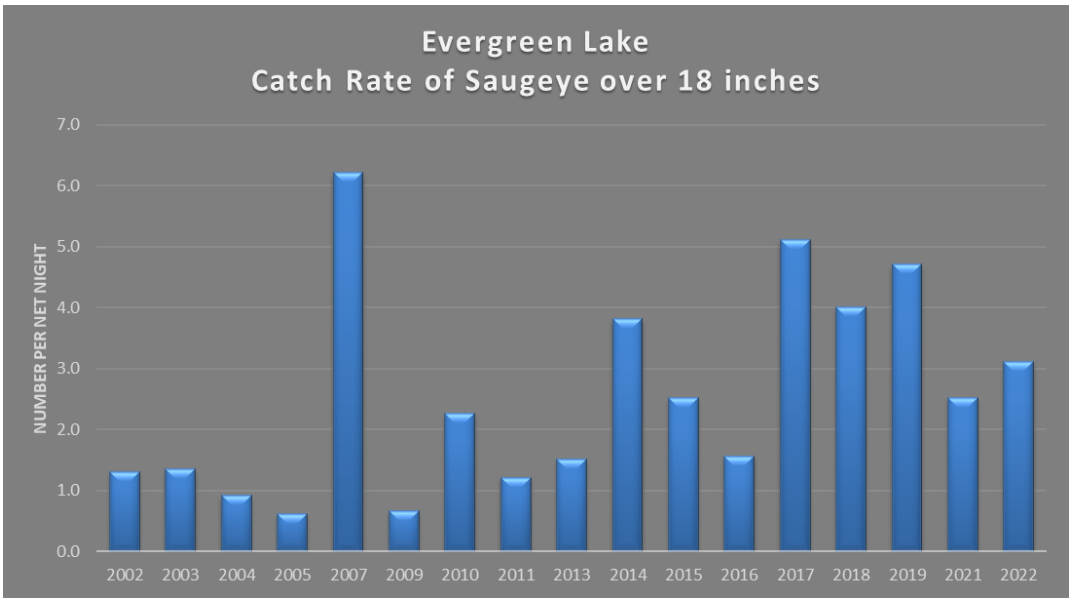
Approximately 85% of the Saugeye collected in 2021 came from 3 nets, net 1 (56), net 2 (46), and net 20 (41). In 2022, 53 of the 54 Saugeye were collected from 2 nets: net 1 (45) and net 20 (8).

The walleye management plan has a catch rate objective of 2.5 walleye per net-night. There currently is not a Saugeye management plan for Illinois.



Size Structure

Of all the Saugeye collected over 9 inches in 2021, 100% were longer than 14 inches and 69% were longer than 18 inches. The catch rate for Saugeye in the 14" to 17.9" size range has been declining since 2018.
In 2017, the catch rate for Saugeye over 18 inches was 5.1 per net-night and was the second highest catch rate over the past 15 surveys. In 2019, the catch rate for Saugeye over 18 inches was 4.7 per net-night and was the third highest catch rate over the past 15 surveys. Three of the of the top four catch rates for Saugeye over 18 inches have occurred since the regulation change. In 2021, the catch rate for legal Saugeye declined to 2.5 per net-night but increased to 3.1 in 2022.



Condition

Condition, based on relative weight values, was adequate for all sizes and the average relative weight was 96.

SPECIES: SAUGEYE
LAKE: EVERGREEN LAKE
COUNTY: MCLEAN
ACRES: 925
GEAR: 1" FRAME NETS

YEAR	TOTAL NUMBER AND CPE			<S <230 <9"	S-Q 230-349 9-13.9"	Q-P 350-459 14-17.9"	P-M 460-559 18-21.9"	M-T 560-690 22-26.9"	>T >690 >27"	Relative Weight: Average Relative Weight	Relative Weight: S-Q 230-349 9-13.9"	Relative Weight: Q-P 350-459 14-17.9"	Relative Weight: P-M 460-559 18-21.9"	Relative Weight: M-T 560-690 22-26.9"	PSD	RSD-P	RSD-M	EFFORT
2021	NO.=	67		0	0	34	29	4	0	98		95	100	112	100	49	6	20
	CPE=	3.4		0.0	0.0	1.7	1.5	0.2	0.0									
	%			0	0	51	43	6	0									
2022	NO.=	9		0	0	1	7	1	0			99	107	105	100	89	11	10
	CPE=	0.9		0.0	0.0	0.1	0.7	0.1	0.0									
	%			0	0	11	78	11	0									
1.5" FRAME NETS																		
2021	NO.=	100		0	0	51	37	10	2	97		96	94	110	100	49	12	20
	CPE=	5.0		0.0	0.0	2.6	1.9	0.5	0.1									
	%			0	0	51	37	10	2									
2022	NO.=	45		0	0	14	26	5	0			94	94	106	100	69	11	10
	CPE=	4.5		0.0	0.0	1.4	2.6	0.5	0.0									
	%			0	0	31	58	11	0									

Recommendations**:**

1. The hatchery should stock 37,040, 2-inch Saugeye in May or June each year.

2. A spring electrofishing survey for Saugeye should be conducted during the night.

Rick Bushman, Illinois DNR, LaSalle hatchery

Sauger

Broodfish and Egg Collection

Collection of adult sauger broodfish was carried out at two tournaments held on the Illinois River in 2022. The Battle on the River (BOR) tournament was on Sunday, March 13 and the Masters Walleye Circuit (MWC) tournament was on March 18-19. Both tournaments were held at the Spring Valley Boat Club. A total of 37 teams participated in the BOR tournament and the water temperature was 39 °F. The river level was normal. The tournament officials provided two Rubbermaid tanks to hold the anglers fish baskets prior to weigh in.

A total of 167 fish were caught by the anglers. At the weigh-in, sauger were separated by sex and the fish were transported to the hatchery in a 1 ton hauling truck. A total of 93 females and 25 males were taken to the hatchery. Another 1 ton hauling truck was used to transport the remaining 30 sauger and 19 walleye to a release site on the Illinois River.

Upon arrival at the hatchery, the male sauger were placed in a 600 gal tank with flowing well water chilled to 53 ºF. Sauger males were injected with approximately 250 IU/lb HCG (0.4-0.5 ml/fish) on March 13. Sauger semen was extended according to Moore (1996) on five occasions from March 18-31 (Table 2). The male sauger were re-injected with HCG at 250 IU/lb each time semen was extended.

Upon arrival at the hatchery, the female sauger were placed in tanks with well water chilled to 53 ºF. On Thursday, March 17 (4 days after collection), the female sauger were checked for spawning. None of the females spawned on March 17 and 72 females were injected with 500 IU/lb HCG and placed in tanks with 58 ºF water, 21 females were returned to the Illinois River.

A total of 96 teams participated in the MWC tournament. A total of 890 fish were caught during the two day tournament. A total of 199 female sauger and 142 male sauger were transported to the fish hatchery. The male sauger were injected with 250 IU/lb HCG (0.4-0.5 ml/fish) on March 19 as they were placed in the hauling tank. The female sauger were transported to the hatchery and placed in tanks with well water at 58 °F. The

remaining 491 sauger and 58 walleye were transported to a release site on the Illinois River immediately after the weigh in each day.

The female sauger collected at the MWC were checked for spawning on March 22, female sauger that did not spawn were injected with 500 IU/lb HCG. The female sauger from the BOR were also checked at the same time, a total of 9 female sauger spawned on March 22. The female sauger from the BOR were checked for spawning daily from March 22-March 25. Fish that had not spawned by March 25 were returned to the Illinois River. The female sauger collected at the MWC were checked for spawning daily from March 26-April 1. The post spawn females were returned to the Illinois River on the same day they were spawned.

The eggs were spawned using the "dry method" and fertilized with extended sauger semen. The semen was mixed with eggs both immediately prior to the addition of water and 30 seconds after the addition of water. The eggs and semen were stirred for 2 min, mucked with fuller's earth for 3 min and rinsed in well water. The eggs were water hardened for 1.5 hours, then treated for 15 min in 100 ppm povidone iodine (Ovadine, Western Chemical Inc.). The egg baskets were then placed in well water and the eggs were siphoned into hatching jars.

A total of 15.55 million eggs were taken from 217 females collected at both tournaments and 11.2 million fry hatched, resulting in a 72.0% hatch rate (Table 3). The average weight of the female sauger was 2.0 lb (1.4-3.3 lb). A total of 531.7 ml of HCG was injected into male (191.0 ml) and female (340.7 ml) sauger. It took 7 to 9 d for the eggs to hatch (189-243 T.U.) at water temperatures of 58-60 °F. A total of 10.27 million fry were stocked into the Illinois River (Table 4), three LaSalle Hatchery ponds (2.1 million) and 650,000 were transferred to the Fin N Feather rearing pond.

Fingerling Production

Three 2.5 acre LaSalle Hatchery ponds (2,3,10) were stocked with 3-7 day old fry on April 11 and 13. The total number of fry stocked was 700,000/pond, which was an average of 280,000/acre. The stocking rate was increased from the normal stocking rate of 200,000/acre due to an approaching cold front that decreased pond temperatures April 16-18. The ponds were finished filling to approximately 1/3 full 7-9 days prior to the initial stocking. The ponds continued to fill in stages after the initial stocking and were full at three weeks post-stocking. Filter socks (300 micron) were used on the inflowing lake water and although they required cleaning usually twice per day, they were effective at eliminating foreign fish species and large cladocera spp. from the water flowing into the ponds.

All ponds were fertilized with alfalfa meal. The initial fertilization rate was 160lb/acre the first week and 100lb/acre each following week. The total amount of fertilizer was applied on two different days each week. This was the "base" fertilization rate and adjustments to the fertilization rates were made depending on water quality and the zooplankton populations.

A total of 246,398 fingerlings were produced for stocking in state waters (Table 5).
The fingerlings were cultured for an average of 51 d (42-63 d), averaged 1.6 inches (1.3-2.2 inches) and weighed 1,251 fish/lb (404-1,953 fish/lb) at harvest. A total of 183.8 lb of sauger fingerlings were produced (24.5 lb/acre). Fish production was below normal, averaging 32,853/acre. Survival averaged 11.7% in the ponds (Table 6).

Pond water temperatures were 52 °F at stocking (April 11). Pond temperatures were colder than normal and stayed below 50 °F until April 21. A cold front dropped 1 inch of snow overnight on April 18 (seven days post stocking). Historically, water temperatures that are below 50F have a negative impact on larval sauger. Pond temperatures were favorable in early May (60°F) and increased to (70 °F) mid May.

Zooplankton populations were slow to develop and were comprised mainly copepods and rotifers throughout April. The zooplankton population was very weak in pond 10 throughout the spring. Results from test seine sampling on May 17 revealed fish averaging 1.1 inches and harvest began May 23.

Tribune and Cutrine Plus were used to control filamentous algae (Spirogyra and Pithophora) and Chara. Treatments of Cutrine Plus liquid and Tribune were applied to the ponds as needed, individually or as a 50:50 mixture at 0.3-1.5 gal/acre depending on the severity of the algae growth. Treatments began May 10 and were applied as needed, through the second week of June. Aquathol K was used to control pondweed in early June in Pond 2, at a rate of 0.7gal/acre. The total amount of chemical used in each application was diluted with 25-50 gallons of water and applied using a HYPRO power sprayer. Cutrine Granules were added to Pond 3 to control Chara in early June.

