American Currents

Publication of the North American Native Fishes Association

Volume 48 Number 1 Winter (January) 2023

(See Contents page.)

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The North American Native Fishes Association

Est. 1972 — John Bondhus, founder

Mission: The North American Native Fishes Association (NANFA) is dedicated to the appreciation, study and conservation of the continent's native fishes. NANFA is a 501(c)(3) not-for-profit, tax-exempt corporation chartered in the State of Maryland. The purposes of the organization are: • to increase and disseminate knowledge about native North American fishes; • to promote practical programs for their conservation and the protection/restoration of their natural habitats; • to advance the educational, scientific and conservation benefits of captive maintenance and husbandry; • to encourage the legal, environmentally responsible collection of native fishes for private aquaria as a valid use of a natural resource; and • to provide a forum for fellowship and camaraderie among its members.

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American Currents

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Volume 48 Number 1 Winter (January) 2023

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FRONT COVER: A Bowfin *Amia calva* at the surface of Gilchrist Blue Springs Run, Florida. (Photo by Isaac Szabo)

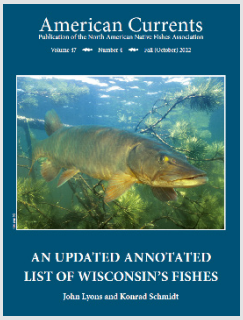
BACK COVER: A few of the hundreds of spawning Common Shiners *Luxilus cornutus* seen spawning at the tail end of a pool in the New Haven River (Vermont), May 2022. (Photo by Ethan Rising)

American Currents (ISSN 1070-7352) is the quarterly publication of the North American Native Fishes Association (NANFA).

NANFA News

MEMBERS, EVENTS, ACCOMPLISHMENTS, AND ADMINISTRIVIA

FANTASTIC FEEDBACK



Bryn Tracy (North Carolina) emailed Fritz Rohde in late December after receiving his fall issue of *American Currents* (*AC*) to say, "Received my *AC* yesterday. I find more enjoyment and education out of *AC* than any issue of AFS's *Fisheries* magazine. Please share my appreciation with all the authors, editors and reviewers." Doug Carlson (New York) wrote, "I'm really enjoying reading through the issue devoted to Wisc. Fishes. What a good idea to have the publication become available without being restricted or confounded by digital media. I think this article performs a terrific service to the scientific and lay audiences as they are able to better understand the changes in names and the changes in fish distribution, as well as their in-depth introduction of the current literature. Wow!" Olaf Nelson (Illinois), *AC* design and layout editor, shared an encounter with his mail carrier. "Today my mailman (an angler who has shown a marked increase in interest in non-game fishes over the last couple years) rang the doorbell and knocked simultaneously. I thought it was a registered letter from the IRS or something, but he wanted to know more about this American fish magazine he brings me every so often and how he could join. I think the latest issue and its blue cover must have been the final temptation. I had an extra copy, so I gave it to him. He was excited to go home and start reading." Co-author John Lyons (Wisconsin) suggested a new NANFA motto: *Fostering a greater appreciation of our native fishes, one mail carrier at a time.*"

The blushing editorial staff (Fritz, Konrad Schmidt, Olaf Nelson, John Olson, Bruce Bauer, Tom Watson, Bruce Lilyea, and Christopher Scharpf) appreciate these glowing comments. We always take great pride in editing and publishing *AC,* but even more so when we hear that members have enjoyed the content. We must thank the authors of this issue and all who have submitted a steady stream of high-caliber articles, photos, and other materials for publication. We hope this wonderful synergy continues to flow for years to come.

2022 NANFA CORCORAN EDUCATIONAL GRANT AWARDED

The NANFA grant committee selected the Native Village of Eklutna, Chugiak, Alaska, and their proposal, "Salmon Day at Native Village of Eklutna's Environmental Culture Camp." Their funding request is for $1,085. The target audience includes Eklutna Tribal youth, youth of neighboring tribes, and the public. Lesson topics include salmon life history, macroinvertebrates, and water quality. The grant award will be used to purchase waders, life jackets, minnow traps, and macroinvertebrate sampling gear.

The project summary states: "The Native Village of Eklutna (NVE) started an Environmental Culture Camp in 2021. The goal of this weeklong camp is to connect tribal youth with their Tribal Elders (and their Traditional Ecological Knowledge) and the environment. In its first year, the camp did this through activities such as plant identification and edible harvests; the identification, harvest, and processing of salmon, and through the harvesting of necessary materials and the construction of a traditional cache. This upcoming year, the Native Village plans to expand on environmental activities by having a full day devoted to salmon and their freshwater habitat. Planned topics of discussion include the salmon lifecycle, freshwater habitat, waquality, and habitat conservation. These activities will be conducted streamside, giving the youth firsthand learning experiences, and allowing them to get their feet wet and their hands dirty. This type of interactive outdoors education leaves a lasting impression and has been shown to increase student motivation, self-discipline, and attention (Kuo et al. 2019. Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. Frontiers in Psychology Vol. 10). These environmental components will be taught alongside cultural components such as traditional harvest and preparation of salmon and the Dena'ina language pertaining to salmon."

2022 NANFA CONSERVATION RESEARCH GRANT AWARDED

This year's NANFA Conservation Research Grant proposal review committee (Bruce Lilyea, Derek Wheaton, and Michael Wolfe) selected the proposal from Owen Ridge, a Conservation Biology student at the University of Toronto, "Freshwater Mussel Shells and *Noturus* Madtoms in Ontario: A Rare Opportunity for the Conservation of Two At-Risk Groups." The project is "a study on the interdependent relationship between *Noturus* madtom species and freshwater mussels in Ontario to understand if or how declines in native mussel species may be affecting *Noturus* populations." The research questions for the proposed study are: "Do the madtoms of the Carolinian zone (namely Stonecats, Brindled, and Northern madtoms) make significant use of mussel shells for shelter in Ontario as they do in Kentucky? If so, which mussels are preferred (rare or common species)?"

Ridge's proposal states that "relatively little is known about the reasons behind its [Ontario's Northern Madtom] decline, besides the fact that habitat destruction and alteration play a role. But what are the specifics? Based on my observations and those

NANFA News, continued

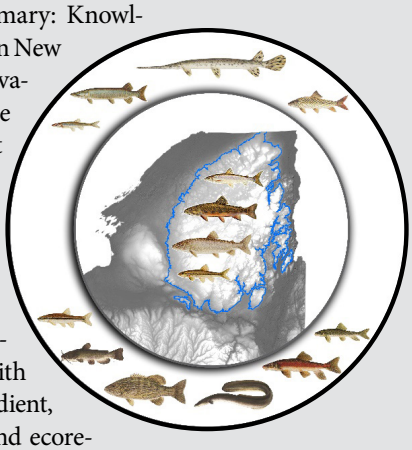
made by Lienesch and Brumley in Kentucky, I postulate that one of the specific threats facing the Northern Madtom, and by extension Ontario's other madtom species, is the simultaneous decline in freshwater mussel populations that share habitat with these madtoms. More specifically, with changes in water quality causing reductions in the populations of mussels in the heavily developed parts of Carolinian Ontario, there are fewer shells for the madtoms to make use of as shelter, and thus they are more vulnerable to predation." He suggests that the research "would allow for a better understanding of a heretofore under-appreciated threat to these poorly studied madtoms, and ideally, would allow us to make plans for the conservation of two at-risk groups at once in Ontario—the madtoms and the freshwater mussels."

Stonecat (Konrad Schmidt).

At the completion of the study, the results will be shared with NANFA members. Thank you to all who participated in this year's Conservation Research Grant process, especially all of the applicants. Please join us in congratulating Owen!

FISHES OF NORTHERN NEW YORK AND THE ADIRONDACKS

NANFA member Doug Carlson recently had his monograph on fishes of northern New York and the Adirondacks (co-authored with Jane Carlson) published in the *Northeastern Naturalist* Volume 29. Monograph 21 (2022). This is a terrific achievement and congratulations to both authors! The 50-page report can be obtained in digital for free or a print copy will be sent for a cost of $17.50. Contact Doug at: carlsodm@potsdam.edu



From the report's summary: Knowledge of the fishes of northern New York can help with conservation planning and landscape interpretations. This report draws from fish surveys from the 1930s to 2018 to summarize and interpret the distribution of fishes in the region surrounding and including the Adirondacks. The study area, with its broad elevational gradient, includes lowland and upland ecoregions, for which we compare fish assemblages. Of the 116 taxa, 111 are in lowlands and 77 in uplands. Many of the species that are native to the lowlands do not occur naturally in the uplands, becoming widespread there only after transferal or stocking. The continued expansion of non-native species has caused changes in fish communities and losses of native species. Brief annotations are provided for each of the 116 taxa, including summaries of recent studies, changes in their status before and after 1989, and proposed conservation classifications.

IOWA DARTERS RESCUED AND RELOCATED

This spring, Minnesota DNR found that Iowa Darter *Etheostoma exile* had spawned in a Muskie rearing pond near Park Rapids, MN. On July 26, 2022, 3,400 of them were hauled to St. Paul and distributed to four teams for placement into six lakes. Two teams were from DNR, and the other two were all NANFA members: Jay Hatch, Laurie Sovell, Jenny Kruckenberg, and Konrad Schmidt. The six lakes were part of a project to reestablish sensitive fishes in lakes with exceptional water quality. Amazing what a collaborative effort can accomplish!

Top left: divvying up the darters. Top right: ready, set, seed! Bottom left: acclimating darters. Bottom right: releasing darters (Jenny Kruckenberg and Konrad Schmidt).

IN SEARCH OF FRESHWATER DRUM TISSUES IN THE RED RIVER OF THE NORTH

Freshwater Drum *Aplodinotus grunniens* has one of the widest latitudinal ranges of any freshwater fish in North America, occurring from northern Central America to northern Canada. There has never been a study of the genetic relationships within the species across this huge range. John Lyons (University of Wisconsin Zoological Museum) Kyle Piller (Southeastern Louisiana University), and Norman Mercado-Silva (Universidad Autonoma del Estado de Morelos, Cuernavaca, Mexico), aided by other scientists and native fish enthusiasts in Canada, the US, and Mexico, have begun such a study and are gathering Freshwater Drum specimens and tissues from populations in many different river basins and drainages for DNA analyses. The geographic scale of this effort makes the field work time consuming and challenging, but the hope is to gather a representative set of samples from across the entire distribution in the next two years and to begin genetic analyses in 2024 or 2025.

NANFA News, continued

In August 2022, John Lyons, John Olson (Iowa), and Konrad Schmidt (Minnesota) headed for the Red River of the North on the Minnesota–North Dakota border at Breckinridge, Minnesota. John Lyons wanted tissues of Freshwater Drum for his research from the Hudson Bay Drainage. In 2018, Konrad had collected several young of the year (yoy) drum at the confluence of the Bois de Sioux and Otter Tail rivers at Breckinridge, which is considered the source of the Red River of the North, but no yoy were found this time. After several seine hauls through knee-deep muck in dark-chocolate water, two adults were seined. John Lyons declared victory on acquiring the minimum number of specimens needed and then pondered what else the three could do there. In September 2021, Konrad was looking for Flathead Chub *Platygobio gracilis* downstream of the last remaining population on the Red River of the North in US waters at Drayton, North Dakota. He got skunked, but a happenstance encounter with a North Dakota game warden revealed a "Holy Grail" discovery. The warden had photos on his cell phone of anglers catching them in the tailwaters of the Drayton Dam to use as cut bait. Despite being 175 miles distant, John Lyons proposed giving it a shot. Though no Flatheads were found, Konrad cleaned up on Silver Chub *Macrhybopsis storeriana* and Goldeye *Hiodon alosoides* by angling with worms. Not bad for someone who has not casted a line in over 20 years! All in all, a marathon trip but a very memorable one.

Left: Freshwater Drum wearing Red River mud (John Olson).
Right: Konrad's Goldeye at Drayton, North Dakota.

A LEGACY LIVES ON

R. Bruce Gebhardt was one of NANFA's earliest members. He served as President from 1982–88, was editor of *AC* from 1984–94, and authored 32 articles for the publication. He was well known for his beautiful photographs, and many have been published in *The Audubon Society's Field Guide to Fishes: North America* (2002), *The Royal Ontario Museum Field Guide to Freshwater Fishes of Ontario* (2009), and *Fishes of Toronto: A Guide to Their Remarkable World* (2012), as well as numerous fish magazines. After his death in 2011, his friend Roy Allen curated the massive collection of slides to digitize and label some of Bruce's best shots. These native fish photos are a part of Bruce's legacy, and over 500 of them are available for the enjoyment of members on the NANFA Gallery : http://www.gallery.nanfa.org/v/members/Bruce+Gebhardt/

AMERICAN CURRENTS HAS MADE THE OXFORD ENGLISH DICTIONARY

Editor Emeritus Chris Scharpf reports that the editors of the Oxford English Dictionary (the definitive dictionary of the English language), who scour printed material for "new" words and new uses of words, are aware of NANFA's publication. "In a recent discussion of the name 'Johnny darter' on an email thread, I decided to look it up in the OED and was amazed to discover that a 2009 article from *AC* by Brian Torreano is cited for the use of the noun 'Johnnies!'"

"For logophiles such as myself, this is quite the honor—and demonstrates the breadth and depths to which OED editors look for words."

Thesaurus » Categories »

c. *U.S. regional.* A small freshwater darter of the percid subfamily Etheostomatinae; *esp.* (more fully ***Johnny darter***) *Etheostoma nigrum*. Also: a sculpin of the Pacific coast; *esp.* (more fully ***tidepool Johnny***) *Oligocottus maculosus*.

1875 D. S. Jordan in *6th Ann. Rep. Geol. Surv. Indiana 1874* 213 *Percina*... Barred Darters... Hog Fish. Johnny. Jack Pike.

1882 *Proc. U.S. National Mus. 1881* **4** 59 *Oligocottus maculosus* Grd.—Johnny.

1912 A. B. Comstock *Handbk. Nature Study* I. II. ii. 177/1 The johnny darters are, with the sticklebacks, the most amusing little fish in the aquarium.

1941 J. Steinbeck & E. F. Ricketts *Sea of Cortez* xxi. 206 The sharp spines of an urchin may protect a tide-pool johnny from a larger preying fish.

2009 *Amer. Currents* Winter 21/1 Tank-care of Johnnies is quite simple.

SUPER STARHEADS

Snow removal from Starhead pond in 2019 (Dave Marshall).

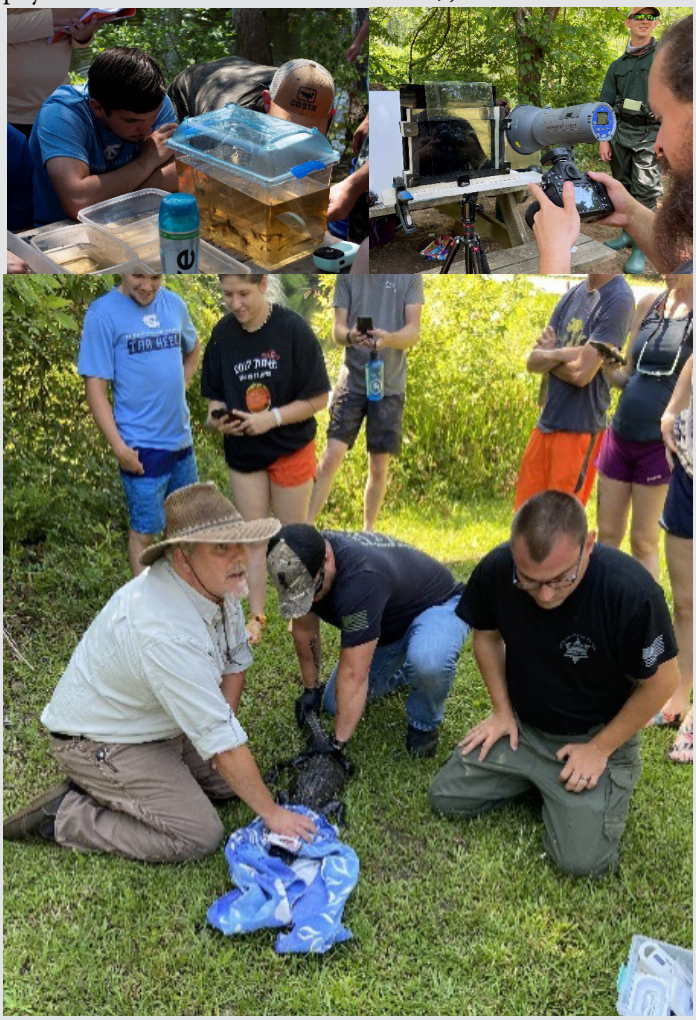
In the fall of 2021, Dave Marshall—one of the authors of a three-part series recently published in *AC* about conserving the Starhead Topminnow *Fundulus dispar* in Wisconsin—was confident that all of the Starheads had been stocked and none remained in the pond. The well pump that fed the pond had stopped working in June, and there was no effort to remove snow from the pond

NANFA News, continued

over the winter. Guess what? Some Starheads had been missed and had somehow survived. They did breed in the pond this year so the stocking program will live on. Dave's hypothesis is that last winter's snow cover was insufficient to cause winterkill. The pond was also stocked with Lake Chubsucker *Erimyzon sucetta* for a new restoration project, but Dave does not yet know if reproduction was successful.

WCU SPRING FIELD TRIP 2022

Professor Keith Gibbs of Western Carolina University in Cullowhee, North Carolina, brought his Ecological Studies class from their mountain home to the coast in May 2022. NANFA President Fritz Rohde hosted them at Lake Waccamaw on the coastal plain, where they caught the endemic Waccamaw Killifish *Fundulus waccamensis* and numerous other fishes. One highlight for the students was watching NC Wildlife Resources Commission biologists capture, measure, tag, and release an American Alligator *Alligator mississippiensis* as part of their population studies. After viewing the nature-like fish passage structure on the Cape Fear River at Lock and Dam No. 1, they headed for the Eno River in the Piedmont. Here NANFA member Scott Smith demonstrated the effectiveness of backpack electroshocking. The class also received a mini-workshop in streamside fish photography from fellow NC fishes team member, Jesse Bissette.



BIOTOPE AQUARIUM CONTEST (BAC) 2022

There were five excellent entries in the North America category, judged this year by NANFA members Lawrence Kent and Fritz Rohde, ranging from the Congaree Swamp in South Carolina, with healthy and happy Blackbanded Sunfish *Enneacanthus chaetodon,* to an urban stream in Texas. The winner was a Chesapeake Bay Oyster Reef biotope (above) submitted by NANFA member Kevin Wilson. Second place was a visually stunning display of a riverbank in Big Walnut Creek, Ohio, from Vinny Andersson. The North American category was sponsored by Aquael (Poland). All you aquarists should consider entering the 2023 contest!

Kevin's entry is a "100-gallon brackish aquarium connected to a 40-gallon sump/refugium." It measures three feet square by 18 inches tall, "giving the appearance of visual depth that you might experience while snorkeling."

He began it in 2007 and finished in 2022. Everything in the tank was collected from Chesapeake Bay. "The showcase fish species is the Striped Blenny *Chasmodes bosquianus*. Other faunal species in the aquarium include Skilletfish *Gobiesox strumosus,* Naked Goby *Gobiosoma bosc*, Sheepshead Minnow *Cyprinodon variegatus*, Mummichog *Fundulus heteroclitus,* Black-fingered Mud Crab *Panopeus herbstii*, Harris Mud Crab *Rhithropanopeus harrisii*, Thinstripe Hermit Crab *Clibanarius vittatus*, American Oyster *Crassostrea virginica*, a couple species of mussels and barnacles, and clam worms. Also, two common bay macroalgae are grown in the system: Sea Lettuce *Ulva lactuca* and a red algae of the genus *Gracilaria*. Other than the blennies, I'm most proud of collecting the hermit crab. I collected it in Saxis, Virginia, along with two blennies, a goby, and a skilletfish, all in one scoop of oyster shells using my Perfect Dipnet."

To make the reef, he gathered oyster shells from various locations, paired half shells and glued them together, leaving spaces as breeding locations, then "glued each complete oyster shell into the cultches [reef sections] that form the reef. I modeled the reef to resemble the shallow oyster reefs that you can see at low tide in various lower Chesapeake Bay locations."

He says "winning was a great honor, but the best thing is that it pushed me to complete this project so I can sit back and enjoy the aquarium of my dreams. I'm happy that I've been able to share my projects on the Biotope Aquarium Project, NANFA Forum, and YouTube. I hope that [it spread] awareness of the beauty and importance of these reefs, the Striped Blenny, and other oyster reef inhabitants."

NANFA News, continued

SPREADING THE GOOD WORD ABOUT NATIVE FISHES

2022 NANFA Field Trip to Salem Creek (John Olson)

Jon Ness (Minnesota) hosted a NANFA convention field trip to his beautiful property along Salem Creek near Kasson and provided a picnic lunch for members. As wonderful as his "Salem Acres" appeared, he expressed grave concern about the rapid agricultural development occurring throughout the watershed. Members found 20 fishes, including two special concern species (Ozark Minnow *Notropis nubilus* and Redfin Shiner *Lythrurus umbratilis*). Not bad for a headwater stream! Jon decided to share the news in the neighborhood and recently reported on how it went. "After the convention, I met with a lot of the neighbors (some of them farmers others simply homeowners). I shared images of the species NANFA had identified in Salem Creek, including the species of concern. Most were intrigued, others quickly concluded that, 'Oh great, I suppose we can't farm near the creek because of these stupid fish.'" ***Editor's Note:*** This is truly a rare reach of stream in a sea of agriculture. In 2012, the Minnesota Pollution Control Agency surveyed a station on Jon's property and found 18 fishes, including another special concern species (Black Redhorse *Moxostoma duquesnei*). An analysis of the data assigned an Index of Biotic Integrity score of 85. To put this into perspective, the maximum score of 100 would be a stream in a pristine wilderness. In 2004, Konrad Schmidt translocated almost 1,000 Rainbow Darters from here to a stream where they had been extirpated for decades (see "A Unique Eagle Scout Project" in the winter 2013 *AC*). During the three collecting trips for Rainbow Darters yet another special concern species was found (Northern Brook Lamprey *Ichthyomyzon fossor*). This makes four found on this little 30-acre parcel.

NANFA WADES INTO THE ENVIRONMENTAL ARENA

A mission objective of NANFA is advocating for the restoration of aquatic habitats. The Mississippi River once flowed for miles in a roaring, rapids-filled gorge between Minneapolis and St. Paul, but construction of US Lock and Dam 1 (USLD 1) in the early 1900s for commercial navigation impounded the gorge. The structure is no longer used for this purpose, and the US Army Corps of Engineers (USACE) has begun a study to make a recommendation to Congress regarding what should be done with USLD 1 and the Lower St. Anthony Falls Lock and Dam upstream. See "What would an undammed metro Mississippi River look like?" by Friends of the Mississippi River (https://fmr.org/updates/land-use-planning/what-would-undammed-metro-mississippi-river-look).

Left: US Lock and Dam 1 (Wikipedia). Right: Lower St. Anthony Falls (Wikimedia Commons).

In December 2022, on behalf of NANFA and based on our mission, President Fritz Rohde submitted comments and questions to the USACE. His letter made it clear that NANFA supports the eventual removal of the dams but suggested a number of questions that must be studied and answered. These include studies of other large-scale dam removals such as those on the Klamath River in California and Oregon set to begin this year to see what can be learned to improve the process in Minnesota, analysis of sediment upstream of the dams for contaminants, and, assuming the sediment is safe, stream morphology impacts of sediment release. The letter further calls for thorough fish surveys (full-community studies beyond the standardized surveys targeting large species) both upstream and downstream of both locks and dams to assess how many species may re-colonize the impounded reaches. It points out the recreational potential of a restored gorge and suggests a recreational analysis. It notes that hydropower is an inefficient source of electricity with substantial impacts on the aquatic environment, and that the energy generated by the dams may soon be eclipsed by other, cleaner energy sources. Finally, the letter questions whether the funding for dam removal will be available.

2022 CONVENTION CRITIQUE

After the convention, Jenny Kruckenberg emailed participants for their comments, and in December she, Ray Katula, and Konrad Schmidt met to discuss the feedback. Overall, responses were very positive. The few complaints were minor, with the worst being the dorms' lack of coffee and spartan beds. A suggestion for improvement was to use social apps to inform participants of any changes to the schedule of the field trips and provide reminders of locations and times of events. Jenny is preparing a more detailed checklist to aid the 2023 South Carolina hosts in their preparation. We know it will be another smashing success!

ZOOMING IN ON NATIVES

A positive outcome of the pandemic is the widespread use of virtual meetings using Zoom and other apps. Fishy academics, professionals, aquarists, and others have continued the practice. In what may be a first for NANFA, Texas regional representative Jeremy Jordan ended 2022 by hosting a virtual event to connect native fish enthusiasts across Texas and beyond. The event included presentations from Ryan Seymour, an aquatic biologist from the Texas Commission on Environmental Quality, and Mark Pyle, a seasoned aquarist and wildlife rehabilitator. Getting together is tough, but virtual events are an excellent way to connect. NANFA members and state reps should look for more chances to use them.

WISCONSIN'S DISAPPEARING OXBOW LAKES

David W. Marshall

Barneveld, Wisconsin

During the 30 years I worked for the Wisconsin Department of Natural Resources (WDNR), and well into my retirement, oxbow lakes were rarely the focus of monitoring and management. Oxbow lakes, also referred to as sloughs, are former river channels. It wasn't until late in my career when I learned the importance of these lakes. After I retired in 2006 and established Underwater Habitat Investigations LLC (UHI), I was finally able to learn more about these important waters.

From 2007–2012, I surveyed fish populations in oxbows along nine rivers in southern Wisconsin (Figure 1). I applied for and received numerous state grants sponsored by nonprofit organizations and county governments. UHI also benefited from the help of WDNR staff and other volunteer "slough pirates." The goal was to assess the distribution of rare off-channel river fishes including Weed Shiner *Notropis texanus*, Pugnose Minnow *Opsopoeodus emiliae*, Starhead Topminnow *Fundulus dispar*, Western Banded Killifish *Fundulus diaphanus menona*, Lake Chubsucker *Erimyzon sucetta*, Pirate Perch *Aphredoderus sayanus*, and Mud Darter *Etheostoma asprigene*. I also collected information on habitats and associated fish species. Fish sampling gear I used included a single-probe DC electrofisher powered by a Honda 1000 generator. A long-handled small-mesh dip net was great for topminnows. I rarely used seines because the backwaters were often too snaggy and weedy to be seined effectively. The other problem with seines is the lengthy time needed to sort fish from plant debris caught in the net, thus resulting in dead fish.

Figure 1: Map of rivers surveyed for rare/uncommon off-channel fish populations.

Photos by the author.

Dave Marshall is a retired Water Quality Biologist for the Wisconsin Department of Natural Resources and covered southwestern Wisconsin and the Lower Wisconsin River.

The surveys showed that oxbow lakes with greater species richness and numbers of rare fishes possessed strong connections to the rivers and were also spring fed (Figure 2). Pirate Perch, Starhead Topminnow, and Mud Darter were three of the study species regularly found in southwest Wisconsin rivers. Table 1 lists the top ten most common fish associated with these three species. The surveys also revealed:

- the first documented Western Banded Killifish in Wisconsin River backwaters.
- the first Starhead Topminnow and invasive Western Mosquitofish *Gambusia affinis* along the Lower Sugar River.
- the Lower Wisconsin River has the largest Starhead Topminnow population in Wisconsin.

Along with rare fish species, the backwater assemblage typically included Tadpole Madtom *Noturus gyrinus*, Central Mudminnow *Umbra limi*, Grass Pickerel *Esox americanus vermiculatus*, Green Sunfish *Lepomis cyanellus*, Warmouth *L. gulosus*, Bluegill *L. macrochirus*, and Largemouth Bass *Micropterus nigricans* (recently split from *M. salmoides*), as well as many other species.

Oxbows that receive groundwater generally have favorable water quality (Amoros and Bornette 2002). In less disturbed rivers, backwater habitats typically range from temporary flood pools to permanent lakes with strong connections to rivers. As a result, biodiversity in floodplains can be very high; they are among the most productive ecosystems on Earth (Opperman et al. 2010). Oxbow lakes support both off-channel and riverine fish populations

Figure 2. High-quality Black River oxbow.

Table 1. Top 10 off-channel fish species associated with Pirate Perch, Mud Darter, and Starhead Topminnow in southwest Wisconsin rivers.

Pirate Perch *Aphrododerus sayanus*	Mud darter *Etheostoma asprigene*	Starhead topminnow *Fundulus dispar*
Bluegill *Lepomis macrochirus*	Bluegill *Lepomis macrochirus*	Bluegill *Lepomis macrochirus*
Largemouth Bass *Micropterus nigricans*	Largemouth Bass *Micropterus nigricans*	Largemouth Bass *Micropterus nigricans*
Grass Pickerel *Esox a. vermiculatus*	Grass Pickerel *Esox a. vermiculatus*	Grass Pickerel *Esox a. vermiculatus*
Central Mudminnow *Umbra limi*	Central Mudminnow *Umbra limi*	Central Mudminnow *Umbra limi*
Mud Darter	Pirate Perch	Pirate Perch
Starhead Topminnow	Warmouth *Lepomis gulosus*	Mud Darter
Warmouth *Lepomis gulosus*	Starhead Topminnow	Warmouth *Lepomis gulosus*
Yellow Bullhead *Ameiurus natalis*	Green Sunfish *Lepomis cyanellus*	Yellow Bullhead *Ameiurus natalis*
Tadpole Madtom *Noturus gyrinus*	Yellow Bullhead *Ameiurus natalis*	Lake Chubsucker *Erimyzon sucetta*
Green Sunfish *Lepomis cyanellus*	Pumpkinseed *Lepomis gibbosus*	Green Sunfish *Lepomis cyanellus*

and include habitat for reproduction, early life history stages, lateral migrations, and refugia when river conditions become stressful (Bayley 1995; Killgore and Baker 1996; Roach et al. 2009; Miyazono et al. 2010; Slipke et al. 2005).

FLOODPLAIN AGGRADATION

In spite of their ecological importance, floodplains are among the most degraded ecosystems in the US and globally (Opperman et al. 2010). In many of the southwest Wisconsin watersheds I sampled, floodplain sediment deposition reduced connectivity between rivers and oxbow lakes. Under these conditions, rivers flow between steep banks of an elevated floodplain, what geologists describe as human accelerated floodplain aggradation (Knox 2006). Nearly 200 years of overbank sedimentation has reduced floodplain habitats in many agricultural watersheds. This means many fish species have lost access to spawning sites, and lateral fish migrations are becoming rare. In addition to loss of river connectivity, oxbows in sediment-deposited floodplains become perched above the groundwater table (Figure 3). Without groundwater inputs, oxbows often dry up during the summer months.

Figure 3. This oxbow was elevated above the water table in an aggraded floodplain. These types of oxbow lakes are most vulnerable to droughts and climate change.

GROUNDWATER POLLUTION

The Lower Wisconsin River flows west through the unglaciated Driftless Area and empties into the Mississippi River. Unlike the many other southern Wisconsin rivers that are disconnected from their floodplains, the Lower Wisconsin River remains well-connected to its natural floodplain. This connectedness is an important reason why the Lower Wisconsin State Riverway (LWSR) supports 98 fish species (Lyons 2005) and explains why the vast network of LWSR oxbow lakes has been described as a "fish safe haven" (Marshall and Lyons, 2008).. Special designations have been established to protect the river's rich biodiversity including the 32,000 ha LWSR, Clean Water Act Exceptional Resource Water (ERW), and Ramsar Convention Wetland of International Importance.

Prior to the federal Clean Water Act implementation, from about the mid-twentieth century to the late 1970s, the Wisconsin River was severely polluted from the pulp and papermill industry (Ball and Marshall 1978). Oxbows along the LWSR likely functioned as refugia during the worst periods of industrial wa-

Figure 4. Clear Lake along the LWSR was an active channel and part of a braided river system. Clear Lake and most other Lower Wisconsin River oxbows are typically long and narrow. Sediment scouring can occur when the river reclaims the oxbows during floods. Most of the LWSR oxbows looked very similar to Clear Lake until nitrate pollution degraded them.

Figure 5. Jones Slough along the LWSR. This (spring lake) oxbow was pristine as recently as 2004 before nitrate contaminated groundwater degraded lake water quality.

Figure 6. Beavers can restore off-channel habitats in aggraded river floodplains. A beaver dam is located on the right side of the photograph. Jean Unmuth is seen dipnetting Starhead Topminnow in the beaver pond.

ter pollution. The massive aquifer beneath the river's Pleistocene sand terrace sustained the oxbows' water quality and diluted the industrial pollution. Some of the LWSR oxbows are classified as spring lakes since they are mostly groundwater fed and lack surface water inlets.

Until recently, the LWSR supported the most pristine oxbows in the state (Figure 4). By 2011, water quality had changed. Agriculture had become industrialized across the river sand terrace. Liquid manure and nitrogen fertilizers were applied in greater amounts needed for higher crop yields. The groundwater beneath the sand terrace quickly became polluted with very high nitrate concentrations. High nitrate levels can affect lakes and streams in two ways: eutrophication and toxicity. As the nitrate-contaminated groundwater reached the oxbow lakes, dense mats of duckweed and filamentous algae began to blanket the water surface of previously clear waters (Figure 5). Dense mats of free-floating plants are also plaguing many Mississippi River floodplain lakes (Giblin et al. 2013; Houser et al. 2013).