Walleye

Broodfish and Egg Collection

Broodfish were collected from the Fox Chain O 'Lakes (FCOL) and Kankakee River in 2022. Upon arrival at the hatchery the fish were separated by location. They were also separated into two groups; green females and males. Ripe flowing females were spawned immediately off the truck and green females were injected with 500 IU/lb HCG. Upon arrival at the hatchery April 5, a total of 68 male walleye from the FCOL were injected with HCG (250 IU/lb). Prior to injection, semen was collected and extended (3:1) from 31 of male walleye, yielding 30 flasks. An additional 39 male walleye were received from the FCOL on April 7 and were injected with 250 IU/lb HCG.

Broodfish collection on the Kankakee River was performed by Region 2 Streams personnel and was carried out on March 25 and March 29. A total of 23 females were collected from the Kankakee River and 18 spawned from March 27-March 30. Four females were spent upon arrival, one female spawned upon arrival and the remaining fish were injected with 500IU/lb HCG. A total of six male walleye were collected on March 29, semen was extended upon arrival and all fish were injected with 250 IU/lb HCG. The average weight of the females was 4.1 lb (2.4-6.3 lb).

A total of 1.67 million eggs were collected and incubated in five separate batches. The overall hatch rate was 67.4%. Egg volume averaged 110,000/L with an average of 92,889 eggs collected per fish. The eggs were fertilized with both extended and fresh semen, water hardened, and treated with iodine identical to the sauger eggs. The eggs hatched in 8 d (216 T.U.) at a water temperature of 59 °F. A total of 500,000 fry were stocked in one LaSalle Hatchery pond 627,000 were stocked in Monster Lake.

Region 2 personnel electrofished the FCOL April 4,6 and 7. Broodfish were held at the Spring Grove Hatchery Park overnight and picked up the next day. A total of 107 walleye females were transported to the hatchery on April 5,7 and 8. Seventeen of the females spawned upon arrival at the hatchery, four were spent and the remaining females received a 500 IU/lb injection of HCG. The females averaged 5.4 lb (2.2-10.4 lb).

The fish were spawned using the dry method. The eggs were fertilized extended semen prior to the addition of water and with two males approximately 30 sec after the addition of water. The eggs were stirred for two min, mucked with fuller's earth and rinsed in well water. The eggs were water hardened for 1.5 hours, then treated for 15 min in 100 ppm povidone iodine (Ovadine, Western Chemical Inc.). The egg baskets were then placed in well water and the eggs were siphoned into the hatching jars.

A total of 9.37 million eggs were collected from 63 FCOL walleye females from April 5-April 11. Egg volume was 118,000/L with an average of 148,571 eggs/fish. The eggs hatched in 8-9 d (216-243 T.U.) at a water temperature of 59 °F. A total of 5.4 million eggs eyed up and hatched (57.6% hatch rate).

A total of 2.4 million fry were stocked in six LaSalle hatchery ponds, 450,000 fry were transferred to the Jake Wolf Fish Hatchery (JWFH) ponds, and 100,000 to Southern Illinois University. Additionally, 2,450,000 fry were stocked in the Fox Chain O'Lakes (Table 7).

Fingerling Production

The 4-6 d old FCOL fry (2.4 million) were stocked into a total of six LaSalle Hatchery ponds (4,6-8,12,14). The ponds were stocked April 21 and April 26 with a total of 200,000-500,000 fry/pond (133,000-200,000 fry/acre). Pond 9 was stocked with a total of 500,000 Kankakee River strain fry (2-4 day old) on April 12 (200,000/acre). The water temperature was 54°F at stocking. The ponds were finished filling to 1/3 full an average of 9 d (6-11 d) prior to stocking. The ponds were filled to 2/3 full two weeks after the initial fry stocking.

Lake water was filtered through 300 micron filter socks before entering the ponds. The fertilization rate was 160 lb/acre the first week and 100 lb/acre each week thereafter. The fertilizer was added to the ponds in two separate applications each week.

A total of 1,325,330 fingerlings were produced for stocking various lakes and rivers in Illinois including 292,025 in the FCOL, 193,389 in Clinton Lake, 86,752 in the Kankakee River and 107,268 in the Rock River (Table 8). The fish were cultured for an average of 46 d (33-56 d), the average length was 1.8 inches (1.2-2.2 in) at harvest. The fish weighed an average of 851 fish/lb (343-1,554 fish/lb). Overall survival averaged 45.7%, with a range from 36.2-58.4% (Table 9). Fish production was above normal, averaging 79,670/acre. A total of 1,621.4 lb of walleye fingerlings were harvested (96.4 lb/acre).

Fry were stocked when the water temperature was above 54°F. Moderate pond temperatures post stocking allowed for good survival and growth of the larval walleye.

Moderate numbers of zooplankton, consisting of 50%-75% copepods and rotifers were present by the third week of April. By late April zooplankton populations began shifting to more daphnia and copepods with total number of organisms increasing. By the third week of May zooplankton consisted of mainly daphnia. Results from test seine samples on May 17 revealed fingerlings averaging 1.1 inches, with fish harvest beginning May 24.

Filamentous algae (Spirogyra and Pithophora) and Chara in the ponds were treated with Cutrine Plus liquid and Tribune either individually or as a 50:50 mixture at 0.3-1.5 gal/acre. Treatments were carried out in early May through the first week of June on an, as needed basis. Two ponds required Aquathol K in early June, to control pondweed, at a rate of 0.7-1.1 gal/acre. The total amount of chemical used in each application was diluted with 25-50 gal of water and applied using a HYPRO power sprayer. Cutrine granules were applied to five of the ponds to control Chara growth.

Walleye x Sauger Hybrids

Eggs from 27 female walleye from the FCOL were used to produce saugeye in 2022. All the fish were injected with HCG at 500 IU/lb to initiate ovulation. A total of 3.5 million eggs were collected April 7-10. A total of 1.83 million eggs eyed up and the overall hatch rate was 52.9%. The eggs were fertilized with extended sauger semen, water hardened and treated with iodine identical to the sauger eggs. The eggs hatched in 8-9 d (216-243 T.U.) at a water temperature of 59 °F.

A total of 525,000 fry (4-6 day old) were stocked in two hatchery ponds (11,16) on April 21. The overall stocking rate was 150,000/acre. Surplus fry (1,304,000) were stocked in Lake Evergreen (Table 10). The ponds were finished filling to 1/3 full 11 d prior to the initial stocking. The ponds were fertilized with alfalfa meal only. The fertilization rate was 133lb/acre the first week and 100 lb/acre each week thereafter. The total amount of fertilizer was applied to the ponds in two separate applications each week.

A total of 299,256 fingerlings were raised for stocking in lakes (Table 10). The fingerlings were cultured for an average of 40 d (32-53 d). Average length at harvest was 1.8 inches (1.4-2.4) and average weight was

911 fish/lb (275-1,295 fish/lb). Fish production was normal, averaging 88,809/acre. A total of 339.2 lb of fingerlings were produced (101.6 lb/acre) (Table 11). Overall survival was 57.0%.

Zooplankton populations were dominated by copepods (50%) in moderate abundance by the third week of April. By the first week of May zooplankton populations were comprised of 60% copepods and 40% daphnia. The zooplankton populations were dominated by daphnia the third week of May. Test seine sampling on May 17 revealed the fish present were 1.2 inches in length and harvest began May 23.

NE 2022 State Report for Walleye Tech Committee 2023 Winter Meeting

By Joe Rydell

Walleye management efforts at Lake McConaughy were expanded during 2022 and a multi-faceted approach was used to gain a better understanding of what is driving the walleye population. In 2021, a group of walleye anglers approached fisheries staff regarding concerns they had about reduced abundance of small walleye and perceived issues with the April spawn fishery on the dam. Several private meetings were held with this angler group during 2021 and 2022 and a very well attended public meeting was hosted by NGPC in March 2022 in Ogallala to discuss upcoming walleye management plans.

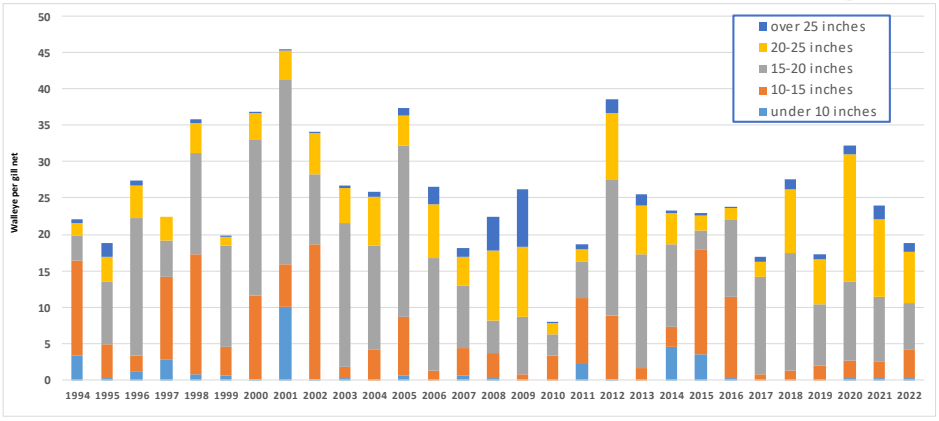
NGPC fisheries staff worked extensively with the Nebraska Cooperative Fish and Wildlife Research Unit to develop an angler survey to focus on angling activities during the April – May walleye spawn fishery on the dam, as well as surveying anglers on the main reservoir during the April – October angling period. NGPC fisheries personnel also coordinated with NGPC research staff and graduate students from the University of Nebraska-Kearney to conduct research projects that evaluated walleye fry and fingerling stockings, as well as alewife food habits, and water quality information.

Fish stocking strategies were altered during 2022 and fry stocking was added in addition to the annual fingerling stockings. During 2022, there were 26 (1000/acre) million fry stocked in early May in the upper reaches of the reservoir. Most fry were stocked from a boat. Fingerling walleye were stocked at a rate of 50/acre in mid to late June. There were 1.3 million 1.25” and 280,000 1.5” fingerlings stocked, all of which were stocked from a boat to increase survival. Walleye spawn collection efforts were also conducted during late April at McConaughy resulting in more than 150 quarts of eggs harvested.

Annual walleye gill netting efforts were expanded during 2022, which included additional effort and expanding net locations into the mid to upper sections of the reservoir. Netting effort was also stratified into two monthly time periods (September and October). In addition, night electroshocking was done in coordination with UNK graduate students to capture young-of-year walleye for OTC evaluations.

Expanded walleye management efforts will continue in 2023. The angler survey and UNK research projects will proceed as they did in 2022. Fish stocking efforts will consist of both fry (20M) and fingerlings (1M) at rates of 1000/acre and 50/acre, respectively. Total number of stocked fish will be slightly lower as reservoir elevations are lower this season. Night electroshocking and fall gill netting will once again be utilized to evaluate stocking success.

Fall Gill Net CPUE 1994-2022



Nebraska had a good year beginning with walleye spawn and production needs in 2022. Walleye eggs were gathered from Sherman Reservoir, Merritt Reservoir, and Lake McConaughy as noted above. Production needs were higher than normal mainly due to the research and response to angler complaints from Lake McConaughy. Hatchery production was excellent and a total of 67,982,037 walleye were stocked in Nebraska Waters in 2022. This included 62,417,919 Fry, 5,518,164 Fingerling (1.25" -3"), and 45,954 advanced fingerling (>8").

Stock contribution of walleye were evaluated on several lakes throughout the state using combinations of fry and fingerling OTC marks. On Lake McConaughy, of the 203 young of the year (YOY) walleye collected 48 (23.6%) were from the fry stocked fish, and 66 (32.5%) were fingerling stocked fish. Otoliths from the remaining 89 fish were sent to a lab in New York where research staff from University of Nebraska Kearney will obtain the chemical signatures and match them to samples of water collected throughout the reservoir. The contribution from fry fish is lower than expected due to the amount of fry stocked, but the fry fish were 5 inches in length compared to around 4 inches in length for the finglerling produced fish.