The same aquifer which sustained high quality LWSR oxbow lakes for millennia had become polluted with nitrate concentrations two or three times higher than the Drinking Water Enforcement Standard of 10 mg/l. In addition to human infant health concerns (methemoglobinemia or blue baby syndrome), many aquatic animals are also sensitive to high nitrate concentrations. A maximum of 2 mg/l NO_3-N is recommended to protect environmentally sensitive fish, amphibians, and invertebrates (Camargo et al. 2005).

Nitrate-laden water degraded numerous state-endangered Starhead Topminnow habitats along the Lower Wisconsin River, such as surface mats of free-floating plants. Our recent conservation aquaculture project, described in several *American Currents* issues, was a response to this threat. Other species threatened by nitrate pollution include Lake Chubsucker, which we began raising this year to expand their distribution upstream of the severe pollution.

WHAT CAN BE DONE TO IMPROVE OXBOW LAKES IN WISCONSIN?

Two options to improve oxbows come to mind: Clean Water Act enforcement and beaver reintroduction. In the latter case, the US Supreme Court recently ruled in the City of Maui v. Hawaii Wildlife Fund that the Clean Water Act can regulate contaminated groundwater discharges to surface waters. Since the Clean Water Act was effective for restoring the Lower Wisconsin River by the early 1980s, now perhaps the federal law can regulate groundwater discharges contaminated with high nitrate concentrations.

While beavers have their critics, beaver dams can expand backwater habitats in floodplains filled with sediment. Beaver dams on small tributaries can establish ponds large enough to support numerous off-channel fish populations (Figure 6). Ben Goldfarb's *Eager: The Surprising, Secret Life of Beavers and Why They Matter* (2018) offers an excellent discussion concerning the ecological value of the North American Beaver *Castor canadensis*.

In 2012 I had reported to WDNR that floodplain lakes appeared to be the most threatened class of lakes in the state. River floodplains require protection and restoration for the important ecological services and habitats they provide. If the late regional author August Derleth (1909–1971) was still around today, he would probably agree. In *Walden West* (1961) Derleth described his frequent visits to a Lower Wisconsin River slough:

> The Spring Slough was the magnet which drew me afternoons and evenings in the spring, and early in the morning hours of many summer days….The Spring Slough teemed with life….The water was never still. Muskrats and turtles broke it; now and then a brown water snake slithered by; flies danced over its surface; sunfish rose, and great northerns came to surface and swirled away…the nostalgic song of the whippoorwills, and, above all, the crying of the frogs—the peepers in a great choir out of the Upper Meadow, the cricket frogs from nearer the slough, the pond frogs conversing across the water, the woods frogs uttering their hoarse croaking out of the tree-grown bottomland to the west-all pulsing and throbbing as in the very rhythm of earth itself…

(Continued on page 19)

PRESETTLEMENT FISH COMMUNITIES OF IOWA'S NATURAL (GLACIAL) LAKES

John R. Olson

Ankeny, Iowa

INTRODUCTION

In 2019, I received a grant from the Iowa DNR's Wildlife Diversity Program to identify the presettlement fish communities of Iowa's natural lakes of glacial origin (glacial lakes).[1] The final report was submitted to Iowa DNR in April 2020. The purpose of the project was to provide information to allow the Iowa DNR Fisheries Bureau to create a more species-rich and ecologically stable fish community following lake restoration projects at Iowa's shallow glacial lakes. Iowa DNR's program for restoring shallow glacial lakes has historically used a low diversity stocking approach that was limited to popular game fish such as Northern Pike *Esox lucius* and Yellow Perch *Perca flavescens*. Iowa DNR biologists suspect that this approach has resulted in a low return in terms of angling success and has contributed to poor water quality conditions due to eventual and relatively rapid overabundance of non-desirable fish species such as Common Carp *Cyprinus carpio* and bullheads *Ameiurus* spp. With better knowledge of the species that comprised the presettlement fish communities of Iowa's glacial lakes, Iowa DNR could implement a high diversity stocking approach for restored natural lakes.

Despite the long history of fisheries work in the state, a summary of Iowa's presettlement lake fish species had not been attempted, possibly because truly pre-settlement fish data for Iowa lakes do not exist. The earliest systematic fish surveys on northern Iowa's glacial lakes were conducted in the early 1890s, about 40 years after European settlement of these areas (Schwieder 1990).[2] Thus, my attempt to describe the pre-settlement fish community of Iowa's glacial lakes defaulted to characterizing the historical fish community that existed in Iowa's glacial lakes while filtering-out species whose presence was likely due to intentional introductions.

My review of the literature revealed several studies that compared late 19th or early 20th century lake fish communities to later 20th century communities (e.g., Clady 1976; Lyons 1989; Pierce et al. 2001). In general, these studies used historical fish community data as a baseline to evaluate changes, for example, in lake littoral zone fish communities over time. My review of the literature, however, did not reveal an attempt to identify presettlement fish communities for a lake or group of lakes.

METHODS

My approach for determining which fish species occurred in Iowa's natural lakes prior to European settlement of the state was primarily historical. Fish survey data and reports from 1890 to 1947 for 32 lakes of glacial origin in northern Iowa and southwestern Minnesota were considered "historical." I used the following factors to determine which species were likely part of the presettlement fish communities of these lakes: (1) the frequency of occurrence of species in the 10 of the 32 lakes (four in southwest Minnesota and six in Iowa) that had pre-1900 fish survey data, (2) the likelihood that either 19th century Mississippi River fish rescue (transplanting) operations or early fish culture activities in the state of Iowa could explain the pre-1900 occurrence of a species in the lakes, and (3) whether the species is considered native or introduced to the portion of the state where Iowa's natural (glacial) lakes occur.

HISTORICAL FISH SURVEYS OF IOWA'S GLACIAL LAKES

The oldest fish data for Iowa's natural lakes comes from Seth Eugene Meek who, while a professor at Coe College in Cedar Rapids, Iowa, in the late 1880s and early 1890s, conducted extensive fish surveys in Iowa under the auspices of the US Fish Commission (USFC). Meek sampled a variety of fish habitats in Iowa, including streams, rivers, glacial lakes, and river bayous. His summaries of these surveys (Meek 1892, 1894) provide the historical baseline fish survey information for the state. A contemporary of Meek's, Ulysses Orange Cox, conducted a survey of lakes in southern Minnesota in the mid-1890s (Cox 1896). Similar to Meek's work in Iowa, Cox's work in Minnesota was directed by the USFC.

There was relatively little fish survey activity in Iowa in the approximately 30 years following the work of Meek in the early 1890s. The first 20th century fish survey of Iowa's natural lakes was conducted by Austin P. Larrabee of the University of Iowa. He surveyed the lakes of the Okoboji lakes region in Dickinson County in northwest Iowa during summers of 1921, 1922, 1924, and 1925 (Larrabee 1926). Next, as part of the development of Iowa's 25-year conservation plan (Crane and Olcott 1933), an exten-

[1] Iowa Department of Natural Resources Wildlife Diversity Program Small Project Grant #19CRDWBKKINK-0103.

[2] Although European settlement of Iowa was well underway in the 1830s, northwest Iowa, where many of Iowa's natural (glacial) lakes occur, was the last portion of the state to be settled (Schwieder 1990).

Photos by the author unless otherwise indicated.

John Olson retired from the Iowa DNR, where he worked for 30 years in the Water Quality Assessment Section, in 2017. He has been involved with stream fish survey work in Iowa since attending Iowa State University, where he participated in a statewide survey of Iowa fishes from 1981–84. He has a degree in Animal Ecology from Iowa State with an emphasis in fisheries biology. He assisted with fish surveys while at Iowa DNR, and he continues to pursue his interest in Iowa (and, occasionally, Minnesota) fishes in retirement.

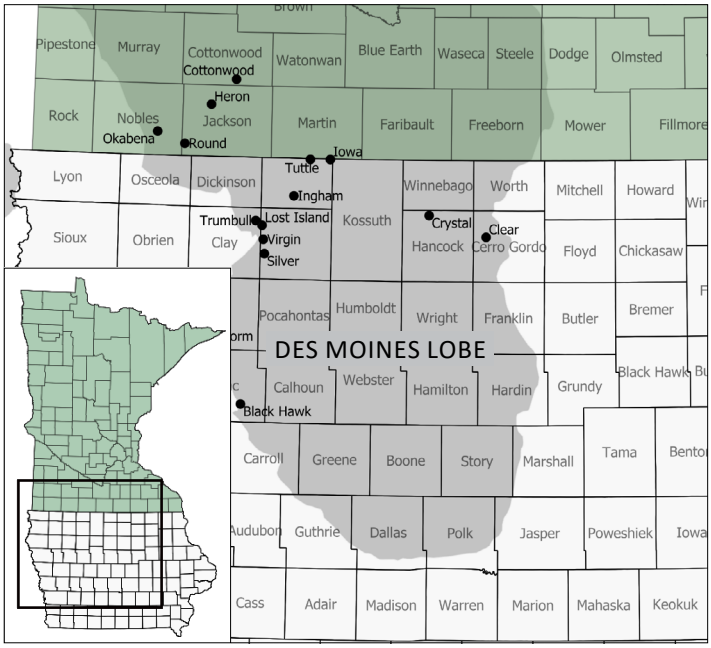


Figure 1. The portions of southern Minnesota and northern Iowa covered by the Des Moines Lobe of the Wisconsinan Glacier that was present in the area from approximately 12,000 to 30,000 year before present. The locations of the glacial lakes with historical data (1890–1947) for fish communities are indicated for all counties except Dickinson County, Iowa (see Figure 2).

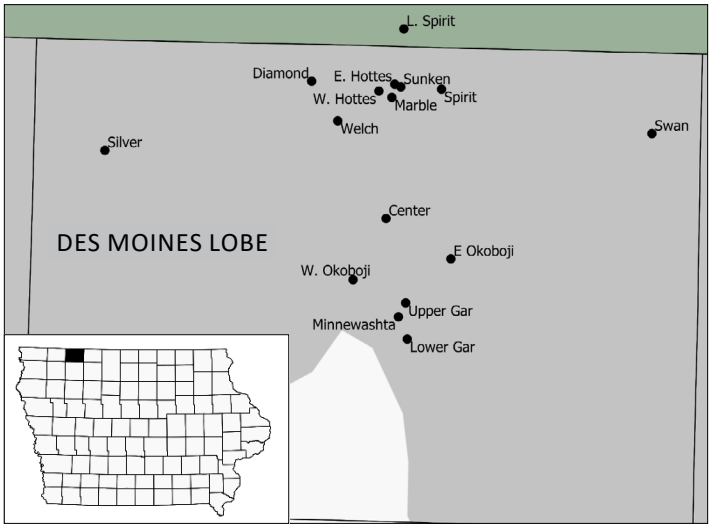


Figure 2. The portions of Dickinson County, Iowa, covered by the Des Moines Lobe of the Wisconsinan Glacier and locations of the glacial lakes with historical (1890–1950) data for fish communities. Spirit, East Okoboji, and West Okoboji lakes are the largest in what is known as the Iowa Great Lakes region.

sive fish survey of Iowa lakes and streams, mostly in the northern half of Iowa, was conducted in 1932 by renowned ichthyologist and then curator of fishes at the University of Michigan Museum of Zoology, Carl L. Hubbs, and his assistant, J. Clark Salyer. Although their work in Iowa remains unpublished, a set of typed field notes exists for the approximately 65 fish collections they made on Iowa streams and lakes in the summer of 1932, including at 19 of Iowa's natural lakes (Salyer 1932). About 10 years later in 1941, Raymond E. Johnson, then a student of Hubbs at Michigan, conducted a fish survey of the fish fauna in the lakes of the Okoboji Lakes region in Dickinson County. Similar to the work in Iowa in 1932 by Hubbs and Salyer, Johnson's work was never published, but a set of typed field notes survives (Johnson 1941). The catalog of Iowa State University's Collection of Fishes was reviewed for additional information on fishes of Iowa's glacial lakes.

For purposes of characterizing Iowa's presettlement fish communities, the historical fish data for Iowa's glacial lakes was divided into pre-1900 and post-1900 periods. The pre-1900 period includes fish survey data from ten glacial lakes: six lakes in northern Iowa that were surveyed by Meek (1892, 1894), and four lakes in southwestern Minnesota that were surveyed by Cox (1896) (Table 1). For several reasons, the sampling history, location, and physical setting of four lakes of glacial origin in southwest Minnesota made them appropriate for identifying native fish species of Iowa lakes: (1) their proximity to Iowa's glacial lakes (Figure 1); (2) they are in river basins that drain from Minnesota to Iowa (Little Sioux River and Des Moines River basins) and in the same river basins as the majority of the pre-1900 Iowa lakes; (3) they are in the same Level IV ecoregion (Des Moines Lobe-47b) as the Iowa lakes; and (4) their physical characteristics (e.g., surface areas and mean depths) are within the range of the Iowa glacial lakes (Table 1).

The post-1900 period includes fish data from the 28 glacial lakes in Iowa that were sampled, in part, by Larrabee (1926), Salyer (1932), Johnson (1941), and records for which preserved specimens exist up through 1947 in the fish collection of Iowa State University. The physical characteristics of all 32 glacial lakes with fish data for the years 1890 to 1947 are summarized in Figure 3. The year 1900 was chosen as a break point for the historical data due to (1) the increasing spread of Common Carp (introduced in the early 1880s) across the state after 1900 and (2) the acceleration of fish plantings that began in the mid-1870s as part of Iowa's Mississippi River fish rescue program (Carlander 1954). The upper boundary of the historical period was set just before 1950 (1947) in an attempt to avoid the post-1950 advent of boat electrofishing and to thus keep sample gear type similar (i.e., seines) over the entire 1890 to 1947 historical period.

Lacking any truly pre-settlement information, the pre-1900 lake dataset was the best available for identifying candidate species for the characterizing the presettlement fish community of Iowa's glacial lakes. The post-1900 lake dataset was used to determine the frequencies of occurrence of species found in the pre-1900 period in the post-1900 period. A comparison of the two datasets was used to identify fish species common in glacial lakes in the post-1900 period but that were not reported in the pre-1900 period. All candidate species for the presettlement fish communities of Iowa's glacial lakes come from the species found in the six lakes in northern Iowa sampled by Meek (1892, 1984) and the four lakes in southwestern Minnesota sampled by Cox (1896).

CONFOUNDING FACTORS

Even by 1890, human-caused impacts to Iowa's glacial lakes existed. Agricultural development of the landscape was well un-

Table 1. Physical characteristics of the 10 glacial lakes with pre-1900 data on fish communities from northern Iowa (Meek 1892, 1894) and southwestern Minnesota (Cox 1896).

Lake Name*	County	State	Major River Drainage	River Basin	Surface Area (acres)	Max. Depth (feet)	Mean Depth (feet)
Clear[C]	Cerro Gordo	Iowa	Upper Mississippi	Iowa-Cedar	3,664	18.1	10.1
Cottonwood[B]	Cottonwood	Minnesota	Upper Mississippi	Des Moines	155	10	8
East Okoboji[A]	Dickinson	Iowa	Missouri	Little Sioux	1,835	22	10
Heron[B]	Jackson	Minnesota	Upper Mississippi	Des Moines	2,641	5	3
Okabena[B]	Nobles	Minnesota	Missouri	Little Sioux	776	16	8
Round[B]	Jackson	Minnesota	Missouri	Little Sioux	930	9	8
Silver[C]	Dickinson	Iowa	Missouri	Little Sioux	1,066	9.8	6.5
Spirit[C]	Dickinson	Iowa	Missouri	Little Sioux	5,366	22.5	15.9
Storm[A]	Buena Vista	Iowa	Upper Mississippi	Des Moines	3,097	13	8
West Okoboji[C]	Dickinson	Iowa	Missouri	Little Sioux	3,900	138.9	36.6

*Sources/references for measurements of surface area, maximum depth, and mean depth:
[A]Bachmann et al. 1980
[B]Minnesota DNR, Lake Finder (https://www.dnr.state.mn.us/lakefind/index.html)
[C]Iowa DNR lake mapping: 2008, 2009, 2015, 2019; available online at "Iowa DNR, Where to Fish"

Table 2. Depth categories used to summarize percent occurrences of fish species from the 32 glacial lakes in northern Iowa and southwestern Minnesota with historical (1890–1947) fish data.

Depth Category	Mean Depth	No. of Lakes
Shallow	< 5 feet	13
Mid-depth	5 to 10 feet	12
Deep	> 10 feet	7

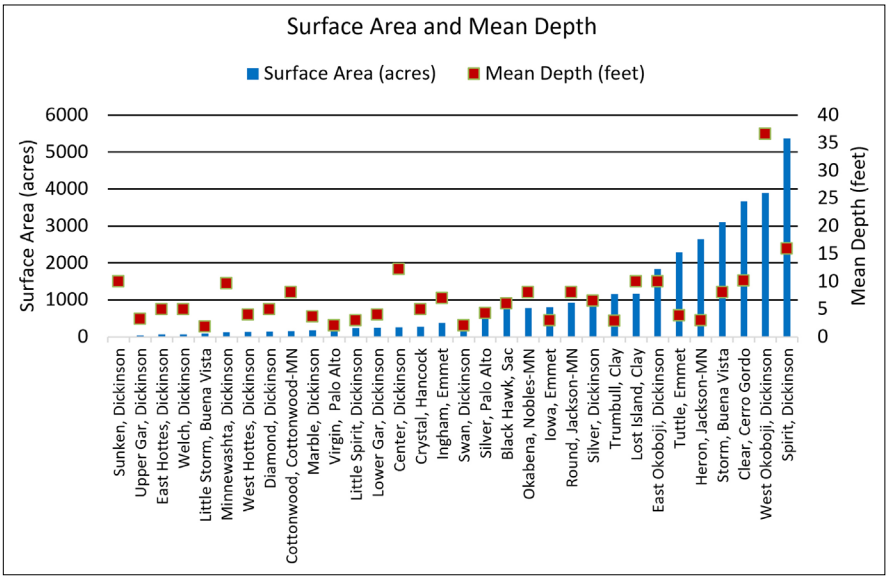


Figure 3. Surface areas and mean depths of the 32 glacial lakes in northern Iowa and southwestern Minnesota with historical data from 1890–1947 for fish communities. X-axis labels: lake name, Iowa county name, and (for Minnesota lakes) state abbreviation.

derway, and the Common Carp, which had been intentionally introduced into state waters in the early 1880s (Bernstein and Olson 2001), was spreading rapidly and was beginning to be perceived as the invasive species that it turned out to be (Lincoln 1902). Fortunately, the arrival of Common Carp in Iowa's glacial lakes seems to have been delayed somewhat, possibly until after 1900 (based on information in Larrabee 1926), thus possibly delaying significant carp-related alterations to Iowa's pre-settlement fish communities. Once established, however, the ability of this prolific, fast growing, and large species to directly (through feeding) or indirectly (through increased turbidity) suppress growth of aquatic macrophytes profoundly altered and degraded the aquatic habitats of Iowa's shallow glacial lakes.

The 32 lakes in this dataset (28 in Iowa and 4 in Minnesota) have a wide range of physical characteristics. Surface areas range from 15 to over 5,300 acres, and mean depths range from 1.8 feet to over 36 feet (Figure 3). Physical characteristics, especially mean depth, influence lake water quality, aquatic habitat, and overall ecological stability and, through these factors, influence the composition of the fish community. Due to the importance of mean depth, presettlement lake fish communities were approximated for three mean depth categories in the 32 lakes: shallow (mean depths less than 5 feet), middle depth (mean depths from 5 to 10 feet), and deep (mean depths greater than 10 feet) (Table 2). In the context of Iowa and Minnesota lakes with fish data over the 1890–1947 period, these groupings provide at least an approximation of whether the fish species were typical of Iowa's shallow, middle-depth, and/or deep glacial lakes. Choosing a mean depth to separate the shallow,

Table 3. Fish species collected by Meek (1892, 1894) and Cox (1896) from the 10 glacial lakes in northern Iowa and southwestern Minnesota sampled prior to 1900.

Rank	Common Name	Family	Scientific Name	No. of the 10 lakes found:
1	Yellow Perch	Percidae	*Perca flavescens*	10
2	Northern Pike	Esocidae	*Esox lucius*	8
3	Golden Shiner	Leuciscidae	*Notemigonus crysoleucas*	7
4	Banded Killifish	Fundulidae	*Fundulus diaphanus*	7
5	Black Bullhead	Ictaluridae	*Ameiurus melas*	7
6	Walleye	Percidae	*Sander vitreus*	5
7	Spottail Shiner	Leuciscidae	*Notropis hudsonius*	5
8	Fathead Minnow	Leuciscidae	*Pimephales promelas*	5
9	Iowa Darter	Percidae	*Etheostoma exile*	4
10	Johnny Darter	Percidae	*Etheostoma nigrum*	4
11	Blacknose Shiner	Leuciscidae	*Notropis heterolepis*	4
12	Bluegill	Centrarchidae	*Lepomis macrochirus*	3
13	Black Crappie	Centrarchidae	*Pomoxis nigromaculatus*	3
14	Largemouth Bass	Centrarchidae	*Micropterus nigricans*	3
15	Smallmouth Bass	Centrarchidae	*Micropterus dolomieu*	3
16	Bigmouth Buffalo	Catostomidae	*Ictiobus cyprinellus*	2
17	Bluntnose Minnow	Lecuciscidae	*Pimephales notatus*	2
18	Pumpkinseed	Centrarchidae	*Lepomis gibbosus*	2
19	White Bass	Moronidae	*Morone chrysops*	2
20	Longnose Gar	Lepisosteidae	*Lepisosteus osseus*	2
21	Green Sunfish	Centrarchidae	*Lepomis cyanellus*	1
22	Orangespotted Sunfish	Centrarchidae	*Lepomis humilis*	1
23	White Sucker	Catostomidae	*Catostomus commersonii*	1
24	Spotfin Shiner	Leuciscidae	*Cyprinella spiloptera*	1
25	Northern Rock Bass	Centrarchidae	*Ambloplites rupestris*	1
26	Common Shiner	Leuciscidae	*Luxilus cornutus*	1
27	Tadpole Madtom	Ictaluridae	*Noturus gyrinus*	1
28	Smallmouth Buffalo	Catostomidae	*Ictiobus bubalus*	1
29	Trout-Perch	Percopsidae	*Percopsis omiscomaycus*	1
30	Northern Sunfish	Centrarchidae	*Lepomis peltastes*	1
31	Blackchin Shiner	Leuciscidae	*Notropis heterodon*	1
31	Brook Silverside	Atherinopsidae	*Labidesthes sicculus*	1
33	Fantail Darter	Percidae	*Etheostoma flabellare*	1
34	Rainbow Darter	Percidae	*Etheostoma caeruleum*	1
35	Sauger	Percidae	*Sander canadensis*	1

Table 4. Occurrence in 28 Iowa glacial lakes of 14 fish species not reported in the 10 lakes in northern Iowa and southwestern Minnesota lakes in the pre-1900 period (1890–1894) but reported in three or more lakes during the post-1900 period (1926–1947).

	Common Name	Scientific Name	No. of the 28 lakes reported, post-1900
1.	White Crappie	*Pomoxis annularis*	19
2.	Common Carp [I]	*Cyprinus carpio*	13
3.	Brassy Minnow	*Hybognathus hankinsoni*	8
4.	Freshwater Drum	*Aplodinotus grunniens*	8
5.	Sand Shiner	*Notropis stramineus*	7
6.	Red Shiner	*Cyprinella lutrensis*	6
7.	Shorthead Redhorse	*Moxostoma macrolepidotum*	6
8.	Brown Bullhead	*Ameiurus nebulosus*	5
9.	Bigmouth Shiner	*Notropis dorsalis*	4
10.	Bullhead Minnow	*Pimephales vigilax*	4
11.	Channel Catfish	*Ictalurus punctatus*	4
12.	Yellow Bullhead	*Ameiurus natalis*	4
13.	Logperch	*Percina caprodes*	3
14.	Shortnose Gar	*Lepisosteus platostomus*	3

Table 5. Fish species reported in pre-1900 surveys at 10 lakes in northern Iowa and southwestern Minnesota by Meek (1892, 1894) and Cox (1896) that were likely part of the presettlement fish communities of Iowa's glacial lakes. Species are listed by the number of lakes they occurred in of the 10 lakes sampled during the pre-1900 period.

Rank	Common Name	Scientific Name	Nomenclature of Meek (1982, 1894)	No. of lakes:
1.	Yellow Perch	*Perca flavescens*	[same]	10
2.	Northern Pike	*Esox lucius*	*Lucius lucius*	8
3.	Golden Shiner	*Notemigonus crysoleucas*	[same]	7
4.	Banded Killifish	*Fundulus diaphanus*	*F. zebrinus*	6
5.	Black Bullhead	*Ameiurus melas*	[same]	6
6.	Walleye	*Sander vitreus*	*Stizostedion vitreum*	5
7.	Spottail Shiner	*Notropis hudsonius*	[same]	5
8.	Fathead Minnow	*Pimephales promelas*	[same]	5
9.	Iowa Darter	*Etheostoma exile*	*E. iowae*	4
10.	Johnny Darter	*Etheostoma nigrum**	[same]	4
11.	Blacknose Shiner	*Notropis heterolepis*	*N. cayuga*	4
12.	Bluegill	*Lepomis macrochirus*	*L. pallidus*	3
13.	Blackchin Shiner	*Notropis heterodon*	*[same]*	1

*As Scaly Johnny Darter, *E. n. eulepis*. Despite Underhill's (1963) dismissal of the scaly subspecies of Johnny Darter, the scaly form is, and historically has been, limited to the larger glacial lakes in Iowa.

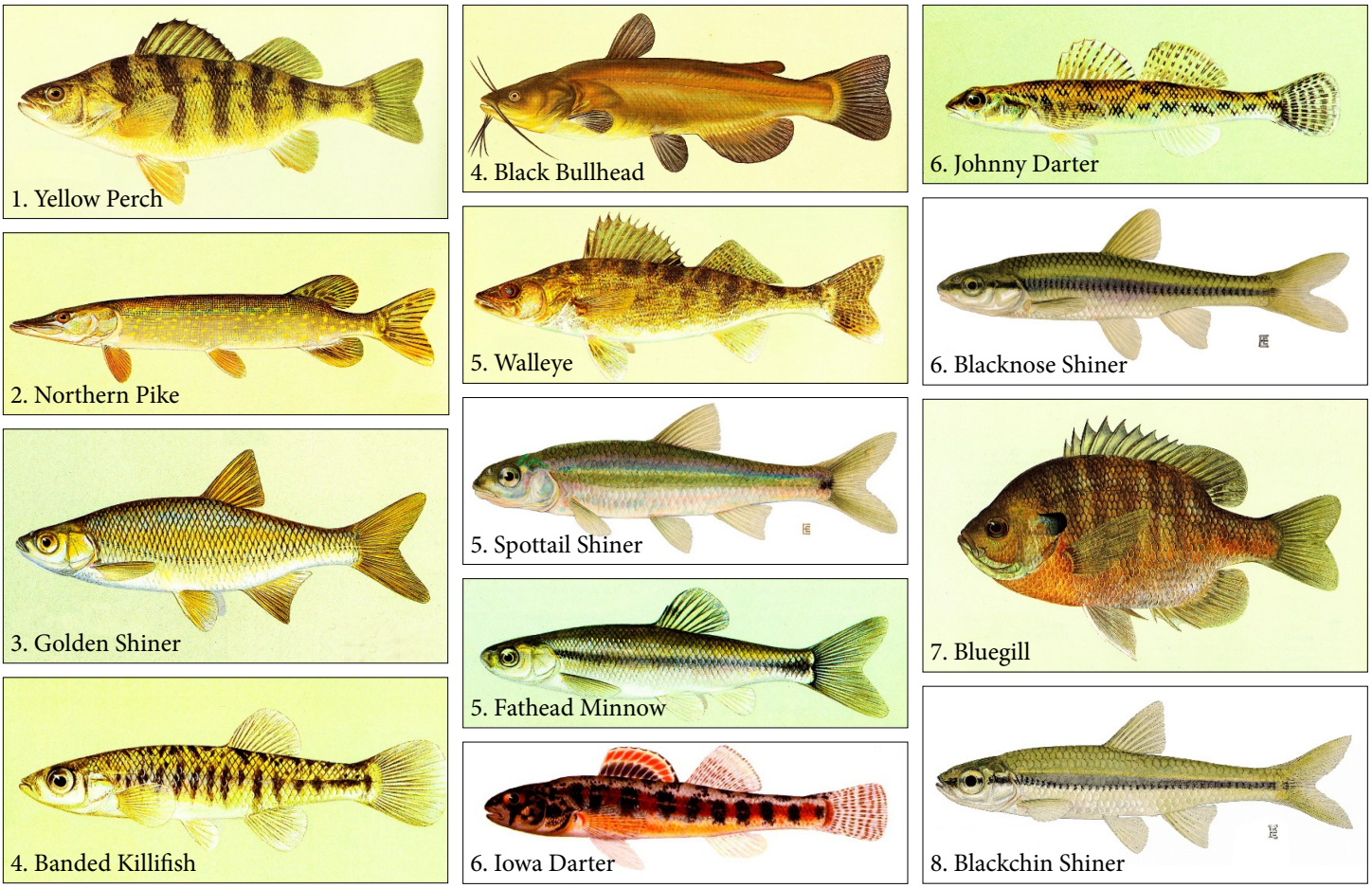


Figure 4. The thirteen fish species believed to have been part of the presettlement fish community of Iowa's natural (glacial) lakes. Species are ranked by frequency of occurrence. Illustrations by Maynard Reece (in Harlan et al. 1987; used with permission), except Spottail, Blacknose, and Blackchin shiners, by Ellen Edmondson (in Edmondson and Crisp 1926-39; used with permission).

middle-depth, and deep lake categories was challenging and was ultimately arbitrary, but an attempt was made choose mean depth breakpoints that had at least some limnological basis (i.e., thermal stratification of deep lakes) and that resulted in a roughly similar number of lakes in each category.

These 32 lakes occur in two major North American river drainages: 20 lakes are in the Missouri River drainage, and 12 are in the Upper Mississippi River drainage. Overall, the fish faunas of the Missouri and Mississippi drainages vary considerably. Most of Iowa's approximately 140 native fish species are believed to have reached post-glacial Iowa via the Mississippi River valley from southern or other glacial refugia, while fewer species are believed to have used the Missouri river route (Menzel 1987). Considerable mixing of the Upper Mississippi and Missouri drainage fish faunas seems evident and is believed due, in part, to flood-related inter-drainage connections in the headwaters of the upper Little Sioux (Missouri drainage) and upper Des Moines (Mississippi River drainage) river basins in southwestern Minnesota (Bailey and Allum 1962). These inter-drainage connections appear to have allowed fish to move from one major basin to the other. This movement has resulted in a mixing of the fish faunas of the Missouri and Upper Mississippi drainages in northwest Iowa and southwest Minnesota. Thus, when attempting to identify presettlement fish communities of Iowa's glacial lakes, the differences in the composition of the fish faunas of the Missouri and Upper Mississippi drainages do not appear to be a significant factor.

RESULTS

Species reported in the historical period (1890–1947): A total of 71 fish species were reported from the 32 glacial lakes in northern Iowa and southwestern Minnesota from 1890–1947. A total of 35 species were reported by Meek (1892, 1894) and Cox (1896) from 10 glacial lakes in northern Iowa and southern Minnesota in the pre-1900 period (Table 3). Due to the increasing impact on lake populations related to fish stockings from Iowa's Mississippi River fish rescue program and from state hatchery introductions after 1900, results of the pre-1900 surveys of Meek and Cox provide the best available picture of the presettlement fish community of Iowa's glacial lakes.

A total of 36 species was reported from 28 of Iowa's glacial lakes in the post-1900 period (1926–1947) that were not reported by Meek (1892, 1894) or Cox (1896) from the 10 pre-1900 lakes. Fish species reported only in the post-1900 period at three or more of the 28 lakes during the post-1900 period are summarized in Table 4. At least in part, Iowa's fish rescue program and/or its early fish culture program are likely responsible for the post-1900 appearance of these species in Iowa's glacial lakes and for the relatively high reporting frequencies of some of these species in the post-1900 period, e.g.,

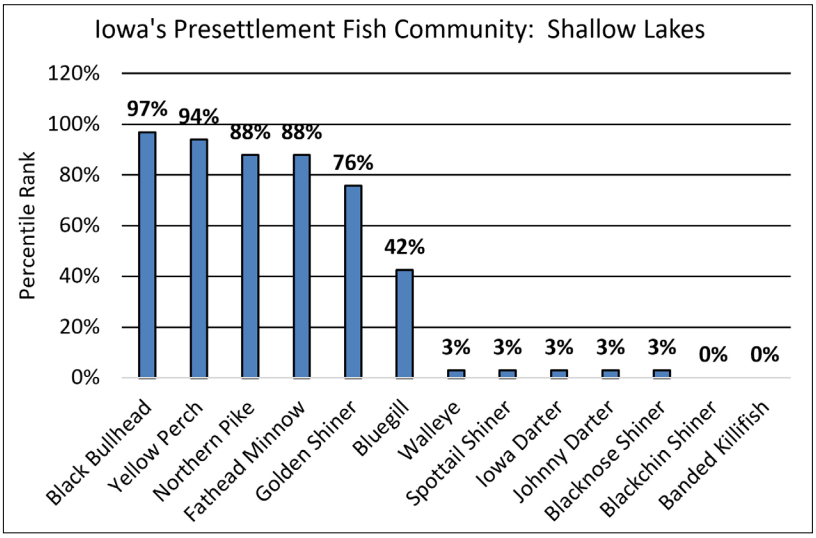


Figure 5. Percentile rankings of the 13 presettlement fishes of Iowa glacial lakes based on reported occurrence in 13 shallow glacial lakes (mean depth < 5 feet) in northern Iowa and southwestern Minnesota from 1890–1947.