At Merritt Reservoir two stockings of finglering size walleye were stocked split between standard (1.25") and larger (1.75"). The standard fingerlings were significantly longer than the larger fingerlings stocked when collected in the fall.

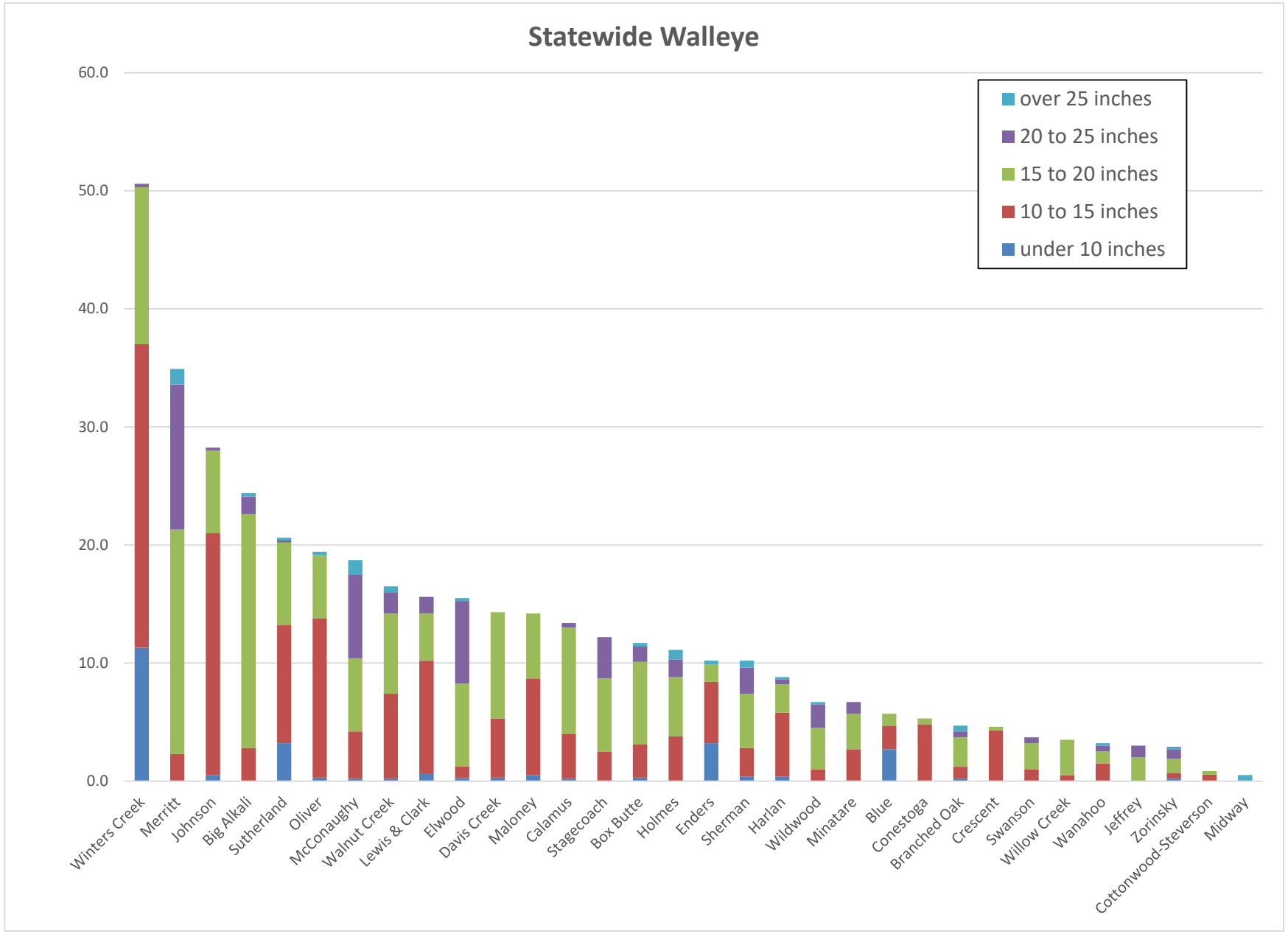
Sherman Reservoir showed that marked fingerling walleye did not contribute to the year-class at an expected ratio compared to fry stocking or natural recruited fish (non-marked fish).

Elwood Reservoir found similar results to Merritt Reservoir where standard size (1.25") fingerling walleye contributed more to the recruitment than the larger (1.75") fingerlings or naturally produced walleye. However, no there were no significant differences in length between these sizes of fish at time of capture.

Northeast Nebraska biologist are also evaluating walleye stock contributions in Calamus Reservoir and Davis Creek Reservoir and Lewis and Clark Reservoir in 2022.

A walleye / sauger tagging project partnered with South Dakota Game Fish and Parks looking at movement through and within Missouri River Reservoirs continued in 2022. Results of this study will come in future reports.

Of the 32 lakes surveyed for walleye in the fall of 2022, Lake Winters Creek had the highest catch rates with 50.6 walleye per gillnet-night. Most Nebraska walleye waters had good proportions of the catch over the statewide minimum length limit of 15 inches with several lakes finding some walleye over 25 inches.


Statewide Walleye
60.0
50.0
40.0
30.0
20.0
10.0
0.0
over 25 inches
20 to 25 inches
15 to 20 inches
10 to 15 inches
under 10 inches
Winters Creek
Merritt
Johnson
Big Alkali
Sutherland
Oliver
McConaughy
Walnut Creek
Lewis & Clark
Elwood
Davis Creek
Maloney
Calamus
Stagecoach
Box Butte
Holmes
Enders
Sherman
Harlan
Wildwood
Minatare
Blue
Conestoga
Branched Oak
Crescent
Swanson
Willow Creek
Wanahoo
Jeffrey
Zorinsky
Cottonwood-Steverson
Midway

Walleye Technical Committee
SD State update – Submitted by Mark Fincel, SDGFP

Lewis and Clark Walleye Telemetry Project, Will Radigan (University of Nebraska-Lincoln)
Walleye *Sander vitreus* and Sauger *Sander canadensis* are both socioeconomically important sportfish species in Lewis and Clark Lake, an interjurisdictionally-managed mainstem Missouri River reservoir fishery. Since 2011, adult catch per unit effort (CPUE) of both Walleye and Sauger has remained at approximately 50% of pre-2011 levels. Presumed reasons for the suppressed CPUE of Walleye and Sauger are sedimentation occurring in the reservoir since impoundment exacerbated by a catastrophic flood in 2011 and substantial entrainment of both age-0 and adult fish resulting from the reservoir's high turnover rate (7 d). Acoustic telemetry was used to quantify adult movement and entrainment and ichthyoplankton trawls were used to assess larval entrainment. Male Sauger and Walleye use more of the reservoir than female conspecifics, and Sauger use more of the reservoir than Walleye of the same sex. Female Sauger tagged in the delta move frequently throughout the entire reservoir at different parts of the year, while male Sauger do not use the lake zone of the reservoir. Both male and female Walleye tagged below Fort Randall Dam move down from this dam in the spring to near Gavins Point Dam in the fall to overwinter in the lake section of the reservoir. Preliminary entrainment and exploitation data suggests these rates are substantial sources of loss for adult Walleye and Sauger, and larval entrainment resulted in emigration exceeding immigration in a year with more flow (2021) compared to a year with less flow (2022).

Walleye Stocking Success Evaluation, Amy Gebhard (SDGFP)
In central South Dakota a project will begin this summer looking at stocking success between pond reared and RAS large Walleye fingerlings on three small impoundments. The goal of this project is to learn which hatchery product is superior when stocking large fingerlings into small South Dakota impoundments. Stocking will occur yearly with both product for five years. Stocking success will be evaluated when stocked individuals reach three-year-old via spring electrofishing. Microchemistry will be used to determine which hatchery product is more available for anglers to catch at three years and older.

Reservoir Saugeye Stockings, Brian Blackwell, Todd Kaufman, Mark Ermer (SDGFP)
Elm Lake (Brown County, 480 hectare), Richmond Lake (Brown County; 333 hectare), and Mina Lake (Edmunds County, 326 hectare) are impoundments located in northeast South Dakota. Saugeye stockings (small fingerlings except for Richmond Lake in 2016) were reinstated in 2016 after years of poor success with walleye stockings. Fall electrofishing for age-0 *Sander* spp. shows potential year classes, but the cohorts have not materialized in the gill net (standard North American gill net) catch as age-2 or age-3 fish (Table 1).

Table 1. The number of small fingerling saugeye stocked by year, and corresponding age-0 electrofishing catch per unit effort (CPUE; number/hour), age-2 gill net CPUE (number/net), and age-3 gill net CPUE for each *Sander* spp. cohort at Elm Lake, Richmond Lake, and Mina Lake, South Dakota (2016-2022).

		Cohort						
Reservoir	Parameter	2016	2017	2018	2019	2020	2021	2022
Elm								
	# stocked	121,080	91,520	91,120	92,075	0	91,000	90,470

	age-0 CPUE	117.5	109.5	114	153	55	126	na
	age-2 CPUE	0.5	0.1	1.2	na	0.7		
	age-3 CPUE	0.3	0.5	na	2.2			
Richmond								
	# stocked	6,030[a]	60,320	62,640	62,350	0	63,700	63,080
	age-0 CPUE	10.5[b]	36.0	109.0	112.5	3.0	70.8	208.2
	age-2 CPUE	0.2	0.8	0.6	na	0		
	age-3 CPUE	0.3	0.3	na	0.9			
Mina								
	# stocked	115,890	65,420	60,180	60,900	0	61,100	61,420
	age-0 CPUE	77.6	133.5	74.0	99.0	17.2	268.5	548.9
	age-2 CPUE	1.3	0.6	0.8	na	0		
	age-3 CPUE	0.2	0.5	na	0.1			

a – large fingerlings

b – electrofishing completed before stocking

Inability of Hormone Treatment in Wild-Caught Female Walleyes to Increase Egg Ripening, Brian Blackwell, Matthew Ward, Todd Kaufman, Mark Ermer (SDGFP)

The use of human chorionic gonadotropin (hCG) to increase the percentage of green female Walleyes ripening while held in the field during artificial Walleye Spawning was assessed in 2022. An increase in ripe Walleyes could reduce the days needed to collect gametes or the number of lakes necessary for artificial spawning operations. We injected hCG (500 IU/kg) into freshly caught green females (n = 197 Middle Lynn Lake, n = 40 Piyas Lake) and held each day's fish in a separate in-lake net pen, controls (n = 40 Middle Lynn Lake, n = 20 Piyas Lake) were placed in separate pens, and fish in all pens were checked daily for ripening. The percentage of injected females ripening (58.9%) was significantly less at Middle Lynn Lake than the percentage of control females ripening (77.5%), and no difference was identified at Piyas Lake, where 53.7% of injected fish ripened and 60.0% of controls. At each lake, positive relationships between the percentage of females ripening and water temperature and Julian day were identified for daily caught at-large fish, injected females, and controls. Including hCG in Walleye field spawning operations did not increase the number of green females ripening in 2022.