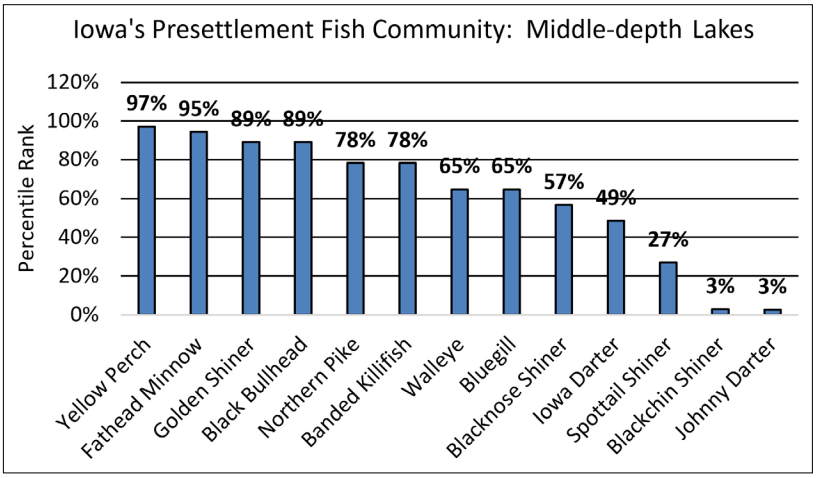


Figure 6. Percentile rankings of the 13 presettlement fishes of Iowa glacial lakes based on reported occurrence in 12 middle-depth glacial lakes (mean depth from 5 to < 10 feet) in northern Iowa and southwestern Minnesota from 1890–1947.

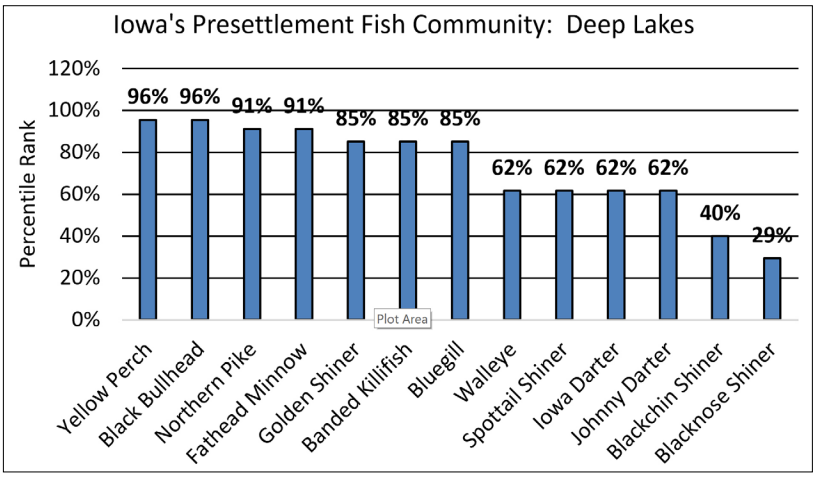


Figure 7. Percentile rankings of the 13 presettlement fishes of Iowa glacial lakes based on reported occurrence in seven deep glacial lakes (mean depth > 10 feet) in northern Iowa from 1890–1947.

White Crappie *Pomoxis annularis:* 68%, Common Carp *Cyprinus carpio:* 46%, and Freshwater Drum *Aplodinotus grunniens:* 29%.

The post-1900 appearance of several species in Iowa's glacial lakes is not surprising (e.g., the introduced Common Carp and common species in the Mississippi River such as Freshwater Drum and Shorthead Redhorse *Moxostoma macrolepidotum*). The lack of several ictalurid species in Iowa's glacial lakes during the pre-1900 period—especially catfish species (Brown *Ameiurus nebulosus* and Yellow *A. natalis* bullheads and Channel Catfish *Ictalurus punctatus*)—is surprising. Most, if not all, of the species in Table 4 were likely introduced into Iowa's glacial lakes as part of the Mississippi River fish rescue plantings. For example, both Johnson (1941) and Bailey (1953) stated that populations of Brown Bullhead in Iowa lakes were probably introduced from such plantings.

THE PRESUMPTIVE PRESETTLEMENT FISH COMMUNITY OF IOWA'S GLACIAL LAKES

I identified 13 fish species that likely occurred in Iowa's presettlement glacial lakes (Table 5, Figure 4). The available distributional and historical information for these 13 species suggest that they were not planted or stocked as part of either fish rescue, fish culture, or other human-related fish management activities into the 10 pre-1900 lakes surveyed by Meek (1982, 1894) or Cox (1896). Frequency of occurrence in the pre-1900 lakes was a primary factor in selecting the presettlement species.

Figures 5, 6, and 7 present the occurrence rankings of these 13 fish species in 13 shallow, 12 middle-depth, and seven deep natural (glacial) lakes, respectively, in northern Iowa and southwestern Minnesota.

SOURCES OF UNCERTAINTY

Several sources of uncertainty exist regarding selecting species that likely were members of the presettlement fish community of Iowa's glacial lakes. The late 19th and early 20th century plantings of fishes via Iowa's fish rescue operations and early fish culture activities were done with good intentions, i.e., to increase the supply of food fish. These programs, however, altered the presettlement distribution of Iowa's fish species before Iowa's earliest fish surveys were conducted in the late 1800s. Thus, determining which species were naturally occurring in an Iowa lake (or stream or river) is difficult. Sampling bias also introduces uncertainty. All sampling includes error, and the sampling of lake fishes with common sense minnow seines in the late 19th century no doubt resulted in underreporting of the number of species present. An additional source of uncertainty is misidentification of rare species and attempts of subsequent authors to resolve these misidentifications.

Figure 8. An early 1900s Iowa fish rescue crew seining a backwater of the Mississippi River. Photo from Hinshaw (1915).

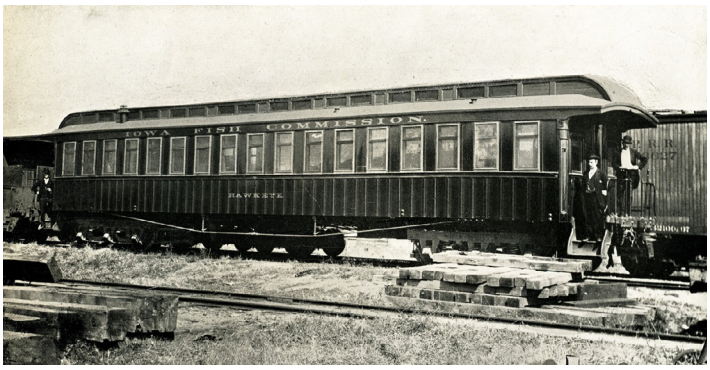


Figure 9. Iowa's first state-owned fish car, the "Hawkeye," purchased by the state of Iowa in the late 1890s (Delavan 1897). Prior to purchasing this car, the state relied on the generosity of the railroad companies for use of one of their cars for transporting rescued fishes. Photo from Lincoln (1902).

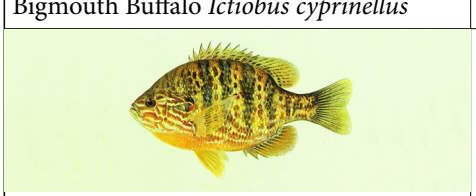
1. **Fish Rescue:** Iowa conducted state-sponsored "fish rescue" operations that began in the mid-1870s and continued into the mid-20th century (Carlander 1954). The establishment of railroad lines across Iowa in the 1870s made this program possible. As a result, Iowa's presettlement fish communities were forever altered, and the presettlement distributions of Iowa's native species were forever obscured. Originated and promoted as the best use of the resource by a member of Iowa's first fish commission, B.F. Shaw (Shaw 1878), "fish rescue" involved spring and summer removal (seining) of fishes from bayous and overflow pools of large rivers (primarily the northern Iowa portion of the Upper Mississippi River) and transportation via rail of the fishes captured to Iowa's inland waters, including the glacial lakes of north-central and northwest Iowa (Figures 8 and 9).

   As part of his fisheries work in Iowa in 1932 for Iowa's 25-year Conservation Plan (Crane and Olcott 1933), University of Michigan ichthyologist Carl Hubbs, along with his assistant, J. Clark Salyer, conducted an evaluation of Iowa's fish rescue program (Hubbs 1932). Although Hubbs approved of the program overall, many of his comments were negative. He found "a considerable ignorance" of species identification, and he used the Orangespotted Sunfish *Lepomis humilis* to demonstrate that ignorance. He reported that he could not find anyone where rescued fishes were being sorted that realized that they were sending a species of sunfish (Orangespotted Sunfish) to be stocked in inland waters "that never reaches a legal or catchable size" (Hubbs 1932). Regarding the movement of Orangespotted Sunfish to inland waters, Hubbs stated that "we believe that the wholesale spread of this runt fish into interior waters has been a very serious mistake." Hubbs made recommendations regarding which species should be returned to the Mississippi River and which species should be stocked inland in Iowa, including Channel Catfish, Northern Pike, Walleye, White Bass *Morone chrysops*, Largemouth Bass *Micropterus salmoides*, and Bluegill, which he called the "most desirable fish for inland distribution." He felt that Pumpkinseed, Green Sunfish, and Warmouth *Lepomis gulosus* also "seemed worth planting." He agreed with those in charge of fish rescue operations that "predator fish" such as gar and Bowfin *Amia ocellicauda* (formerly *A. calva*) should be thrown on the bank.

   Evidence suggests that the four glacial lakes in southwest Minnesota that were sampled in 1894 by Cox (1896) were less—or possibly not—affected by early fish rescue activities. Although Iowa Fish Commissioner B.F. Shaw (1884) mentioned that fish rescue programs were being adopted by other states along the Mississippi River, he did not identify specific states. Anfinson (2003), however, notes that Missouri and Illinois began rescuing Mississippi River fishes in the 1880s and that Wisconsin began its program in 1895, but he does not mention a pre-1900 fish rescue program in Minnesota. Anfinson continues that the USFC (aka US Bureau of Fisheries) began Mississippi River fish rescue operations in 1899 and that it would come to dominate fish rescue operations on the river. Carlander (1954) summarized Mississippi River fish rescue stations established by the USFC for all upper river states (Iowa, Illinois, Minnesota, Missouri and Wisconsin). Her summary suggests that the earliest of Minnesota's 11 fish rescue stations was established at Homer [near Winona] in 1911.

2. **Early fish culture:** As described in the Fourth Biennial Report of the State Fish Commission of Iowa (Shaw 1882), a new fish hatching-house was established by the Iowa Legislature in 1880—about 10 years before Meek's initial lakes surveys in Iowa—between Spirit and East Okoboji lakes in Dickinson County in northwest Iowa. In early 1881, Shaw and his assistant fish commissioner experimented with propagating native fishes. They concluded that "the result of our operations satisfied us that we can hatch pike, bass, buffalo, and perch and the like with very little trouble." Also, "most of our native fish can be artificially propagated under favorable circumstances to any extent desired, and that depleted waters can be restocked" (Shaw 1882). In the next (fifth) biennial report of the state fish commission, Shaw (1884), again mentions that he and his assistant conducted some "experimental" work with artificial propagation of native species in spring 1882, including "wall-eyed pike, bass, perch, pickerel, and buffalo." These statements introduce the possibility that at least some of the species of game fishes and food fishes reported for Spirit Lake by Meek (1894) (e.g., Largemouth Bass) were introduced via the new Spirit Lake hatchery.

Table 6. Species reported from the 10 pre-1900 lakes that were not considered part of the presettlement fish community of Iowa's glacial lakes but that have at least some evidence of a presettlement presence. Illustrations by Maynard Reece (in Harlan et al. 1987; used with permission).

Species and Illustration	No. of pre-1900 records	Lakes	Rationale for possibly considering species as presettlement
 Longnose Gar *Lepisosteus osseus*	2	Spirit Okabena-MN	No known pre-1900 fish rescue in MN; only select species were part of early fish culture at Lake Okoboji region lakes.
 Bluntnose Minnow *Pimephales notatus*	2	Clear Silver (Dickinson Co., IA)	Not usually considered a lakes species (Page and Burr 2011). Occurrence possibly due to stream connections.
 White Sucker *Catostomus commersonii*	1	Okabena-MN	Presence in Okabena suggests presettlement occurrence; otherwise, lack of presettlement reports.
 Bigmouth Buffalo *Ictiobus cyprinellus*	2	Okabena-MN Round-MN	Gathering information on spring runs of buffalo (*Ictiobus* spp.) was reason for Cox's (1896) survey.
 Pumpkinseed *Lepomis gibbosus*	2	Spirit Okabena-MN	Possibly pre-settlement but just as likely a rare species prior to 1900 in NW Iowa and SW Minnesota.
 Smallmouth Bass *Micropterus dolomieu*	3	Clear Spirit West Okoboji	Native occurrence in the Missouri River basin of northwest IA and southwest MN is uncertain(Cross et al. 1986); possibly introduced to Lake Okoboji region via early fish culture.

3. **Sampling lake fish assemblages:** The fish communities reported in the historical surveys of Meek (1892, 1894), Cox (1896), Salyer (1932), and Johnson (1941) should be viewed as rough approximations of the communities that actually existed in the glacial lakes they sampled. Characterizing fish assemblages of lake systems is inherently difficult due to habitat heterogeneity and especially water depth. The thoroughness of inventories of lake fishes depends on many factors such as season, growth of aquatic vegetation, time of day sampling was conducted, and the selectivity of the sampling gear(s).

Because all these studies were conducted before the advent of electrofishing and use of other collection methods in Iowa waters,[3] the primary sampling gear used in the lake studies during the period 1890–1947 was the seine. Meek, Cox, and Larrabee all mention seining as their collection method. They all, however, would occasionally include anecdotal mentions of rare species or common sport fish species associated with the lakes they sampled. In his survey of the fishes of the Lake Okoboji region, Larrabee (1926) mentioned that seines were commonly used but that hook-and-line sampling was also used. He also examined fishes in live bait boxes and catches of local fishers, and he incorporated local information on fishes. Regarding the abundance of larger fishes, Meek (1892) commented that "it was often difficult to reach satisfactory conclusions by the use of ordinary collecting seines." Not surprisingly, the use of a seine to sample a well-vegetated lake of several hundred acres or more, with water depths often much deeper than seines can effectively sample, will not provide a complete list of the species present. Regardless of this significant short-

[3] Based on information in Harrison (1955), boat-mounted electrofishing was first evaluated on Iowa waters in the early to mid-1950s.

coming, the largely seining-based information provided on fish communities in Iowa's glacial lakes prior to 1950 is the best and only information available.

OTHER POSSIBILITIES FOR PRESETTLEMENT FISH SPECIES

Just under half (17) of the 35 fish species reported from the 10 pre-1900 lakes in northern Iowa and southwestern Minnesota (Table 2) lacked evidence of a presettlement presence in the glacial lakes and were rejected for inclusion to the potential presettlement fish community of Iowa's glacial lakes. Most of these species had only one pre-1900 report from the 10 lakes, and those single reports were often from Iowa lakes and were attributable to human activity (e.g., early fish rescue activities or early fish culture activities). Several species that occurred at low frequencies in the pre-1900 lakes, however, could not be eliminated from pre-settlement consideration due to a fish rescue or fish culture-related explanation (Table 6). Several, if not all, of these species may have been part of the presettlement fish communities of Iowa's glacial lakes.

CONCLUSIONS

Although the process involved several types of uncertainty, the identification of a presumptive presettlement fish community for Iowa's glacial lakes (Table 5) provides guidance for implementing a high diversity fish stocking program for lake restoration projects in Iowa. The influence of mean depth on the historical occurrence frequency of presettlement species suggests that stocking at restored glacial lakes should be focused on species that tend to occur at relatively high frequencies in the depth category of the restored lake (see Figures 5, 6, and 7).

The group of 13 species that I identified as the presettlement fish community of Iowa's natural lakes is not what I expected when I began this project. I had presumed that the presettlement community would be dominated by environmentally sensitive species. I did not anticipate that the environmentally tolerant Black Bullhead and Fathead Minnow would be two of the most frequently found species in the 10 lakes sampled before 1900, yet that is exactly what the pre-1900 sampling results suggest. That either the Black Bullhead or Fathead Minnow would be stocked into a post-restoration shallow lake as part of a high-diversity stocking approach seems unlikely. The presence of only one centrarchid species (Bluegill) in the presettlement community of Iowa's glacial lakes also seems unlikely. My expectations included the presence of a centrarchid top predator such as Largemouth Bass or Smallmouth Bass and an additional littoral zone *Lepomis* such as Pumpkinseed. The low frequency of pre-1900 occurrence for Smallmouth Bass and Pumpkinseed may simply reflect the presettlement absence or rarity of these species in the Missouri River drainage where six of the 10 pre-1900 lakes occur.

In terms of the literature on Iowa fishes, relatively little attention has been given to the influence of either Iowa's approximately 75-year (1875–1950) Mississippi River fish rescue program or its early fish culture activities on the distribution of Iowa fish species. Other than brief specific mentions (e.g., Bailey and Harrison (1945) attributing Yellow Bass *Morone mississippiensis* in Iowa's Clear Lake to Mississippi River fish rescue operations), these subjects have largely been ignored. Although the history of Iowa's fish rescue programs, both on the Mississippi River and on inland rivers, is described in detail by several authors (e.g., Aitken 1938 and Carlander 1954), these topics are not addressed in two reports on the distribution of Iowa fishes: Cleary (1956) and Menzel (1987). As demonstrated by this report, both fish rescue and early fish culture influenced the presettlement distribution of fish species in Iowa's glacial lakes. This topic, especially as related to fish distribution in Iowa's streams and rivers, would appear to deserve further attention.

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(Oxbow Lakes, continued from page 9)

ACKNOWLEDGEMENTS

I wish to thank the WDNR Bureau of Endangered Resources and Surface Waters Grants Program for funding. Invaluable assistance was provided by John Lyons, Jean Unmuth, Jerrod Parker and the many other volunteer "slough pirates," a name honoring the mighty Pirate Perch.

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A RECAP OF THE 2022 NANFA CONVENTION

The 2022 NANFA Convention in Minnesota was a rousing success and was ably hosted by Ray Katula, Jenny Kruckenberg, and Konrad Schmidt. The editors asked Jenny to provide a summary of the talks, as she has so often done for past conventions, and have tried to capture the essence of her extensive work. The summaries are followed by a reflection by one of several young native fish enthusiasts for whom this was the first NANFA convention. We know it will not be their last, and believe that if they are the future leaders of this organization, it will be in good hands.

JOHN BONDHUS, FOUNDER OF NANFA: 50 YEARS OF MEMORIES
Ray Katula

John was the CEO of the Bondhus Company (Monticello, MN), which made hand tools sold around the world. He was a close friend to Ray since Ray was twelve years old. As a boy, Ray wrote to Herbert Axelrod, owner/editor of *Tropical Fish Hobbyist* magazine (*TFH*), wondering why there was no publication devoted to colorful native fishes. To his surprise, Axelrod wrote back and suggested there should be a study group founded to meet that need, and in the August 1972 issue, John took out an ad supporting this. Ray quickly wrote to John, John responded, they went on several collecting trips, and a strong friendship ensued.

One of the first times they met, John gave Ray *How to Know the Freshwater Fishes* by Samuel Eddy. In 1973, John asked Ray to fly with him in his Piper Cherokee to attend the first NANFA gathering in Maryland. There, Ray got to meet some of the early pioneers of NANFA, like Bruce Gebhardt, Robert Rosen, and others. During the meeting, John commented that someday he wanted to have his own fish hatchery and raise his own fish, including rare and endangered species. Thirty years later, he would act upon this.

John was President of NANFA and later Treasurer. The first "national" convention Ray attended was in Champaign, IL, with Phil Nixon, Casper Cox, Mark Otnes (who were all at the 2022 convention), James Sternberg (deceased), and Larry Page (known for the *Peterson Field Guide to Freshwater Fishes*). [Editors' Note: Another of the attendees was Tom Near, now an ichthyologist from Yale University.] I (Jenny) was at the 1993 convention in St. Paul and John showed up with his family and expressed to Ray and others how he wished that *American Currents,* which was running two years behind, was back on schedule; he also wanted it to become a full color publication. In the late 1990s, John became President a second time to get things running smoothly again. Once things were back on track, he left again. Eventually NANFA did get a full color publication, but that came in 2014, after John had passed away.

Anyone who met John knew him as a humble man who drove a modest car. One day, as he was giving Ray and Konrad a tour of his tool company, he couldn't find a parking spot. Kon asked, "John, don't you have a special spot?" and John replied he did not believe in that sort of thing.

In 2002, John began his dream of revitalizing Spring Valley Ponds. Ray was hired as the fish hatchery manager to help oversee the project. In his premier pond, John had plans to view fish in their underwater environment. His plan was to have not only an area for catch-and-release game fish but also a stream for non-game fish such as darters as well as a research center. In 2005, regulations were crippling his efforts to build the hatchery and he was ill. He passed away on August 20, 2006, before the Spring Valley Ponds project reached fruition.

RESTORING CONNECTIVITY AND FISH COMMUNITIES IN MINNESOTA STREAMS
Dr. Luther Aadland, Minnesota Department of Natural Resources (retired)

Luther grew up in the southwest part of Minnesota on Charlie Creek near the headwaters of the Cottonwood River. One of the things he realized—and that bugged him—while he was talking to the old-timers was that a number of fishes that had occurred there in the late-1800s were not there anymore. One of the problems was a dam about 100 miles downstream.

Streams are complicated. Luther started out in Ecology and Fisheries, but as his career progressed, he realized that in order to understand streams, he needed to understand water quality, geomorphology, connectivity, hydrology, and connections to the floodplain. Over time, we have altered these dramatically and we cannot expect them to support the same fish communities they once did. He pointed out that many river-related problems were more than dam construction, e.g., channel instability, changes in climate and land use, degraded water quality, increased nitrate, phosphorus, and sediment loads, and straightening the creeks.

Why is fish migration important? Answers include not only fish reproduction/spawning runs but re-colonization after extreme droughts and seasonal movements. Native mussels rely on their fish hosts and, since mussels are keystone species, they're important for stabilizing the stream bed and removing harmful bacteria like *E. coli* and cyanobacteria from the water.

Luther examined 32 barrier dams around the state. Dams have been responsible for a decline in biodiversity of perhaps half the species, not just here but around the world. However, the impact on species isn't consistent. Rare, imperiled, large-bodied, and pollution-sensitive species are the ones most likely lost. Many shiners, like the Carmine Shiner, are sensitive to low dissolved oxygen and are absent upstream of dams. However, pollution tolerant species, such as Black Bullhead, Fathead Minnow, Common Carp, White Sucker, and Creek Chub, thrive upstream of dams.

As the dams have aged, dam failures have become more common. Where they have failed and have been removed, such as on High Island Creek (tributary to the Minnesota River), many species have returned fairly quickly.

One of the first things Luther did when he went to work for the MN DNR was to quantify micro-suitability habitats for fishes. Even for the life cycle of an individual species, a diverse variety of habitats is critical. The goal is to set up and re-establish meandering patterns in streams so natural riffles, pools, and glides form again. Restoring rapids and establishing meanders connecting rivers back to their floodplains are essential to recovery.

Dam removal is always the preferred option, but where we can't do that, other methods such as bypass channels are used to get


LUCKY FISHING SHIRT
DO NOT WASH
NANFA
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fishes around dams. The first dam on the Minnesota River was about 240 miles upstream of the confluence with the Mississippi. About 30 species of fishes ended their upstream limit at this dam. Luther worked with Excel Energy (the owners of the dam) to remove it in 2013. He said it was actually cheaper to remove it than to try and repair it. Minnesota Falls was restored, and pretty quickly Lake and Shovelnose Sturgeon, Blue Sucker, and Sauger started moving upstream past the removed dam.

Luther went through other examples, including a dam failure in 2014 that, after restoration, greatly improved habitat for and range of Topeka Shiner and Plains Topminnow. Overall, about two-thirds of the missing species returned. In the Red River of the North, you have to go back to pre-European settlement and a report by voyageur Alexander Henry, who travelled with the Ojibwe in 1799, to get evidence of a healthy Lake Sturgeon population. They caught up to 120 sturgeon a day, and some weighed as much as 180 lbs., which really gives a historical perspective of what the basin was like before we messed it up!

Along the Cottonwood, where Luther grew up, three more dams were removed, and it is now fully connected without any barriers to the Minnesota River.

STATUS OF THE FEDERALLY ENDANGERED TOPEKA SHINER IN MINNESOTA
Andrew Herberg, Regional Non-Game Specialist with the MN DNR

The Topeka Shiner is a small leuciscid similar to a Sand Shiner. In spawning season, the males have super intense orange/red fins, so there is no difficulty identifying them then. Their preferred habitat in southwestern Minnesota is in tributaries in the Missouri River drainage, such as off-channel pools of the Rock River, that contain cobble, sand, and muck. The Topeka Shiner is fairly tolerant of harsh conditions, including low dissolved oxygen and high temperatures, but it is intolerant of high sedimentation loads. It has an early maturation and a rapid population turnover. They have been known to use the nests of Orangespotted and Green sunfish, but that is not mandatory for spawning.

Their range is from South Dakota, Minnesota, Iowa, Nebraska, Kansas, and Missouri, but they have been absent from 90% of their former range for the last 20–40 years. This decline is attributed to extreme weather events (100-year floods), climate change, dams, culverts, land use, tiling, altered hydrology, introduced predators (bass), a reduction in low-flow habitat, and a mass reduction in tall grass prairie due to agricultural practices causing more fragmentation. In Minnesota, the species is classified as Special Concern. In 1998, the Topeka Shiner was federally listed as Endangered.

What's being done? From early 1997 to 2001, Jay Hatch and his students from the University of Minnesota started looking at Topeka Shiner populations and found a significantly greater distribution and abundance in the Minnesota range than in middle Midwestern states. In 2004, MN DNR began annual monitoring of Topeka Shiner populations. Population estimates (common/abundant) were started in 2006, and there have been wide fluctuations ever since. A decline was noted in 2009–2010 and 2012–2014. Andrew called it a "worrisome" decline in occupancy. But from 2015–2019 there was a population climb that was closer to pre-2012 levels.

In Kanaranzi Creek, early 2000s surveys found Topeka Shiners, but they were gone in later years. The US Fish and Wildlife Service began a large-scale habitat improvement in 2014. Luther Aadland touched earlier on what they were doing: removing barriers and reconstructing oxbows, connecting them back to the main river. Some 128 sites were selected for monitoring and, while not all were sampled, 90% of the sites that were monitored had Topeka Shiners.

Minnesota is one of the last strongholds for this species. MN DNR surveys are on hold while the survey is redesigned. The USFWS draft recovery plan includes eDNA work, which will use water samples to detect the presence of Topeka Shiners, so stay tuned.

AN AQUANAUT'S DNA
Casper Cox, NANFA Fellow

Casper talked about doing his DNA test. He's 95% English, 5% Scottish, and 1% unknown, but he considers that everything he is has been passed down from his ancestors, especially his great uncle Casper Waldo Cox, who wrote a book on hunting and fishing called *Hoot Owls, Honeysuckle and Hallelujah* (search the internet and you can find it). Casper read from the book about how Yancy (his great grandpa) was seining in Panther Creek after a thunderstorm with a 20-foot seine spread from bank to bank. A few folks came thrashing downstream and all sorts of fishes went into the net, including an American Eel, which Yancy bit with his teeth as it went up onto the bank. Casper said that's what's in his DNA.

He talked about how getting into the water was not like hunting on land with his Dad waiting for a squirrel to come by. He said when you get into the water, you're surrounded by life, and water is life. The critters come to you, and it is highly invigorating, like laying in a liquid air conditioner. As a beginner, Casper just wore shorts, t-shirts, and tennis shoes, but he has since worn out many wet suits. He advises wearing a wet suit, especially in the spring. He talked about his early days, grabbing his gazetteer, gasoline, and gear. It was a very low-cost hobby, just driving and exploring.

At the Tennessee NANFA convention he hosted in 1998, there were about 25 people in attendance. He shared some names and memories of those attending. Casper also talked about his contributions to the club by offering graphic art in the form of tee-shirts/printing and contributing to *American Currents*. Casper's son did an Eagle Scout project, and they constructed a sign to mark an area on the Conasauga River in Tennessee with funds contributed by NANFA.

Casper's house has a pool in the yard. It was pea-green when his family moved onto the property, but later he built a 6-ft waterfall and gave the pool good filtration. He has a camera to spy on the fishes in the pool. The stonerollers run into each other like little bulldozers. Alabama and Rainbow shiners reproduce in the pond. There is a Black Redhorse that would be shy in the wild, but it is used to Casper being in its pond.

We all agreed that the *Hidden Rivers of Southern Appalachia* film, shown on Thursday night, was wonderful and that Casper was an integral part of its making and one of its "stars." He wondered as they were filming, "Would I be portrayed as a hillbilly snorkeler, or as a rabid environmentalist, or a fish porn enthusiast?" All agreed that he fit all three categories. For all of this good work, Casper was awarded some money, and he decided to use the money to write and design a *Hidden Rivers* companion book, *Snorkeling the Hidden Rivers of Southern Appalachia*. Over 800 have been sold ($20 each, with $10 going to NANFA and $10 going to *Freshwaters Illustrated*). Thank you, Casper!!

[Editor's Note: By the end, Casper, the ultimate storyteller, had run out of time and energy—he had a respiratory infection during the convention and was not his usual entertaining, energetic self.]

MEMORIES OF HER FATHER, PHIL COCHRAN, A LONGTIME NANFA MEMBER
Dr. Jennifer Biederman, St. Mary's University

Jennifer talked about her dad, Prof. Phil Cochran, for whom the auditorium we were in was named. After attending St. Mary's as an undergrad, Jennifer went on to Texas A&M and worked on freshwater fishes of Belize, followed by some more studies at the University of Minnesota (UM). Eventually, she came back to teach at St. Mary's, following in her father's footsteps.

Phil grew up near Chicago in Bensenville, Illinois, and Jenny credits his love of nature to her grandma (Phil's Mom). She said her dad was really fond of a book series called *How and Why* and read them till they were dog-eared. Starting around nine years old, he kept little field notebooks. He was a true naturalist from the start. His brother reported that their childhood bedroom was filled with jelly jars full of all sorts of pond critters.

She said that Phil was extremely smart. He had to take the SAT twice because he had scored so high that they thought he cheated! When he came from Chicago to visit St. Mary's, he fell in love with the Mississippi River and Gilbert Creek and loved the landscape of the Driftless Area. The biology department at St. Mary's was very strong going back to the 1930s, and he was able to do a lot of research. His thesis was on Spiny Soft-shelled Turtles. He met Jenny's Mom here at St. Mary's and they started their family quite young. He went to the UM and worked with Ira Adelman on a Largemouth Bass project, then moved (with the family) to the University of Wisconsin, Madison, where he worked with Jim Ketchel on parasitic lampreys.

He wanted to teach and do research, so he started teaching at St. Norbert College in De Pere, Wisconsin, in 1984. In 2000, a fish biologist job came open at St. Mary's, and Phil came back to Winona. He loved mentoring undergraduate students and opening up students to doing their own research. Between 1979 and 2015, Phil published 155 articles, chapters, and books. He authored 15 articles for *American Currents*. As for species richness, his work covered 76 different species of fishes, herps, and even a bird. While many professors want to teach just a few classes over and over, he taught 35 different courses, both lectures and labs, over a broad range of topics, while also doing research. The students and faculty loved him and the impact he made on their lives. They said, "He'll be missed, but never forgotten!" He encouraged them to keep their own field journals, and even Jenny's eight-year-old daughter keeps one!

UPDATE ON THE FISHES OF MINNESOTA
Dr. Jay Hatch, University of Minnesota (retired)

Jay's first slide showed the Stephen Hawking book *A Brief History of Time,* which was published in 1988. That same year, Jay and his advisor, Dr. James C. Underhill, began working on a definitive book about the fishes of Minnesota. The species accounts are expected to be finished by December 31, 2022, but the rest of the book is in various stages of preparation. There really aren't 164 reproducing species of fish, just 154 in Minnesota, but that's what they'll be trying to cover; 153 are done. They are hoping to finish the entire book by December 31, 2023. It will be massive.