Effects of Stocking and Environmental Variables on Walleye Recruitment in Eastern South Dakota Lakes, BJ Schall, Brian Blackwell, Dave Lucchesi, (SDGFP) and Jeff Wesner (University of South Dakota)

Factors influencing age-2 Walleye relative abundance in eastern South Dakota lakes were evaluated using 20 years of standardized sampling, stocking history, and concurrent environmental data. Seven Bayesian Gamma hurdle models were developed to assess the influence of stocking, stocking product size, the objective for stocking, waterbody characteristics, environmental conditions (winter severity, growing degree days, and spring precipitation), and relative abundance of stock-size Walleye and centrarchids on age-2 Walleye relative abundance. Generally, there was substantial variability in age-2 catch per gill net (CPGN), and model fits were poor, with all Bayesian R2 values <0.24. The probabilities that fry stocking years coincided with higher CPGN than small fingerling, large fingerling, and non-stocked years all exceeded 80%. The probability that the mean posterior estimated CPGN was twice as high in stocked years (4.7 fish/net) versus non-stocked years (2.0 fish/net) was 94.4%. Introductory stocking and maintenance stocking coincided with higher age-2 CPGN than supplemental stocking or no stocking. Estimated age-2 CPGN did not exhibit a meaningful relationship with the surface area of natural lakes and impoundments, winter severity index, growing degrees days, spring precipitation, or

stock-size Walleye CPGN during the cohort year. Age-2 Walleye CPGN declined as stock-length centrarchid trap net catch rate increased and exhibited a biotic-abiotic constraining relationship. Results suggest that a multitude of factors may be influencing Walleye recruitment, but we had limited success describing these relationships.

Third Crop (i.e., Large Fingerlings) Walleye Production at Blue Dog Hatchery, Matthew Ward (SDGFP)
At Blue Dog State Fish Hatchery, a third crop period (late July – early October) was used in 2022 to produce large fingerlings in nine ponds. Two ponds were treated differently during the third crop period. One was refilled and stocked with Walleye without any Fathead Minnows and the other pond was only stocked with adult Fathead Minnows during May and did not receive additional minnows. The other seven ponds were stocked with Fathead Minnow adults in early May and supplemental feeding of additional Fathead Minnows began in late July and continued into October. Approximately 1,600 gallons of Fathead Minnows were collected and fed to the Walleyes by the Webster Game, Fish and Parks staff, and Blue Dog staff.
The seven ponds that had been previously stocked with Fathead Minnow adults and continued to receive minnows into October were considered successful at providing large Walleye fingerlings. Walleye survival was above 60% in these ponds (above 88% in 4 ponds) and Walleye size was between 14 and 25 fish/lb. Utilizing a third crop scenario with ponds being refilled following the second crop without any Fathead Minnow prey resulted in low walleye survival (34%) and size (180 fish/lb). Survival was low (15% cannibalism?) in the pond that was prepped with Fathead Minnows but did not receive any further minnow supplementation. Filamentous algae throughout the growing season and during harvest was a problem and likely responsible for the loss of some Walleye from most ponds. The promising results in 2022 are encouraging as a possible replacement of natural rearing ponds in northeast South Dakota for producing large fingerlings.

Success of Fry vs Small Fingerling *Sander* spp. Stockings, BJ Schall, Brian Blackwell, Dave Lucchesi, Todd Kaufman (SDGFP)
New research assessing the success of fry and small fingerling stockings for both Walleye and saugeye in eastern South Dakota will begin in 2023 and conclude in 2032. A total of 17 waters will be included in the Walleye evaluation and 11 waters in the saugeye evaluation. Each water will be stocked twice with fry and twice with small fingerlings during the stocking period between 2023 and 2030. Stockings will occur every other year with size stocked randomly assigned to years scheduled for stocking. Gill net abundance (number/net) at age 2 will be used to assess success of stocking products.

Walleye in South Dakota RAS Systems, Mike Barnes, Brian Fletcher (SDGFP)
South Dakota first began using RAS in the spring of 2021 to successfully incubate a small number of walleye eggs at Cleghorn Springs State Hatchery. Walleye culture in RAS was expanded in 2022 to include intensive rearing using four specialty larval tanks. From this 2022 effort, small numbers of juvenile walleyes were produced and stocked at different sizes. The success of these stocking was documented via fall lake sampling efforts. Approximately 2,200 of the 2022 fish were retained at Cleghorn and are currently around 30 cm long. The plan is to use juvenile rainbow trout to feed train these catchable-sized walleyes, which will then be stocked at a length of around 40 cm into a small, atypical walleye water with heavy fishing pressure (Sheridan Lake in the Black Hills). For 2023, a larger, 40-jar rack will be used at Cleghorn for additional RAS walleye egg incubation. Unfortunately, additional larval tanks have not yet arrived, limiting juvenile walleye production again to only the existing four tanks. By 2024, it is anticipated that Cleghorn will have an addition 12 larval tanks in production, allowing for the rearing of up to 4 million small (2-3 cm) juvenile walleyes, 720,000 larger, fully-scaled juvenile walleyes (spring-stocked product), larger juveniles for fall stocking, and additional adults for

catchable stocking in the spring of 2025. RAS is allowing the hatchery system to produce numbers and sizes of walleyes never before available for fisheries managers. Evaluations on stocking sizes, numbers, and rearing techniques to maximize post-stocking survival are planned for 2023 and will continue for many years in the future.

Walleye Reservoir Tagging Project Update, Laurel Sacco, Steve Chipps (South Dakota State University)
Lake Sharpe:

- Walleye survival probability in Lake Sharpe was primarily influenced by walleye length and the 15" minimum harvest length regulation. Survival declined as walleye length increased and was lower during months without a minimum harvest length limit (86%) compared to months with a minimum harvest length (94%). Annual survival probabilities were lowest in 2019 (20%) and 2021 (15%); estimates ranged between 43-50% in 2017, 2018, and 2020.
- Angler exploitation estimates ranged between 7-15% from 2017-2019 with an increase to 24% in 2021.
- Escapement probability was chiefly influenced by marking location and reservoir outflows: escapement increased with proximity to the dam and during high flows in 2018 (17%) and 2019 (28%). Escapement probabilities were approximately 11% in 2017, 2020, and 2021.
- Walleyes recaptured during tagging procedures were significantly more likely to have dermal tumors than newly caught fish. Histological examinations of tumors showed that both lymphocystis and dermal sarcoma are present in the Missouri River reservoirs.

Western Reservoirs:

- Walleye recruitment measured via year class strength was calculated by tracking individual cohorts overtime. We analyzed the relationship between year class strength and the environmental conditions experienced by cohorts at age-0.
- Angostura Reservoir: Year class strength was driven by fingerling stocking efforts and lower stocking numbers (approximately 190,000-220,000) were sufficient to support strong year classes.
- Belle Fourche Reservoir: Stronger year classes were associated with lower fall temperatures and higher spring reservoir content.
- Shadehill Reservoir: Year class strength showed a negative relationship with total winter discharge and average winter reservoir content. Seasonal temperatures were also an important factor and stronger year classes occurred when cohorts experienced lower temperatures at age-0, particularly during spring and summer.

Factors influencing age-2 WAE abundance in eastern SD lakes, BJ Schall, Dave Lucchesi (SDGFP)
BJ Schall will present findings at the MWFWC from work done to evaluate factors influencing age-2 Walleye relative abundance in eastern South Dakota lakes using 20 years of standardized sampling, stocking history, and concurrent environmental data. He developed seven Bayesian Gamma hurdle models to assess the influence of stocking, stocking product size, objective for stocking, waterbody characteristics, environmental conditions (winter severity, growing degree days, and spring precipitation), and relative abundance of stock-size Walleye and centrarchids on age-2 Walleye relative abundance. He found substantial variability in age-2 catch per gill net (CPGN), and poor model fits, with all Bayesian R^2 values <0.24. The probability that the mean posterior estimated CPGN was twice as high in stocked years (4.7 fish/net) versus non-stocked years (2.0 fish/net) was 94.4%. The probabilities that fry stocking years coincided with higher CPGN than small fingerling, large fingerling, and non-stocked years all exceeded 80%. Introductory stocking and maintenance stocking coincided with higher age-2 CPGN than supplemental stocking or no stocking, and mean age-2 CPGN increased slightly with increased surface area in both natural lakes and impoundments. Estimated age-2 CPGN did not exhibit a

meaningful relationship with surface area of natural lakes and impoundments, winter severity index, growing degrees days, spring precipitation, or stock-size Walleye CPGN during the cohort year. Age-2 Walleye CPGN declined as stock-length centrarchid trap net catch rate increased and exhibited a biotic-abiotic constraining relationship. He is currently working on a manuscript for submission to a peer-reviewed journal.

2023 Iowa Chapter WTC Report

1) Large Reservoir Fisheries Research Update

Contact: Rebecca Krogman, Fisheries Research Biologist, Rebecca.krogman@dnr.iowa.gov

- **Walleye Genetic Strains Stocked:** Determined that the GT-Seq genetic panel developed in Wisconsin can be used to differentiate Iowa's river- and reservoir-origin fish, thereby allowing fin clips alone to be used to identify strain in recaptured fish. We are following up to verify whether individual parents truly can be identified, allowing study fish to be differentiated from naturally-recruited or non-study fish. The goal of this study is to determine whether strain affects recruitment to the fishery in reservoirs ranging from very lacustrine to very river-influenced.
- **Walleye Culture Method Comparison:** Iowa has a long history of producing large, healthy advanced fingerling Walleye for fall stocking using concrete ponds and raceways, but recent expansions of the hatchery in recirculating aquaculture required a re-assessment of Walleye products. This study compares the traditional raceway fish with 1) Walleye raised in a larval RAS and grown out in ponds, and 2) Walleye raised entirely in a RAS. Thus far, fish raised entirely in a RAS had higher deformity rates and apparently lower survival after stocking. – Contact Lewis Bruce
- **Large-Scale Movement and Passage of Walleye in the Des Moines River:** Walleye and River Carpsuckers were acoustically tagged in Saylorville Reservoir, and we have been monitoring their presence upstream and downstream. Downstream detections would indicate passage through Saylorville Dam, and further down through Red Rock Dam or its hydropower facility. We are working to expand and improve the receiver placements throughout the river, but especially upstream of Red Rock Dam and the hydropower inlets, allowing triangulation of the fish's location as they approach. We have seen both upstream and downstream movement from Saylorville, but no detections yet at Red Rock Reservoir. The goal of this study is to assess downstream connectivity and potential for passage through the hydropower turbines or dams of sportfish and other species of interest.
- **Development of R programming version of FAMS:** This coding project is part of a larger national effort to update Ogle's fishR and FSA R packages, and to built new tools from them. The goal of this particular project is to develop R coding that can be applied to standard data tables and used to model length regulation outcomes.