CULTURING RARE MUSSELS AND REINTRODUCTIONS
Mike Davis, malacologist with MN DNR (retired)

Mike, the former Supervisor of CAMP (Center of Aquatic Mollusk Programs), is now on a post-retirement option. The team in Lake City, MN, has been working to re-establish state and federally endangered mussels back into the Mississippi River.

Mike began by covering what mussels are, their reproduction methods, why we should care about them, how they clean the water, and what fascinating creatures they are. There are 51 native species in Minnesota, and they range in size from very small to as large as dinner plates.

The mussel larvae, called glochidia, are very small, but they clamp onto the gills of host fish like a tiny Pac Man. Mike calls the methods mussels use to attract fish "Dancing with Fish," because the mantle tissue of some of the mussels pretends to be something that fish will want to eat, such as a minnow or a black fly larvae, but it is like a Rapala Trojan Horse. Once they drop off the fish, the small mussels grow a byssal thread to hang onto rocks; they start growing into adult mussels fairly quickly.

Mussels, crayfish, amphibians, and freshwater fishes are all good indicators of water quality. Because mussels are long-lived, their shells can give a record of the water quality conditions in the river, and their shells remove and hold contaminants from the water. A court case was decided by using mussel shell contaminant levels as evidence: the mussels upstream of the discharge contained no contaminants. As mussels filter the water, the river ends up being cleaner.

ORANGESPOTTED SUNFISH BIOLOGY AND LIFE HISTORY IN WISCONSIN
Dr. John Lyons, Curator of Fishes, University of Wisconsin Zoological Museum

John explained that you find Orangespotted Sunfish in very turbid water, but they are spectacularly colorful fish and he wondered why. The general rule is you find drab-colored fish in muddy water and colorful fish in crystal clear water, so why is the Orangespotted Sunfish an exception?

They like turbid, slow-moving, warmwater streams and prefer habitat similar to the Topeka Shiner. They are at the northern edge of their range in both WI and MN. They are small—4 inches is a whopper. They have typical sunfish spawning behavior. The males dig a spawning pit and invite the females to come spawn: they nest colonially in groups. The nests are in shallow water (5–6 inches), and the males guard both the eggs and the fry for a time. These sunfish mature quickly and don't live very long.

As is true with other *Lepomis* species, the brighter and more colorful males tend to attract more females, but the trade-off is in the energy needed to produce the brighter colors. Males with brighter colors are also more prone to predation. John and his colleague, Mike Powers, hypothesize that Orangespotted Sunfish are a standard *Lepomis*, but a million years ago they decided to occupy a "vacant" niche, devoid of other species of sunfishes, thus eliminating competition. Their other hypothesis is that the visible spectrum of color for their eyes in turbid water is such that the lighter blues and orange are easier to see than the darker blues, greens, and other colors. The males can come into shallow turbid water to spawn and the females can see them. John also pointed out that the Orangespotted Sunfish have a better sense of smell


ONEILL
ONEILL
POND SUCKED
REDHORSE
2021
67 9 DY
WISCONSIN TOP
GLAMOROUS FISH
NANFA
NANFA
NANFA
Matt Nelson
2021
SPRING SPIN


County Road K Landing
Welcome to the Namekagon River - part of the St. Croix National Scenic Riverway, a unit of your national park system.
Howell Landing
West Howell Landing
Whispering Pines Landing
Retreat to the River
WHITEFISH
MONTANA

and hearing than other *Lepomis*. Males actually produce sounds to attract females. John then delved into Color Vision 101, which prompted many questions from the audience.

ROUGHFISHING AND PROMOTING OPEN-MINDEDNESS TOWARD ALL FISHES
Corey Geving and Drew Geving

The brothers co-founded Roughfish.com in 1998. The site has over 3,000 active users, 45,000 logged fish catches, and over 200 educational articles about how to catch ciscoes, redhorses, Quillback, and others. They are the number one result in searching for rough fish, which is a problematic term.

Growing up, their dad took them out looking for suckers, catfishes, and other non-game fishes. Originally, when they bought the domain name "roughfish," names were being snapped up really quick. The term rough fish was thought of as a fish you should kill when you caught it. But it actually goes back to a time when common folk in Europe could fish for "coarse" fish that were less desirable than species caught on a hook and line like Walleye, bass, pike, salmon, trout, and perch by the more elite folks. The negative attitudes about these fish have slowly been changing all around the country. For example, Alligator Gar is now considered a "charismatic megafauna." There's a "No Junkfish" bill going through the Minnesota legislature right now, calling for all native fishes to be protected by seasons and limits. Corey and Drew are also asking for the removal of the term "rough fish" and replacing it with "non-traditional sportfish."

Angling for non-traditional fishes, like bullheads in a pond, opens up fishing to a wider, more diverse population, and fish are also good food. Catching these fishes can be quite challenging. The NANFA audience did not need to be convinced; it is the average Walleye angler who needs to be converted. Corey pointed out that Native Americans didn't have a term for "rough fish."

Education is not about learning pharyngeal teeth counts but more about how to tell a Golden Redhorse from a White Sucker and raising awareness with the average angler. They also highlight life lists, species contests, "slams," and derbies on their website. They sponsor various fishing contests throughout the year. One challenge was to pick up a bag of trash while you were out fishing. Another challenge was staying local, catching as many species as you could within two miles from your home. It's meant to expand your fishing experience.

Andy also talked about the annual Root River Round-Up, which began in 2002 and is held over Mother's Day weekend near Lanesboro, MN. One year, they had well over 100 people attending, but they don't want it to grow too large. During a three-hour period, they have a species derby contest. The winner gets their name engraved on a traveling Silver Redhorse trophy, which they get to keep until the next year's roundup. A highlight of the event is deep-fried sucker balls, which many of us had enjoyed the previous night at the NANFA Friday night cookout.

TRANSLOCATION OF SENSITIVE SPECIES INTO GLACIAL LAKES STATE PARK
Jeff Marjamaa, MN DNR

The MN DNR Parks and Trails Division has a mandate to re-establish plants and animals that were formerly indigenous species but are now missing. Five sensitive species were originally indigenous to Signalness Lake: Pugnose Shiner, Blacknose Shiner, Blackchin Shiner, Banded Killifish, and Least Darter.

In 2014 and 2019, Konrad Schmidt helped survey the lake, and MNDNR proposed the re-establishment of all five fishes. Originally, Lake Amelia in Pope County was to be the donor source, but this lake was infested with invasive zebra mussels. Union Lake (Douglas County) was slightly farther away than Amelia but had all five sensitive species and no zebra mussels. Union and Signalness lakes are about 21 miles apart. Signalness is a 41-acre lake while Union is a 107-acre lake. The project timeline was expanded to 10 years to monitor the progress of establishing the Pugnose Shiner and the other four species. Years one and two would include two spring translocations and a summer IBI (Index of Biotic Integrity) with a vegetation survey. Years three and four would include a summer survey and translocation of more sensitive species as needed. At five years, another summer IBI and vegetation survey would be conducted. Summer surveys to monitor for species presence would be conducted at six to ten years. The first translocation of fishes occurred in 2020. In late May and early June, approximately 175 Pugnose were transferred from Union to Signalness, along with the other four species. The IBI sampling was conducted in August and September 2020; the survey in the vegetation found 27 species sampled from 24 plots. On June 2, 2021, 25 Pugnose were moved from Union to Signalness. In 2022, no translocations occurred, but a summer survey happened.

In 2021, all three shiners and Banded Killifish were common but were found across the lake from the release sites where the Muskgrass is abundant. However only one Least Darter was found and at a release site. Someone asked why these fish had gone/missing. Konrad answered that the lake was treated with rotenone sometime after 1963 to reclaim it for game fish. Prior to that year, 400 Pugnose Shiner were counted in Signalness.

STATUS OF THE REDFIN SHINER IN IOWA
John Olson, Iowa Department of Natural Resources (retired)

John discussed the distribution of Redfin Shiner in Iowa, Wisconsin, and Minnesota, which are at the northern most part of its range. The shiner prefers pools and deep runs; becomes sexually mature by the second summer; spawns June to August; and lives about three years. It is not listed in Iowa but is a Special Concern species in Minnesota and is listed as State Threatened in Wisconsin. It is more common south in Illinois, Missouri, and Kansas. The Redfin Shiner is a little-known species in Iowa.

John proposed in 2020 to sample the sites (around 40) where he had collected Redfin Shiner in the early 1980s. Jay Hatch, Konrad Schmidt, and George Cunningham helped with the survey in 2021. They found the fish at only 4 of the 40 sites. During their survey, the Redfin Shiner showed an affinity for bridge pool areas with relatively few found in other parts of the streams.

John updated the distribution of this species in Iowa. He found a total of 190 databased Iowa records for Redfin Shiner: 53 records were vouchered, John accepted 99 unvouchered records, 16 were identified as questionable, and he rejected 22 as erroneous. The erroneous records were most likely for Red Shiner. There has been a severe range reduction of this species in Iowa. John says that although it can be difficult to find this fish during surveys, his conclusion is that there's been a 60–80 % reduction in their Iowa range. He believes that this species is vulnerable to extirpation and

should be state-listed. The reasons for the decline are unknown, perhaps including changes in the hydrology of the streams, which appear wider and shallower now than in the 1980s when John first surveyed for this fish.

FROM RAPIDS TO RESERVOIRS AND BACK AGAIN: RESTORING THE MISSISSIPPI RIVER GORGE

John Anfinson, Superintendent of the Mississippi National River and Recreation Area (retired)

Our keynote speaker at the banquet asked: "How often do we get the opportunity to redefine the Mississippi River at any point along its course?" The US Army Corps of Engineers is looking at removing at least two of the dams near the heart of the Twin Cities. We have a choice! The outcome will have profound, long-term, and far-reaching consequences for native fishes. John eloquently reviewed the history of dam building in the Twin Cities area, which you can read about in his book, *The River Which We Have Wrought*.

In 2018, American Rivers called the Mississippi River one of the ten most endangered rivers in the country and identified the removal of Lock and Dams 1 and 2 as a number one priority. The locks are being used less and less. The Corps is no longer dredging like they did. John described how removing Lock and Dam 1 would make the river return to fast rapids. The fish species would return and in large numbers. John encouraged us to help spread the word on what removing the locks and dams would do. Cleaner water is good, but the dam removal and restoration are vital. [Editor's Note. Check out *American Currents* 2019, Vol 44(1), "Return of the Rapids: Could the Upper Mississippi River Run Wild Again?" by Ellen Burkhardt for more information.]

THOUGHTS ON THE 2022 NANFA CONVENTION

Madeline Cleveland (age 12)

As you may know, this year, the 2022 NANFA convention was held in the city of Winona, Minnesota, in the heart of the driftless area. This unique location had so many wonderful surprises in store: diverse ecosystems, interesting fish species, and beautiful vistas. Living in Wisconsin, the event was right in my backyard, and yet most of the rivers, lakes, and streams that we visited on field trips were completely new to me.

It would take multiple pages to list all the highlights of the trip, but the species that I most enjoyed seeing, were: Mud, Blackside, and Western Sand darters, Longnose Gar fry, a young Bowfin, Channel, Carmine, and River shiners, and an American Brook Lamprey ammocoete. I was very fortunate to attend this convention and meet many kind and knowledgeable fellow native fish enthusiasts. I learned so much from the organized talks as well as from the informal conversations I had with other participants. As a new member, I felt very welcomed by the community. Thank you all! I greatly look forward to next year's convention and encourage those who didn't come this year to consider doing so in 2023.

(Photo by Madeline Cleveland)

At left, Perry Creek, one of many beautiful tannic streams, characteristic of the Black River watershed.

NANFA Convention Minnesota Field Trip Locations

Site	Stream	Location	Date	Lat/Long
1	Mississippi River	Latsch Island	6/9/2022	44.058040/-91.635098
2	Mississippi River	Prairie Island	6/9/2022	44.076287/-91.679065
3	South Fork Middle Branch Zumbro River	Oxbow Park	6/10/2022	44.064555/-92.755319
4	Salem Creek (Zumbro River basin)	John Ness Residence	6/10/2022	43.965975/-92.720591
5	South Fork Zumbro River	Below Mayowood Dam	6/10/2022	43.994562/-92.520957
6	Root River	Whalen	6/12/2022	43.734555/-91.919437
7	Root River	Parsley Bridge	6/12/2022	43.816411/-92.139502
8	Middle Fork Zumbro River	Oronoco	6/12/2022	44.162361/-92.534762

NANFA Convention Minnesota Field Trips Species List (June 9–12, 2022)

Common Name	Scientific Name	1	2	3	4	5	6	7	8
Lamprey Family - Petromyzontidae									
American Brook Lamprey	*Lethenteron appendix*							X	
Gar Family - Lepisosteidae									
Longnose Gar	*Lepisosteus osseus*	X	X						
Shortnose Gar	*Lepisosteus platostomus*	X	X						
Bowfin Family - Amiidae									
Bowfin	*Amia ocellicauda*	X							
Mooneye Family - Hiodontidae									
Mooneye	*Hiodon tergisus*							X	

Common Name	Scientific Name	1	2	3	4	5	6	7	8
Minnow Family - Cyprinidae									
Central Stoneroller	*Campostoma anomalum*				X	X			X
Largescale Stoneroller	*Campostoma oligolepis*			X		X			
Spotfin Shiner	*Cyprinella spiloptera*	X	X	X			X	X	X
Common Carp	*Cyprinus carpio*					X			
Common Shiner	*Luxilus cornutus*			X	X	X		X	X
Redfin Shiner*	*Lythrurus umbratilis*				X				
Hornyhead Chub	*Nocomis biguttatus*			X	X		X	X	
Emerald Shiner	*Notropis atherinoides*	X							
River Shiner	*Notropis blennius*	X							
Bigmouth Shiner	*Notropis dorsalis*			X		X	X		X
Ozark Minnow*	*Notropis nubilus*				X				
Carmine Shiner	*Notropis percobromus*			X	X	X	X	X	X
Sand Shiner	*Notropis stramineus*			X		X	X	X	X
Weed Shiner	*Notropis texanus*	X	X						
Channel Shiner	*Notropis wickliffi*	X							
Bluntnose Minnow	*Pimephales notatus*			X	X	X	X	X	
Fathead Minnow	*Pimephales promelas*					X			
Bullhead Minnow	*Pimephales vigilax*	X	X						
Longnose Dace	*Rhinichthys cataractae*			X	X	X	X	X	X
Western Blacknose Dace	*Rhinichthys obtusus*				X	X			X
Creek Chub	*Semotilus atromaculatus*			X	X				
Sucker Family - Catostomidae									
White Sucker	*Catostomus commersonii*			X	X	X	X	X	X
Northern Hog Sucker	*Hypentelium nigricans*			X	X	X	X	X	X
Bigmouth Buffalo	*Ictiobus cyprinellus*	X							
Black Redhorse*	*Moxostoma duquesnei*							X	
Golden Redhorse	*Moxostoma erythrurum*			X	X	X	X		X
Shorthead Redhorse	*Moxostoma macrolepidotum*							X	X
Greater Redhorse**	*Moxostoma valenciennesi*							X	
North American Catfish Family - Ictaluridae									
Black Bullhead	*Ameiurus melas*			X		X			X
Yellow Bullhead	*Ameiurus natalis*	X	X						
Stonecat	*Noturus flavus*		X	X	X	X	X		X
Tadpole Madtom	*Noturus gyrinus*		X			X			
Trout and Salmon Family - Salmonidae									
Brown Trout	*Salmo trutta*						X	X	
Pike Family - Esocidae									
Northern Pike	*Esox lucius*	X	X						
New World Silverside Family - Atherinopsidae									
Brook Silverside	*Labidesthes sicculus*	X	X						
Stickleback Family - Gasterosteidae									
Brook Stickleback	*Culaea inconstans*					X			
Temperate Bass Family - Moronidae									
White Bass	*Morone chrysops*		X						
Sunfish Family - Centrarchidae									
Rock Bass	*Ambloplites rupestris*	X	X	X	X		X	X	
Green Sunfish	*Lepomis cyanellus*	X	X	X	X	X			X
Pumpkinseed	*Lepomis gibbosus*	X	X						X

*Corey Geving one week before the NANFA conference.