2) Natural Lakes Fisheries Research Update

Contact: Jonathan Meerbeek, Fisheries Research Biologist, jonathan.meerbeek@dnr.iowa.gov

- Protected slot limit and minimum length limit changes in Iowa's Walleye broodstock natural lakes: changed from a 17-22 in protected slot (daily bag of 3; 1 fish over 22) in Storm Lake, Spirit Lake, East Okoboji Lake, and West Okoboji Lake to a 19-25 in protected slot (daily bag of 3; 1 fish over 25). At Clear Lake, changed from a minimum length limit of 14 in to a protected slot limit of 17-22 in (daily bag of 3; 1 fish over 22). Staff continue to collect Walleye data from the natural lakes to monitor the effects of the regulation
- Understanding recruitment dynamics for stocked Walleye fisheries is important for evaluating stocking contribution and identifying lapses in recruitment, which may be partially remedied by stocking fall fingerlings. However, hatchery produced Walleye fingerlings (≥ 6 inches) are expensive and production quotas are unpredictable, thus, often leading to uncertainty in where to prioritize fall fingerling stockings. Prioritizing attempts have been made via conducting night electrofishing surveys prior to stocking (*see* Iowa DNR 2013 Fish Stocking Policy), however, since stockings may occur as early as mid-September, surveys have been ineffective

at catching adequate numbers of age-0 Walleye to make informed decisions on fry stocking survival. Thus, stocking fall fingerlings on top of an existing strong year-class cannot fully be avoided due to the timing of effective sampling for age-0 Walleye. Identification of past recruitment patterns, however, may be used to guide fisheries management Walleye stocking decisions in lakes where limited Walleye data is available. The objective of this project is to conduct eight-fall electrofishing investigation to index Walleye recruitment by June 30, 2023. Walleye populations in twelve natural lakes were sampled via night electrofishing during the fall (late September-early November; East Okoboji Lake and Clear Lake sampled during spring, *see* project narrative) at water temperatures between 43-63^{o}F. A minimum of at least three fixed 30-minute sites were sampled at each lake. Fall electrofishing surveys were conducted at ten natural lakes between 10/3/2022 and 10/20/2022 and Walleye catch-per-hour ranged from 13.3 fish/hr at Storm Lake to 528.0 fish per hour at Ingham Lake. Consistent patterns of Walleye recruitment based on age-class indices were more prevalent at Silver (Dickinson County), Tuttle, and Lost Island lakes compared to other natural lakes. Based on these data, managers were able to prioritize stocking assignments for fall 2022 stocked Walleye since Walleye hatchery production in 2022 was limited. Since this was the first survey of this type, inferences on year-class indices values were rather vague in meaning. Future surveys are needed to allow managers to understand the variability in these estimates and help determine the recruitment indices thresholds.

3) Rivers and Streams Fisheries Research Update

Contact: Greg Gelwicks, Fisheries Research Biologist, gregory.gelwicks@dnr.iowa.gov

Evaluation of Interior River Fingerling Walleye Stocking Strategies:

Executive Summary

Walleye fingerling stocking is the primary tool that the Iowa Department of Natural Resources (DNR) uses to improve interior river Walleye populations. Available pond culture space has been a limiting factor for producing the two-inch-long Walleye fingerlings needed to stock interior rivers. Recent research at the Rathbun Fish Culture Research Facility has shown promising results raising Walleye fingerlings using an alternative method, intensive larviculture. Intensively reared Walleye fry are stocked into flow-through tanks and reared with pelleted feed from first feeding, instead of stocking them into ponds where they feed on zooplankton (extensively reared). This method could potentially increase production of Walleye fingerlings, but the performance of this hatchery product in Iowa's interior rivers was unknown. The goal of this study was to evaluate the relative contribution of intensively reared fingerlings to interior river Walleye populations.

Study sites were selected on four rivers and extensively reared fingerlings were marked, hauled, and stocked at these sites alongside marked intensively reared fingerlings to serve as a control. Extensively reared Walleye fingerlings are known to survive and contribute to river Walleye fisheries if river conditions are favorable. During June 2015-2017 and 2020, between 44,000 and 57,600 intensively and extensively reared fingerlings were marked with freeze brands and stocked at sites on 3-4 rivers each year. These sites were sampled by electrofishing during late September and October.

When intensively reared and extensively reared fish were stocked together during 2015-2017, fewer age-0 intensively reared fish than expected were observed at all sites and these results were significant for five site/river combinations. There did not appear to be an advantage to delaying stocking of intensively reared fingerling during 2020, vs. stocking extensively reared fish into high, turbid rivers. Mean and maximum catch-per-unit-effort (CPUE) of age 0 intensively reared fingerlings were only about one third of the catch rates of extensively reared fingerlings across all sites and years. There was little evidence of differences in growth between intensively and extensively reared Walleye fingerlings.

Our results indicate that Walleye fingerlings intensively reared in a flow through system do not survive as well as extensively reared fingerlings in Iowa's interior rivers.

Recommended best management practices from this research were as follows:

➢ Our study showed that culture method had a significant impact on survival of stocked Walleye fingerlings. The potential of small Walleye fingerlings intensively reared in a flow through system for improving Iowa's river Walleye populations appears to be low, unless they are stocked at much higher rates than extensively reared fish are currently stocked.

➢ Intensively reared Walleye fingerlings evaluated in this study were raised in a flow-through system, a production method which has been discontinued and replaced by a recirculating aquaculture system (RAS). Survival and growth of small Walleye fingerlings raised in a RAS and stocked in Iowa's interior rivers should be evaluated before final recommendations are made on the use of intensively reared Walleye fingerlings in Iowa's interior rivers.

➢ Modifications of the intensive culture process that have the potential to facilitate the transition of fingerlings from an artificial diet to live prey should be investigated.

➢ If freeze branding with liquid nitrogen is used as a marking technique in future investigations, the target size for branded fish should be ≤800 fish/lb. and branded fish should be held overnight to recover before stocking.

State Report for North Dakota at the 2023 Winter Walleye Technical Committee Meeting.

The walleye population in Devils Lake is doing well. There are many age-classes of walleye in the lake and some of the fish can become quite old, as a 21-year-old was sampled in 2013, and we sampled 3, 20-year-old walleyes in 2016. We sampled 20-year-old fish in 2017 and 2021 as well.

We conducted our Standard Adult Sampling on Devils Lake in July. Results showed the overall CPUE of walleye increased to about 35 walleye/net-night in our 125' variegated gill nets. (32 last year) This year's catch was a new record high. Another impressive result was that the catch rate of Q-P sized walleye was up again to over 12/net-night this year, which set another record high. The northern pike were below the long-term average again, while yellow perch numbers were above average. White bass numbers were still above average. Many of the white bass are from the strong hatch that occurred in 2015, and they are mostly about 14 to 16 inches long now, although a fair number of 2-year-olds and yearlings were sampled as well. About 310,000 fingerling walleye were stocked in the eastern, more saline portion of the lake in 2022. We observed good results from our young of the year netting survey in September, with about 51 young walleye being caught per net, which is well above the average of about 25. Overall, we've observed 7 good year classes of walleye in a row now, so the future is promising for walleye in Devils Lake.

One of our other large lakes, Stump Lake is doing well too. We conducted our Standard Adult Sampling there in late June. The walleye population appears to be doing well, as our catch rate was about 25 walleye per net, which is above the long-term average of about 18 walleye per net. There were a record number of walleye over 20" captured as well, at about 8/net-night. The northern pike were below their long-term average, whereas yellow perch and white bass numbers were above average, with the white bass catch being at a record high.

In the Northeast District of the state, some of our most impressive walleye waters continue to be new fisheries that were formerly duck-marsh type habitats. Some of these waters are also able to produce good numbers of walleye over 24" long.

Across the rest of the state, the good old days of walleye fishing, and fishing in general, continue to be right now. However, some waters had receded to the point where there were concerns about them. 2021 was a very dry year, but winter snow combined with a wet spring in 2022 gave many waters much needed inflow. Statewide, there are about 450 waterbodies that are being managed for fishing. This is a great increase from only about 175 managed fisheries in the early 1990's. Since 1997 we added over 100 new walleye fisheries. State-wide there are currently about 230 waters that have walleye populations. One of the few places where walleye are currently not doing as well is in the North Dakota portion of Lake Oahe and the Missouri River between Lake Oahe and Garrison Dam. Ongoing drought has worsened forage conditions in this fishery resulting in poor walleye condition, growth, and size structure.

Our state record for walleye was broken again in 2021. In March, a 33-inch-long walleye weighing 16 pounds 6 ounces was caught in the upper portion of Lake Oahe. This fish bested the previous record of 15 pounds 13 ounces that was caught in 2018.

Our department stocked walleye fingerlings in 160 lakes in 2022. About 10.25 million fingerlings were stocked by our department. The fingerlings were generally about 30 days old and were around 1.25" long. Fry stockings were also used in 6 waters, and advanced fingerlings were stocked in 18 waters.

Known zebra mussel populations exist in the Red River, Lake Ashtabula and the lower Sheyenne River, Lake LaMoure, the lower James River (downstream from Lake LaMoure), Twin Lake and Lake Elsie. There were no new zebra mussel discoveries in 2022.

2023 Walleye Technical Committee Winter Meeting

2022 Wisconsin Report – submitted by Lawrence Eslinger (WDNR; WTC Rep)

1. **Wisconsin Walleye Management Plan Update** – submitted by WDNR Biologist, Max Wolter

   Wisconsin recently completed and approved an update to the state's walleye management plan (original version from 1998). The updated plan has goal areas centered around habitat, opportunities, data/monitoring, outreach/communication, stocking, partnerships, and rehabilitation/climate change, in addition to statewide and local issue statements. The final draft of the plan is available upon request (max.wolter@wisconsin.gov) and should be on the WDNR website in the near future. The Wisconsin Walleye Team is starting in on implementation of the plan, with early projects including a likely update to the angling regulations "toolbox" (options available to biologists) and coordinating restoration strategies among agencies working on walleye populations.

2. **WDNR Hatchery Walleye Production** – submitted by WDNR Biologist, Ryen Kleiser

   Hatchery walleye production numbers in 2022 associated with State of Wisconsin walleye stockings. These numbers include surplus fish sourced from our hatcheries, as well as fish the state purchased from vendors towards active work quotas. They do not include fish purchased from private funds, nor do they include independent tribal stockings.

WI DNR 2022 Walleye Stocking		
Age Class		
Fry	Small Fingerling	Large Fingerling
22,418,177	1,009,019	688,838

3. **Walleye Regulation Changes for upcoming 2022 fishing season –** provided by WDNR Policy Specialist, Meredith Penthorn

Waters Impacted	Walleye Regulations
Harris Lake, Vilas County	Ceded Territory regulation (3-fish daily bag limit, 15" minimum length limit with 20-24" protected slot and only 1 over 24")

   During the upcoming 2023 Wisconsin Conservation Congress Spring Hearings, citizens will have an opportunity to vote on a Walleye Team proposal to reduce the standard daily bag limit for walleye and sauger on inland waters from 5 in total to 3 in total.

4. **Wisconsin DNR Office of Applied Science – Fisheries Research Program – Walleye Research** – submitted by WDNR Program Supervisor, Dr. Greg Sass

- **Walleye genetic pedigree analysis of the Sanford and Escanaba Lake, WI walleye populations**. Beginning in 2016, WDNR fisheries research has collaborated with Dr. Wes Larson and Dr. Jared Homola of the Wisconsin Cooperative Fishery Research Unit at UWSP to genetically link age-0 and age-1 walleye with individual parental walleyes and spawning habitat. Preliminary results suggest that larger, older females may be disproportionately contributing to the survival of age-0 fish to their first fall. The SNP panel for walleye was completed in 2019 and published by Matt Bootsma et al. (2020) in Molecular Ecology Resources. UWSP graduate student Levi Simmons will be conducting the walleye pedigree analysis for both lakes for his M.S. thesis. Post-doctoral researcher, Dr. Bobby Davis, of UWSP is developing peer-reviewed manuscripts from this research.

  Bootsma, M., K.M. Gruenthal, G. McKinney, L. Simmons, L. Miller, G.G. Sass, and W.A. Larson. 2020. A GT-seq panel for walleye (*Sander vitreus*) provides a generalized workflow for efficient development and implementation of amplicon panels in non-model organisms. Molecular Ecology Resources 20:1706-1722. DOI:10.1111/1755-0998.13226.

- **Does woody habitat addition increase walleye production?** Beginning in 2015, a long-term study was initiated to test whether the addition of trees to a lake increases fish production, including the production of walleye. Pre-manipulation monitoring of the fish community and aquatic ecosystem has been completed and 160 trees were added to Sanford Lake in June 2018. An additional round of tree drops to Sanford Lake will take place in summer 2023. Fish and aquatic ecosystem monitoring is ongoing to test for responses to the habitat addition.

  Sass, G.G., S.L. Shaw, T.P. Rooney, A.L. Rypel, J.K. Raabe, Q.C. Smith, T.R. Hrabik, and S.T. Toshner. 2019. Coarse woody habitat and glacial lake fisheries in the Midwestern USA: knowns, unknowns, and an experiment to advance ourknowledge. Lake and Reservoir Management 35(4):382-395. DOI:10.1080/10402381.2019.16305309.

  Sass, G.G., S.L. Shaw, C.C. Fenstermacher, A.P. Porreca, and J.J. Parkos. 2022. Structural habitat in lakes and reservoirs: physical and biological considerations for implementation. North American Journal of Fisheries Management https://doi:10.1002/nafm.10812.

- **Does woody habitat addition influence walleye behavior**. As part of the woody habitat addition influences on walleye production study, University of Minnesota-Duluth M.S. graduate, Quinn Smith, in collaboration with Dr. Tom Hrabik and WDNR fisheries research is using radio telemetry and PIT-tag receivers to monitor walleye behavior in relationship to the woody habitat addition. Preliminary results suggest that woody habitat addition had minimal influences on walleye behavior;

however, home range sizes for walleye marginally increased after woody habitat addition. This research was published in Ecology of Freshwater Fish in 2021. Another manuscript evaluating muskellunge, smallmouth bass, and walleye behavioral responses to the coarse woody habitat additions is in preparation.

Smith, Q.C., G.G. Sass, T.R. Hrabik, S.L. Shaw, and J.K. Raabe. 2021. Sportfish behavioral responses to a littoral coarse woody habitat addition in a north- temperate lake. Ecology of Freshwater Fish https://doi.org/10.1111/eff.12643

- **Whole-lake centrarchid removal to improve walleye recruitment**. In collaboration with the Wisconsin Cooperative Fisheries Research Unit at UWSP and the Center for Limnology, UW-Madison, a whole-lake centrarchid removal project was initiated in 2017. Because anecdotal evidence has suggested that abundant largemouth bass populations may negatively affect walleye populations, this whole-lake removal of centrarchids will test whether the removal of a substantial portion of the bass/panfish family improves walleye natural recruitment. Following a year of baseline monitoring of the fish and aquatic community, centrarchid removals were conducted in 2018, 2019, and 2020 and monitoring of the fish community and walleye recruitment responses are ongoing. This study was published in Fisheries Management and Ecology in 2022.

  Embke, H.S., S.R. Carpenter, D.A. Isermann, G. Coppola, T.D. Beard, A.J. Lynch, G.G. Sass, Z.S. Feiner, and M.J. Vander Zanden. 2022. Resisting ecosystem transformation through an intensive whole-lake fish removal experiment. Fisheries Management and Ecology 29:364-377. doi.org/10.1111/fme.12544.

- **Walleye comparative recruitment study**. Beginning in summer 2017, a 7 year comparative walleye recruitment study was initiated with Great Lakes Indian Fish and Wildlife Commission biologists. The project aims to measure within-lake and watershed characteristics from a suite of lakes throughout northern Wisconsin with stable walleye recruitment and in those where natural recruitment has declined over time. The goal of this study is to test for differences between the lake types and to identify management actions that could be applied to improve walleye natural recruitment. As of 2022, we have 5 years of data on 53 lakes (no additional lakes were added in 2020 due to COVID). We plan one more field season to add a few high priority lakes to the dataset. Preliminary results of *in-situ* habitat characteristics were non-significant, but there were some initial trends observed in shoreline development and coarse woody habitat availability (declining walleye population lakes tended to have more development and less wood) as well as aquatic vegetation coverage. Coverage of aquatic plants was similar in declining and stable lakes, but declining walleye lakes had a higher biovolume of vegetation relative to stable lakes. Analysis of lakes with 7 or more years of recruitment data confirms decreases in survival of age-0 walleye in lakes labeled as declining. Ongoing analysis related to the project includes using remote sensing data to evaluate littoral habitat changes related to the drought in the mid-2000s. We will also be completing spawning habitat availability maps as well as estimating thermal optical habitat availability for study lakes. There

have been no new publications since the age-1 walleye index of abundance was published in Fisheries Management and Ecology in 2020.

Shaw, S.L. and G.G. Sass. 2020. Evaluating the relationship between yearling walleye, *Sander vitreus*, electrofishing catch per effort and density in northern Wisconsin lakes. Fisheries Management and Ecology 27:544-549. DOI:10.1111/fme.12449.

- **Hatchery reared walleye sex ratios.** In 2021, OAS research scientists in collaboration with WDNR Fish Management Veterinarians and WDNR and Tribal Hatchery Managers initiated a project to investigate the sex ratios of extended growth walleye fingerlings. This project was initiated after preliminary reports of sex ratios favoring females from 1 hatchery in 2019 (n=50 fish) and 3 hatcheries in 2020 (n=50 fish/hatchery)[Sass et al. 2022 citation below]. The project initiated in 2021 is currently slated for 2 years. Primary objectives include 1) documenting age and size of sexual differentiation for both males and females; 2) evaluating the environmental factors that may influence sexual differentiation both natural (e.g., temperature, pH, rearing density) and chemically induced (e.g., endocrine disrupting or mimicking compounds and hormone profiles); and 3) evaluating temporal trends in adult sex ratio of lakes stocked with different hatchery products (i.e., fry, small fingerling, and extended growth) as well as wild population sex ratios. Histology results from 2021, showed that males (confirmed via presence of early stage sperm) were not generally present at time of stock out in September and October (3 males observed out of 727 total samples). Samples at stock-out included confirmed female fish and undifferentiated fish (which had no primary stage gametes present) which is consistent with the literature that suggest female Walleye differentiate first. Males became more apparent in over-winter samples (held indoors for repeated monthly sampling from October through January). January 2022 sample n = 25 Females, 21 males, 4 undifferentiated. Walleye that had spent any time in lined ponds during rearing tended to have a higher female sex ratio, range 51% - 100% female, whereas Walleye raised in earthen ponds, indoor raceways or the wild sample had sex ratios closer to 1:1 or were dominated by undifferentiated fish, range 18% - 54% female. Water chemistry sampling of lined ponds did not directly indicate any endocrine disrupting chemicals or hormones present in the rearing water that were consistent with observed female dominated sex ratios. However, we tested bisphenols and alkylphenols only and did not test for phthalates or other endocrine disrupting chemicals. Water temperature and pH were significantly higher in lined ponds (however we are still waiting for data from one lined facility) relative to earthen ponds, indoor raceways, and the wild sample. Both water temperature and pH are known to influence sexual differentiation in some fish species but there is little information about the effects of these factors on Walleye. Additional sampling of reared fish at stock-out was completed this past fall, 2022. Samples are currently being processed. Evaluation of the potential effects of rearing conditions (temperature and pH) on sex ratio is ongoing as well additional analysis related to trends in adult sex ratios of stocked and wild populations.

Sass, G. G. et al. 2022. Female sex ratio bias in extended growth hatchery Walleye fingerlings produced in Wisconsin. North American Journal of Aquaculture DOI: 10.1002/naaq.10237.

- **Whole-lake bullhead removal to test for walleye recruitment responses**. In 2019, a whole-lake bullhead removal study was initiated on Howell Lake in Forest County, WI. After a year of baseline fish community monitoring in 2019, over 20,000 adult and 100,000 age-0 bullhead were removed from Howell Lake in 2020. This study is being conducted by UWSP M.S. graduate, Logan Sikora, Dr. Justin VanDeHey, and WDNR fisheries research and management. A review of previous bullhead removal studies in Wisconsin was published by Sikora et al. (2021) in a special issue of the North American Journal of Fisheries Management based on the 3rd International Catfish Symposium proceedings. Previous bullhead removals have shown major shifts in fish community structure favoring percids. Population demographics of bullhead in Howell Lake was also published in 2022.

  Sikora, L.W., J.A. VanDeHey, G.G. Sass, G. Matzke, and M. Preul. 2021. Fish community changes associated with bullhead removals in four northern Wisconsin lakes. 2021. Proceedings of the Catfish 2020; 3rd International Catfish Symposium. North American Journal of Fisheries Management 41:S71-S81. DOI:10.1002/nafm.10594.

  Sikora, L.W., J.T. Mrnak, R. Henningsen, J.A. VanDeHey, and G.G. Sass. 2022. Demographic and life history characteristics of black bullheads *Ameiurus melas* in a north temperate USA lake. Fishes doi.org/10.3390/fishes7010021. (Editor's Choice Article)

- **Depensation in Wisconsin walleye populations**. Depensation, or elevated age-0 mortality rates at low adult stock size, was tested for in about 80 Wisconsin walleye populations. Results suggested that about half of the walleye populations examined showed depensatory recruitment dynamics. This suggests that a critical adult density threshold exists such that reductions in stock size below this level will result in failed recruitment without intervention. This study was published in Fisheries in 2021 by WDNR fisheries research scientists, Dr. Greg Sass, Dr. Zach Feiner, and Dr. Stephanie Shaw. A current study and manuscript led by Dr. Colin Dassow of the WDNR examining abiotic and biotic covariates of walleye depensation has been provisionally accepted in Fisheries Research.

  Sass, G.G., Z.S. Feiner, and S.L. Shaw. 2021. Empirical evidence for depensation in freshwater fisheries. Fisheries 46(6):266-276. DOI:10.1002/fsh.10584.

  Dassow, C.D, G.G. Sass, S.L. Shaw, Z.S. Feiner, C. Nieman, and S.E. Jones. Depensation in fish recruitment driven by context-dependent interactions with another predator. Fisheries Research (provisionally accepted).

- **Walleye spawning phenology related to climate change**. WDNR fisheries research scientist, Dr. Zach Feiner, has an ongoing study testing for the influences on climate change on walleye spawning phenology and subsequent recruitment responses. In addition, a collaboration among WDNR fisheries research and UW-Madison, Center for Limnology scientists is examining the influence of high ice off variability on walleye recruitment. A perspective on climate change phenological effects on aquatic ecosystems and walleye was published in the Canadian Journal of Fisheries and Aquatic Sciences, showing shifts toward earlier ice off and walleye spawning in spring, but also that ice off and walleye spawn timing was becoming increasingly unpredictable and variable over time. Extreme ice-off years (either early or late) were related to poor recruitment in Escanaba Lake.

  Feiner, Z.S., H.A. Dugan, N.R. Lottig, G.G. Sass, and G.A. Gerrish. 2022. A perspective on the ecological and evolutionary consequences of phenological variability in north-temperate lakes. Canadian Journal of Fisheries and Aquatic Sciences doi.org/10.1139/cjfas-2021-0221.

  A follow-up paper analyzed patterns in walleye spawning phenology and recruitment across ~250 lakes in Wisconsin, Minnesota, and the Upper Peninsula of Michigan. Both ice-off and walleye spawn timing was shifting earlier and becoming more variable across all lakes, however, walleye spawn timing was shifting at only about half the rate as ice-off, suggesting increasing risks of trophic mismatches for newly hatched walleye. Walleye recruitment was negatively related to the degree of mismatch (measured as the deviation of spawn timing in a given year from the average timing for that lake) in the majority of lakes, suggesting that increasing variability in spawn timing will likely increase the frequency of poor walleye year classes. Lastly, lakes that were stocked exhibited different phenology patterns (shifting to spawn later in the year) than non-stocked populations (shifting to spawn earlier in the year), although this phenomenon requires further study to understand possible mechanisms. This was presented at the 2022 WI AFS Meeting and is currently in review at Global Change Biology.

  Barta, M., J.R. Reed, T.A. Cichosz, A.D. Shultz, M. Luehring, G.G. Sass, and Z.S. Feiner. In review. Lagging responses, increasing extremes, and stocking exacerbate phenological mismatches for walleye (Sander vitreus) in north-temperate lakes. Global Change Biology.

  Finally, an ongoing project is seeking to use walleye spawn timing to uncover critical periods for larval and juvenile walleye survival in Wisconsin lakes. Initial results suggest that temperature in the month before spawning is the dominant trigger for walleye spawning. Few clear critical periods for larval or juvenile walleye survival to the fall have been discovered, which may suggest that critical periods vary year to year based on environmental conditions. This work is preliminary and will continue in 2023.

- **Restoring walleye populations in rainbow smelt invaded systems**. In 2019, baseline research was conducted between UW-Madison, Center for Limnology Ph.D. student, Joe Mrnak, and WDNR fisheries research to restore walleye in a rainbow smelt dominated lake. Restoration is being attempted by stocking cisco, yellow perch, and adult walleye, while subsequently removing rainbow smelt during spring spawning. This research is ongoing and cisco were stocked into Sparkling Lake in fall 2020 and 2021. A review of invasive rainbow smelt effects on fish communities and the theory behind this research project were published in Reviews in Fisheries Science and Aquaculture in 2022.

  Mrnak, J.T., L. Sikora, M.J. Vander Zanden, and G.G. Sass. 2022. Applying panarchy theory for aquatic invasive species management: a case study on invasive rainbow smelt *Osmerus mordax*. Reviews in Fisheries Science and Aquaculture https://doi.org/10.1080/23308249.2022.2078951.

- **Black crappie and walleye interactions**. An ongoing WDNR fisheries research study is testing for relationships between black crappie and age-0 walleye. Results suggest a strong, negative interaction between the species such that walleye age-0 recruitment is always low when black crappie relative abundance is high. This manuscript was published in the North American Journal of Fisheries Management in 2022.

  Broda, S., Z.S. Feiner, J.T. Mrnak, S.L. Shaw, and G.G. Sass**.** 2022. Black crappie influences on walleye natural recruitment in northern Wisconsin lakes. North American Journal of Fisheries Management 42:1202-1214. https://doi.org/10.1002/nafm.10814.

- **Compensatory density-dependent mortality between age-0 and age-1 walleye**. Afisheries research study is examined density-dependent mortality between age-0 and age-1 walleye in Ceded Territory of Wisconsin lakes. Density-dependent mortality of age-0 walleye was highly evident. This study also tested for abiotic and biotic covariates that may explain additional variability in this relationship. This research was published in Fisheries Management and Ecology in 2022

  Zebro, L.R., J.T. Mrnak, S.L. Shaw, S.R. Chipps, and G.G. Sass. 2022. Density-dependent and environmental influences on juvenile walleye survivorship in northern Wisconsin lakes. Fisheries Management and Ecology 29:897-910. https://doi.org/10.1111/fme.12591.

- **Fish community productivity**. Walleye production because of poor natural recruitment has declined over time in Ceded Territory of Wisconsin lakes. Determination of fish community production distribution in lakes with stable walleye natural recruitment versus those where natural recruitment has declined over time will be used to inform applied management actions to rebalance fish community production to favor walleye natural recruitment. A M.S. graduate student at UWSP will continue this study in 2023-2025.

- **Evaluation of the Wisconsin Walleye Stocking Initiative**

  Walleye *Sander vitreus* are culturally and recreationally important in Wisconsin, USA and have experienced population declines in some lakes due to reduced natural recruitment over time. In 2013, the Wisconsin legislature implemented the Wisconsin Walleye Stocking Initiative, a statewide rehabilitation effort to help declining Walleye populations by stocking fall fingerling Walleye (150-250 mm). An evaluation of stocked fish survival and cost to harvestable age is important for assessing the program's goals. Our objectives were to: (1) test for differences in natural mortality (*M*) of stocked Walleye among stocking densities (12.4, 24.7, 37.1 fish/ha), lake recruitment status, and lake conductivity; (2) estimate cost of survival to a harvestable age; and (3) test for differences in predicted adult Walleye abundance (resulting from stocking) among lakes across various stocking densities. We found significant differences in *M* among recruitment status, lake conductivity, and stocking density. Natural mortality was lower in lakes with some some natural recruitment, with medium-low and high conductivities, and stocked at 24.7 fish/ha. No estimates of survival resulted in stocked Walleye populations reaching densities of natural reproducing populations (≥7.4 adult Walleye/ha) or that of a "fishable" population (≥3.7 adult Walleye/ha) following one stocking event. No conditions resulted in the naturally reproducing population density standard to be met after multiple stockings. Two to four stocking events were required to achieve the "fishable" population standard, depending on lake conditions. When estimating cost to harvestable age, lakes stocked at 24.7 fish/ha had the lowest cost to age-4 ($17.70 - $35.41/fish). Lakes stocked at 12.4 fish/ha had the highest cost to age-4 ($91.17 - $182.34/fish). Our results suggest that the stocking density to reduce juvenile Walleye *M* from age-0 to age-1 was dependent on lake conductivity and recruitment status, with lakes stocked at 24.7 fish/ha providing the lowest cost to age-4. This manuscript will be submitted for publication in spring 2023.

- **A RAD tool for walleye (Sander vitreus) management in Wisconsin** – submitted by WDNR Fisheries Research Scientist, Collin Dassow

  The impacts of climate change on recreational fisheries will not be equally distributed across all species and waterbodies. While large-scale modeling and prediction provide insight into general impacts of climate change on inland recreational fisheries, small-scale dynamics and local expertise will be key in developing explicit goals for managing recreational fisheries in the face of a warming climate. The resist-accept-direct (RAD) framework encompasses the entire decision space managers consider when addressing climate impacts in their local system, but to decide whether to resist, accept, or direct in their local systems managers need tools to understand how specific systems will be impacted by climate change. Here a decision-support tool was developed and applied to the walleye recreational fishery in the state of Wisconsin, USA as an example of how to link the RAD framework to real-world

management of a recreational fishery. This research was accepted for publication in Fisheries Management and Ecology in 2022.

Dassow, C.J., A.W. Latzka, A.J. Lynch, G.G. Sass, R.W. Tingley III, and C. Paukert. 2022. RAD decision-making tool: an application to walleye (*Sander vitreus*) in Wisconsin. Fisheries Management and Ecology 29:378-391. doi.org/10.1111/fme.12548.

5. **Lake Winnebago System Management Project Updates –** submitted by WDNR Biologist, Angelo Cozzola

Reward tag study:
Walleye exploitation on the Winnebago system has been estimated since the early 1990`s using large scale tagging efforts and tag returns from anglers. One of the major components of the exploitation estimate is the tag reporting rate used, which was previously estimated at 50%. In order to evaluate the accuracy of the 50% tag reporting rate for the Winnebago system, a 5-year reward tag study was conducted from 2016-2021. Each year of the study involved tagging 100 female and 100 male Walleye with pink floy tags reading "reward 100$". The return rates of the reward tags were compared with the return rates of our normal non-reward tags (yellow floy tags) each year to calculate a corrected tag reporting rate. The results of the study show an average tag reporting rate of 32.6% (2016: 27.6%, 2017: 40.8%, 2018: 34.3%, 2019: 24.8%, and 2021: 35.6%). The use of the lower tag reporting rate established in the study resulted in an increase to the Walleye exploitation estimates. The preliminary findings from the earlier years of the study were a significant contributor to the Walleye bag reduction that occurred in 2020. Overall, this study led to a better understanding of Walleye exploitation on the Winnebago system.

Walleye movement study:
A new Walleye movement study on the Winnebago system started in the fall of 2021. The goals of this project include tracking Walleye movement around the system and identifying areas of habitat use, specifically for spawning. Walleye in the Winnebago system are known to spawn in the Wolf River, the Upper Fox River, and the shorelines of the system lakes. A previous Walleye movement study, as well as spring shocking and tagging efforts, have established the Wolf River as the most productive spawning sites for Winnebago system Walleye. The previous study tagged fish all over the system including spawning marshes on the Wolf and Upper Fox River as well as Lake Winnebago. The first year of the new study only tagged fish in Lake Winnebago, aiming to get a more accurate picture of where Winnebago tagged fish spend the spawning period. In addition to this, acoustic receivers have been added the system`s receiver array since the last study including 20 in Lake Winnebago and several in the Upper Fox River. The addition of the Lake receivers will allow for the detection of fish that remain in the lake to spawn as well as identify areas within the lake they spend the spawning period.

74 adult Walleye were tagged in the fall of 2021 at various locations around Lake Winnebago and there has been one receiver download so far. The study will likely span 3-5 years, though the first year of downloads has yielded some preliminary results. Out of the 74 fish tagged 16 were harvested (21.6%), but out of the 16 harvested fish, time stamped detections indicate only 8 of the fish had their spawning run impacted by harvest. After accounting for fish with harvest impacted spawning runs, we observed 90.2% of tagged fish traveling up the Wolf River, 6.5% of fish spending the spawn in Lake Winneconne or Poygan, and 3.3 % spending the spawn in Lake Winnebago. There were no tagged fish observed running the Upper Fox River. Further analysis was done on the Wolf River fish showing 51.1% spawned above Fremont, 30.6% above New London, and 18.4% above Shiocton. We observed 1 tagged fish migrating downstream to Little Lake Butte Des Morts.

Future tagging efforts for this project will include fish in the Upper Fox River, The upriver Lakes (Butte Des Morts, Winneconne, Poygan) and targeted areas of Lake Winnebago. The 16 fish that were harvested in the first year of the study all successfully returned the implanted sonic tag, and these returned tags, with an estimated 2 years of remaining battery life, were implanted into Lake Puckaway Walleye in the fall of 2022. The upper Fox River walleye spawning run has become less substantial and predictable in recent years. Fishways have been installed to improve fish passage including Eureka in 1993 and more recently in Princeton and Montello. Many of the historical walleye spawning marshes are located downstream of Princeton on the upper Fox River, but walleye should now have access to upstream reaches with the recent Princeton and Montello fishways. It will be important to evaluate if walleye movement and habitat use has changed on the upper Fox River. The additional receivers added to the Winnebago system array and future tagging of Fox River fish, should provide insight on the lesser known about spawning areas of the Winnebago system located in the Upper Fox. All sonic tagged fish also received a $100 reward loop tag to help ensure that we receive information regarding harvested fish in the study and have the potential to reuse sonic tags. This study is currently being funded by the Department, NRDA, Walleyes for Tomorrow, and Sheboygan Walleye Club. Below is the message we send out to anglers for tag reporting.

All sonic tagged fish are also marked with an orange loop tag near the dorsal fin that reads, RESEARCH REWARD. Anglers that happen to catch a sonic tagged fish are asked to record the tag number information and approximate length, take a picture with the fish and close up of both sides of the loop tag showing the number, and report their catch. If the fish is released please leave the loop tag intact. If the fish is harvested please contact the DNR, the internal sonic tags have a 3 year battery life and may be able to be reused. Anglers that report the catch or harvest of a loop tagged fish and have proper confirmation (the physical loop tag or picture with fish and verifiable loop tag number) will receive a $100 reward (reward expires Dec. 31, 2025). To report tags and catch information, anglers can email the information to DNRWINNEBAGOSYSTEMTAGRETURNS@wisconsin.gov, call 920-303-5429, or mail to the Oshkosh DNR office (625 East County Road Y, Oshkosh WI 54901).

6. **Walleye Lakes of Concern project update** submitted by WDNR Biologist, Lawrence Eslinger

   Over the past several years DNR, Great Lakes Indian Fish and Wildlife Commission (GLIFWC), and Lac Du Flambeau Band of Lake Superior Chippewa (LDF) partners have been working on a shared management plan to rehabilitate four, northeastern Wisconsin walleye populations. These fisheries were once sustained entirely by natural reproduction and recruitment, but by the mid-2010s they were all showing marked declines in natural age-0 fall recruitment. More intensive monitoring and stocking efforts began, followed by public outreach, voluntary reductions in LDF spring harvest (2021), and implementation of a new angling regulation aimed at promoting population rehabilitation (2022: 18" minimum length, 22-28" no harvest, 1 > 28"; 1 daily bag limit). The completed management plan is available upon request (lawrence.eslinger@wisconsin.gov) and should be on the DNR website soon. The plan identifies specific management objectives, project timeline, outreach and reporting requirements, and thorough documentation of population and fishery characteristics over time. The partner group will meet annually to discuss fishery status and adaptive management strategies, with an initial evaluation of the full plan to occur in 2027.

7. **Minocqua Chain Walleye Rehabilitation –** Submitted by WDNR biologists Nathan Lederman, Lawrence Eslinger, Royce Zehr, and Stephanie Shaw and GLWFIC biologists Aaron Shultz, Adam Ray, and Mark Luehring

   Great Lakes Indian Fish and Wildlife Commission, Headwaters Basin Chapter of Walleyes for Tomorrow, Lac du Flambeau Band of Lake Superior Chippewa, and Wisconsin Department of Natural Resources formed a partner group in 2014 to address the declining Walleye population in the Minocqua Chain of Lakes, Oneida County. The partner group implemented a rehabilitation plan in 2015 attempting to restore a self-sustaining Walleye population with at least 3 adult fish per acre and improve the age diversity of Walleye across the lakes (TWG 2016). A 5-year closure of angler and tribal harvest (extend till 2025), regular stocking of extended growth Walleye (10/acre every other year) and increased population monitoring within the Minocqua Chain of Lakes (7 population estimates, annual fall recruitment surveys) has occurred as a result. Adult Walleye abundance has increased but sufficient young of year recruitment still lacked after five years. The partnership continued to address Walleye reproduction by adding 550 linear feet of new spawning reefs funded by Walleyes for Tomorrow and supplementing extended growth stockings with fry stocking reared in a Walleye Wagon operated by Walleyes for Tomorrow. Partners also compiled a list of factors potentially inhabiting Walleye reproduction and recruitment success (Shultz et al. 2022; table 3). Topic specific subgroups were formed investigating availability and condition of Walleye spawning habitat and change in adult sex ratios which were identified as the highest priority. The partner group was unable to determine if spawning habitat was a limiting factor influencing

Walleye recruitment. If additional habitat alternations are made within the Minocqua Chain of Lakes, a rigorous scientific approach will be taken. Future habitat assessments will also take a more systemic and standardize approach across lakes ensuring comparability across lakes. A decreasing male to female sex ratio from the 7:1 benchmark was suggested to be influenced by poor natural recruitment, halting Walleye harvest which allowed females to persist longer, and stocking practices that introduced high proportions of females into the fishery. Modifications to the stocking protocol and special harvest regulations, when harvest opens, are being considered to alter the adult sex ratio. There is still much to be learned about the Minocqua Chain of Lakes Walleye fishery, but findings should support future assessments, enhancements, and monitoring effort by the partner group.

A. Shultz, M. Luehring, A. Ray, J. Rose, R. Croll, J. Gilbert, M. Price, J. Graveen, L. Chapman. 2022. Case study: Applying the resist-accept-direct framework to an Ojibwe Tribe's relationship with the natural world. Fisheries Management and Ecology 29:392-408.

Technical Working Group (TWG). 2016. Minocqua Chain Walleye Rehabilitation Plan. Madison, Wisconsin.

8. **Molecular Conservation Genetics Laboratory; Wisconsin Cooperative Fishery Research Unit; University of Wisconsin – Stevens Point**
Submitted by Dr. Jared Homola

The Molecular Conservation Genetics Laboratory at University of Wisconsin-Stevens Point has continued to advance efforts to facilitate parentage-based tagging (PBT) as a walleye stocking assessment and management tool throughout Wisconsin. In 2022, we expanded broodstock reference genotype databases and screened several hundred wild caught samples to determine their origin. Upcoming analyses will complete broodstock genotyping for walleye used in hatchery production from 2014-2022, providing a long-term asset for evaluating stocking success, as well as potentially influential factors, such broodstock and recipient waterbody selection, traits of broodfish, and hatchery conditions.

9. **Wisconsin Cooperative Fishery Research Unit; University of Wisconsin – Stevens Point**
Submitted by Dr. Dan Isermann & Dr. Dan Dembkowski

Walleye and yellow perch in northern Wisconsin lakes: recruitment trends and importance of perch as prey for larval and post-larval walleye

The objectives of this study were to determine if the following differ between lakes with different walleye recruitment histories (sustained vs. declined): 1) density and spatial distribution of zooplankton prey; 2) relative importance of larval yellow perch and zooplankton to larval and post-larval walleye diets; and 3) trends in age-0 yellow perch abundance. Densities of zooplankton and spatial and temporal trends in these densities did not significantly differ between lakes with different walleye recruitment

histories. Larval walleye as small as 9 mm had fish present in their diets. Yellow perch recruitment (indexed as fall age-0 CPE) was similar between lakes with different walleye recruitment histories. Sampling is complete and MS thesis (led by AnaSara Gillem) is in preparation.

Spawning locations, movements, and potential for stock mixing of walleye in Green Bay, Lake Michigan

A total of 359 adult walleye were implanted with acoustic transmitters at multiple locations within northern and southern Green Bay during fall 2017 and spring 2018 to test the current conceptual model for walleye management in Green Bay and determine if: 1) the walleye stocks in Green Bay primarily consist of fish that spawn in tributaries; 2) walleye spawning in Green Bay show high fidelity to specific spawning locations; 3) stock contributions to the northern and southern zones of Green Bay vary among seasons; 4) a measurable proportion (> 10%) of walleye leave Green Bay and enter Lake Michigan; and 5) the probability of a walleye moving to northern or southern Green Bay or out into Lake Michigan is influenced by tagging location, sex, or length. Telemetry detections suggest many Green Bay walleyes use tributary habitats for spawning but open-water spawning locations contribute to fisheries in southern (21%) and northern Green Bay (26%), suggesting open-water locations may represent more important sources of recruitment than previously thought. Spawning location fidelity was > 75%. We observed the potential for stock mixing, with more northern Green Bay walleyes moving south than southern fish moving north; transitions between northern and southern Green Bay typically occurred during summer and fall. More northern Green Bay walleye than southern Green Bay walleye were detected moving into Lake Michigan. Transition probability was influenced by tagging location and length; tagging groups closer to zone boundaries were more likely to cross receiver lines than less proximate tagging groups and larger fish were more likely to transition but only for some tagging groups and length was confounded with sex. We hypothesize that differential movements of northern Green Bay walleyes (to southern Green Bay and into Lake Michigan) are related to habitat, productivity, and prey resources. Our results also suggest that adjusting monitoring efforts to account for open-water spawners may provide a more complete picture of stock status. Manuscript (led by Lisa Izzo, postdoctoral researcher at UWSP) in revision with North American Journal of Fisheries Management.

Supply-and-demand dynamics associated with using stocking to maintain walleye fisheries in the face of climate change

Climate-driven losses of suitable habitat and reduced viability of naturally recruiting walleye populations could lead to increased demand for supplemental stocking. Consequently, management decisions about where stocking will occur may become more complex and the decision-making process will require better information on where stocking is likely to be successful in meeting management objectives. The objectives of this project are to: 1) identify factors that influence walleye stocking

success; 2) provide model frameworks to state agencies to help identify suitable stocking locations; and 3) forecast changes in stocking success based on climate change scenarios. Data have been obtained, collated, and cleaned from multiple state agencies (IL, IN, IA, MI, MN, NE, ND, OH, SD, WI), resulting in over 3,000 lake-year observations to evaluate walleye stocking success. These data were combined with relevant environmental and limnological information when available. Preliminary analyses are underway and suggest that important factors influencing walleye stocking success may include largemouth bass CPE and lake productivity. Future data analyses will include sub-setting the data to more complete lake-year cases to understand the important of missing data in influencing results of the global random forest model and fine tuning the model fitting process. Project led by Bobby Davis, postdoctoral research at UWSP.

Evaluating walleye thermal-optical habitat preferences in northern Wisconsin lakes using two forms of technology

Declines in preferred thermal-optical habitat (TOHA; the fraction of a lake considered suitable for walleye in terms of both temperature and light conditions) has been implicated as a factor contributing to declines in walleye recruitment throughout the upper Midwest. However, current models describing TOHA and expected walleye use of TOHA are mostly observational in nature and lacking empirical support. Advances in fish tagging and tracking technology allow abiotic and biotic measurements experienced by individual fish to be transmitted or recorded, thereby providing an opportunity to empirically assess walleye use of model-predicted TOHA and whether lakes with declining walleye recruitment have less TOHA than lakes with sustained recruitment. The objectives of this study are to use acoustic transmitters and archival tags to determine if TOHA use by walleyes varies among lakes or in relation to season and fish size and if previously-used TOHA models accurately define TOHA use for three Wisconsin lakes with different trends in walleye recruitment. Furthermore, results can be used to provide a roadmap for future TOHA studies by determining the data resolution and cost-effectiveness of acoustic telemetry vs. archival data storage tags. We implanted acoustic transmitters into 40 walleye and archival data storage tags into 136 walleye during spring 2022. Tags were distributed among three sizes of walleye and across three lakes with different trends in walleye recruitment. Thermal and optical profiles were measured at each lake periodically during 2022. Archival tag recovery and acoustic detection processing will occur during 2023. This portion of the project is led by MS student Ben Vasquez at UWSP and is part of a broader project to investigate walleye recruitment bright spots in a changing climate. Other team members include personnel from Wisconsin Department of Natural Resources, the USGS National Climate Adaptation Science Center, University of Minnesota, and Center for Limnology at University of Wisconsin-Madison.

Effects of centrarchid removal on percid populations

The Wisconsin Cooperative Fishery Research Unit (WICFRU) at UW-Stevens Point, in collaboration with the Center for Limnology at UW-Madison and with Wisconsin Department of Natural Resources, completed the first year of post-removal monitoring at McDermott Lake where over 280,000 centrarchids were removed during 2018-2021 with goal of assessing effects of large-scale centrarchid removal on walleye recruitment and yellow perch population dynamics and demographic, among other things. During spring 2022 a single larval walleye was captured, representing the only evidence thus far of a walleye recruitment response to manipulation. However, no juvenile walleye were captured in subsequent summer or fall sampling. Yellow perch abundance appears to have increased following centrarchid removals and further research is occurring to determine conditions associated with the observed increase (i.e., if a single or multiple years classes of perch). Although WICFRU's focus has shifted to evaluate effects of the centrarchid removals on dynamics and demographics of the remaining centrarchid populations, walleye and perch population monitoring will continue during 2023. Project led by MS student Becca Henningsen at UWSP.

10. University of Wisconsin-Madison, Center for Limnology

- From Quinn Smith with the CFL: Currently we are working on comparing and modeling littoral and pelagic water temperatures throughout the summer given previous data and understanding the influence of lake morphometry on littoral temperature at different littoral sites. Understanding the relationship between littoral and pelagic water temperatures within our study systems, along with other lake variables, will help predict walleye success in the future and can be applied to other lakes to help identify populations that exceed expectations given climate change. In the future, littoral and pelagic temperature trends and models can be applied to the General Lake Model (GLM) so that lakes that vary in morphology, hydrology, and climatic conditions can be explored when evaluating walleye population success.