Common Name	Scientific Name	1	2	3	4	5	6	7	8
Warmouth*	*Lepomis gulosus*		X						
Bluegill	*Lepomis macrochirus*	X	X						X
Smallmouth Bass	*Micropterus dolomieu*	X	X	X	X		X	X	X
Largemouth Bass	*Micropterus nigricans*	X	X						
Black Crappie	*Pomoxis nigromaculatus*								X
Perch Family - Percidae									
Western Sand Darter	*Ammocrypta clara*	X							
Mud Darter	*Etheostoma asprigene*	X	X						
Rainbow Darter	*Etheostoma caeruleum*			X	X	X	X	X	X
Fantail Darter	*Etheostoma flabellare*				X	X	X	X	
Johnny Darter	*Etheostoma nigrum*				X	X			X
Banded Darter	*Etheostoma zonale*			X		X	X	X	X
Yellow Perch	*Perca flavescens*	X	X						
Logperch	*Percina caprodes*			X					X
Blackside Darter	*Percina maculata*			X		X	X	X	X
Slenderhead Darter	*Percina phoxocephala*			X			X	X	X
Sauger	*Sander canadensis*		X						
Drum Family - Sciaenidae									
Freshwater Drum	*Aplodinotus grunniens*	X							
	Species totals per site	**23**	**21**	**23**	**20**	**24**	**19**	**21**	**25**
	Overall summary	**62 species in 15 families**							
	Sampling Gear	angling, dip net, seine, backpack shocker, and trawl							

* MN Special Concern Species

** Corey Geving a week before the conference.

ALL BOWED UP

Henry Veggian

Chapel Hill, North Carolina

"Though the dinosaurs are long gone, the Bowfin has survived."

Eugene Hester wrote those words in the July 1995 issue of *Wildlife in North Carolina*. It would be rare today to see that sort of generosity afforded to the Bowfin *Amia calva*, a resident of many Carolina lakes, rivers and streams, but it was rarer still a quarter century ago. Most publications ignored that unique native species or disregarded it as a "trash fish." The Bowfin didn't only survive the dinosaurs, it survived a lot of bad press.

We all feel like survivors of late, I should hope. It's been that kind of year, or two. It's been an ordeal for all of us and a tragedy for too many. I feel lucky to gather again with friends and chat with fellow anglers at a boat launch. Survival is luck to some and it is fate to others. For me, survival is a chance to reflect on the good things when we wake to another day and venture to water for another cast.

The Bowfin's survival offers some perspective. Pandemic? No problem. Try surviving the global extinction of most of the dominant saurian species, the rise of the mammals, and the Industrial Age, to name a few significant events. More specifically (and recently), try surviving the rise of a bipedal species with fishing poles and opposable thumbs. Mr. Hester chose his words well, that's for sure.

The author with an early-spring Bowfin in North Carolina.

Republished with minor edits from *Wildlife in North Carolina,* November-December 2021.

Henry Veggian teaches in the Department of English at UNC Chapel Hill. A member of the Jackson Kayak Fishing Team and a former director of the Carolina Kayak Anglers Kayak Fishing Trail, he writes about fishing and kayak fishing and reviews fishing books for his "Bowfin Country" blog, *Kayak Bass Fishing,* and elsewhere.

He knew something that anyone who has ever tangled with the Bowfin on a rod and reel knows well: They never give up on a fight. Hook one well and pray you tied a good knot. The bite will run up your arm like an ungrounded current and tell your brain you hooked a tuna. Then hold on: A mad Bowfin pulled a jon boat loaded with gear, me, and my friend Steve across a bay; later that same year, another one did the same, but upstream, against current, on the Haw River. Both fish weighed just over 10 pounds. Our combined weight was over 400.

Some Bowfin are acrobats, some just dig for deep water. Some play possum until they get to the boat or the bank, and then you have

Editors' Note: Bowfin was considered a single species for 125 years, but in 2022 (i.e., after the original publication of this article), analysis showed "unambiguous molecular evidence for the presence of at least two living *Amia* species with more likely to exist" (Wright et al. 2022). Two species are recognized: *Amia calva* ("distributed from the Pearl River in Louisiana and Mississippi, to the Florida Peninsula, and the rivers draining to the Atlantic Ocean in Georgia, South Carolina, North Carolina and Virginia") and *A. ocellicauda* ("from the Lake Pontchartrain system west in Gulf of Mexico draining rivers to the Colorado River system in Texas, throughout the Mississippi River Basin, the Great Lakes Basin, the St Lawrence River system, including Lake Champlain, and the Atlantic draining Connecticut River system") (Brownstein et al. 2022).

Brownstein, C.D., Kim Daemin, O.D. Orr, G.M. Hogue, B.H. Tracy, M.W. Pugh, R. Singer, C. Myles-McBurney, J.M. Mollish, J.W. Simmons, S.R. David, G. Watkins-Colwell, E.A. Hoffman. and T.J. Near. 2022. Hidden species diversity in an iconic living fossil vertebrate. Biology Letters 18(11). http://doi.org/10.1098/rsbl.2022.0395.

Wright, J.J., S.A. Bruce, D.A. Sinopoli, J.R. Palumbo, and D.J. Stewart. Phylogenomic analysis of the bowfin (*Amia calva*) reveals unrecognized species diversity in a living fossil lineage. Scientific Reports 12. https://doi.org/10.1038/s41598-022-20875-4.

A Bowfin in a clear Florida spring. (Photo by Isaac Szabo)

A male Bowfin *Amia ocellicauda* in spawning condition from a Minnesota River backwater. (Photo by Gijs Van Straten)

a new fight on your hands. Try handling a Bowfin in the confines of a fishing kayak and you should probably earn a black belt.

I could never grasp why the Bowfin is a divisive topic among anglers. I primarily fish for them in the rivers and creeks around Jordan Lake, but I have ranged far and wide to catch them. Using artificial lures like topwater baits, plastic crayfish, and in-line spinners, I fish for them as I do for other sport fish. Yes, I said it—the Bowfin is a sport fish in my book, and one of the best (we'll get back to that).

The Bowfin is also a singularity, literally. Among freshwater fishes, it looks like no other. The gular plate, a bone on the underside of its jaw, is unique. It gulps air from the surface and can live out of water for much longer than other fishes. And it has no scales on its head (this is why Carl Linnaeus partly named it "*calva*" from the Latin word for "*bald*"). And the entire package, from the short whiskers on its nose to the wide, almost circular tail, adds up to make the fish a living, breathing, and fighting reminder that it is the last living member of a family of fishes (Amiidae) that is otherwise extinct.

There's a kinship among the underdogs and stubborn mules that persists despite the odds. Being a fisherman, I look to the Bowfin as a sort of spirit animal. And so, I want to pick up the line where Mr. Hester left us with his appreciation for the Bowfin and make a case for the recognition it deserves.

THE SEASON OF OUR DISCONTENT

Winter is not only a season to anglers, it is also a state of mind. It's a time to reflect on the fish we caught and the memories we share with others of catching them, of longer days, warmer mornings, and of fish waiting near a grass line for a foolish frog to test the water. Winter is also time to reflect on the year ahead, to hoard tackle we probably don't need to buy, and to repair things we broke while using that same tackle we probably didn't need. In the early winter of 2012, I decided to start tournament bass fishing from a kayak. I had just started fishing from a Jackson Coosa, a loaner from my friend Joe, and he persuaded me to fish a local kayak event earlier that fall. I had a good showing and decided to commit.

But I had another motive. Until that time, I spent most days fishing for Bowfin on the Haw River, Jordan Lake, or Shearon Harris. And I had them dialed in, as they say. An example: in 2007, I submitted my first of six applications to the North Carolina Angler Recognition Program (NCARP). All were for Bowfin. When

Iris Nelson loves Bowfins, as everyone should (Newton County, Indiana). (Photo by Olaf Nelson)

it was over, I had my "Master Angler" certificate and patch. And I kept going, catching hundreds more along the way. Over the next few years, I was interviewed in newspapers and outdoor magazines, a TV producer contacted me about a reality TV show, and in 2014 I earned a grant to finish a book I was writing about the fish. I had become "the Bowfin guy." I've worn many hats proudly in life (dad, professor, musician), but that one fit really well.

I wanted to catch Bowfin elsewhere. I wanted to see more of America, and I reasoned that I could use tournament fishing as a premise for "research." Surely, I'd catch Bowfin wherever I went in North Carolina and beyond.

Boy, was I wrong. I spent the next three years driving around North Carolina and barely winning any money. The competition was tough, the sport was booming, and my research idea was a failure. I doubled down. Between 2016 and 2020, I fished tournaments in Texas, Tennessee, Kentucky, Louisiana, and Arkansas, to name a few places, winning just enough money to keep the foolish idea alive. I watched kayak fishing grow and reach a new generation of anglers, and I caught fishes from lakes I only dreamed of fishing when I was a boy. But I never caught a Bowfin, or even saw one, despite fishing through more than a dozen states. Ironically, the fish that I had found so easy to catch in some Carolina lakes were like ghosts everywhere else.

I spent 2020 fishing in a different state. It wasn't on any map, but it was located somewhere between panic and stubborn denial. Frequently asked questions associated with this state include "What on earth is going on?" and "How am I going to go fishing without getting in trouble at work?" I had stopped traveling to out-of-state events, too, but I made an exception for the KBF National Championship. So, in early October I booked a single cabin to myself, turned off my phone, and drove to Lake Guntersville in Alabama. But I wasn't only there to catch bass.

One day, it finally happened. With my pedals and propeller lifted, I was paddling over submerged grass. The sun was behind me and the grass-filtered water was as clear as the air. There, in a deep hole, about four feet under the surface, was a fat Tennessee River Bowfin.

It was parked in the shade, wearing a mottled green coat, its long dorsal fin shimmering like a leaf, its beady little eyes looking right through me. Time stops in such instances, and for all I knew that fish had been sitting there for 200 million years, and I had too.

I remember thinking we were going to survive—not necessarily that fish, or even me—but something somewhere would persist.

A WORTHY FISH

We've all seen license plates with trout on them. Some of you even have one. It's a reminder of what anglers can get done when they have a cause, an organization, and a strong case to make. Consider the Red Drum, our [NC] state fish; we celebrate it with stickers and shirts, and do our best to protect it. We build tackle, boating and guide industries, lodges and resorts, and our fisheries biologists study them in the field and labs, producing valuable data that helps them to manage water and species. All of that translates into the protection these beautiful fishes deserve and need. Conservation, understood in the true sense of the American movement that has for the past century advocated on behalf of the scientific study and protection of the environment, has achieved amazing things for many species. Think of the Bald Eagle, the Striped Bass and the Grey Wolf.

The Bowfin gets no license plates or fancy stickers. There are few tournaments for it, there is no specialized tackle, and while many scientists study its unique scales and musculature, its bones and fossils, there is little written about how it lives, or where.

I've caught Bowfin in every season, with every manner of lure, from the shallowest creeks to the deepest lakes. And I've seen a few weird things along the way. I call them "Unexplained Fishing Observations." I was fishing on Shearon Harris in the early summer of 2017 and a commotion broke the surface on a grassy point near a small cove where a beaver hutch lords over a small creek. I paddled over.

Baitfish were scattering every so often. The water was clear. To my left a school of Largemouth Bass herded the bait toward the right. When the bait moved too far, the wake on my right sprang. It was a big Bowfin. A swirl, and some bait was gone. And then it stalked the bait to the left side of the boat, and the bass would explode. From my perspective, it looked like the bass and Bowfin were cooperating.

ALWAYS A SPORT FISH TO ME

Survival doesn't just happen. We can help it through scientific stewardship and conservation, communication and hard work. I've been attending the meetings of the N.C. Wildlife Resources Commission working group that is restoring native vegetation to Shearon Harris and building new habitat for fishes. We've been meeting to discuss strategies and implement plans. Representatives of the fishing community regularly attend meetings. The B.A.S.S. representative shows up, local guides participate, our kayak fishing clubs are involved, and (if the meetings aren't too early in the afternoon) a representative of a local collegiate fishing club may be present.

I have ulterior motives, of course. When Hurricane Matthew came roaring over us in the fall of 2017, it destroyed the vegetation at the east end of the lake. The wind and rain literally tore out large fields of plants and swept them into coves, creating land where water had been and eliminating habitat where Bowfin build spawning nests on that far end of the lake. The Bowfin and bass I had seen earlier that year had lost prime hunting and spawning areas. Oh, the bass and Bowfin are still there, but they live offshore now.

Juvenile Bowfin, North Carolina. (Photo by Scott Smith)

And so, word on the street is that "Harris isn't what it used to be." That's true in the sense that the fishery has changed, but the more important question is "What will Harris be in a few years?" As native plants are seeded, and the Bowfin, bass and pickerel move back into their weedy haunts, I have a feeling the grumbling will be replaced by anglers singing Hallelujah from one end of the lake to the other.

I noted earlier that winter is a state of mind. It will be late winter when this article appears. The White Bass will be staging for their springtime runs, the frogs will be croaking in ditches on the warm days, and most of us will be sharpening our hooks. Soon, we will be back on the water. Like Shakespeare's Richard the Third, we may plan to make glorious summer of it.

But we aren't Shakespearean villains, and neither is the Bowfin. More than one of you will catch a Bowfin along the way. Some of you may be disappointed to find a Bowfin (or grinnel, or dogfish or mudfish) on the end of your line. Some of you may be confused by it, not having seen one before. You may turn to the *North Carolina Sportfish Identification Pocket Guide* and find it there, where it is listed among "other sport fish."

Is the Bowfin a sport fish? I can quote a hundred sources that attest to its ferocity. I can muster scientific literature that explains why its jaw is so strong or why its smooth head and wide tail make it a powerful swimmer. I can even quote Friedrich Nietzsche to remind us why we admire fishes so much that we chase them down like zany philosophers after a slippery truth. But while it is implied in some places that the Bowfin is a sport fish, and few deny it offers "sport," it is technically not listed as a sport fish, with the associated protections, creel limits, seasons, etc. You can catch, keep and kill as many as you want in North Carolina (granted, it is illegal to "waste" them).

On the prowl. (Photo by Derek Wheaton)

We've been through a lot of late. Our fishing lives have changed. The good news is that many people are taking to fishing and boating again. The bad news is that everyone seems to be fishing in our honey holes. It's a mixed blessing. I've been back at my old haunts around Jordan Lake again, and I've noticed a lot more dead Bowfin on the banks.

Those dead fish are a reminder that we must work together and educate anglers new and old about our fishes and fisheries, about the wonders that live in our lakes and rivers, to celebrate the survival of any and all things and protect the fishes that make our waters healthy and unique. Survival is not something we should take for granted, but it is something we can fight to achieve. What better fish than the Bowfin to remind us, as Eugene Hester did all those years ago, of how important and precious that is?

WELCOME, NEW MEMBERS!

Adam Comer, TX
Kevin Davis, NC
Dave Dollinger , MN
Sam Garcia, CA
Tedd Greenwald, FL
Joe Hennessy, WI
Liam Hopper, MA
Scott Johnson, CA
Thomas Lyons, NC
Ritchie Mathews, SC
Keith Mueller, CA
Jeff Pendergist, MD
Riley Phelps, VA
Dakota Radford, IL
Zachary Ramsey, SC
Michelle Redmond, MD
Matt Sarver, OH
Daniel Schafer, IN
Nicholas Somogyi, TX
Ezra Staengl, VA
Nate Wilson, PA
Bryan Windmiller, MA

NANFA 2022 FINANCIAL SUMMARY
Submitted by Tom Watson, Treasurer

BEGINNING BALANCE: $54,652.24 (AS REPORTED IN APR. 2022 *AC*)

INCOME		EXPENSES	
Membership Dues	14,579.16	Convention[2]	-4,100.57
T-shirt sales	533.62	Snorkle Guide[3]	-444.34
Snorkel Guide	590.31	*AC*	-17,756.75
Convention	10,415.65	Grants	-2,085.00
Donations	3,393.35	USPS	-1,043.11
Misc. Income[1]	713.58	Web Site	-1,109.23
TOTAL INCOME	**30,225.67**	**TOTAL EXPENSES**	**-26,539.00**
		YEAR END BALANCE (12/31/2022)	**$58,338.91**

[1] Includes hats, cards, decals, *AC* CD, etc.
[2] Includes facilities, food, and t-shirts.
[3] Postage and reimbursements to Freshwaters Illustrated.

FISHES OF WISCONSIN POSTERS

The University of Wisconsin Zoological Museum has some amazing fish posters for sale. The 13-foot canvas poster shows all 183 species found in the state, at life size, and costs $150. Nine smaller posters, each depicting a subset (eight show families: the sunfishes, the pikes, the perches, the gars, the suckers, the salmonids, the catfishes, and the minnows; "The Little Fishes of Wisconsin" includes 16 families) are also available. The excellent art is by Kandis Elliot, UW-Senior Artist Emerita, and reference photos were provided by NANFA member John Lyons. See https://charge.wisc.edu/zoology/items.aspx for more info.

THE NORTH AMERICAN NATIVE FISHES ASSOCIATION

DEDICATED TO THE APPRECIATION, STUDY AND CONSERVATION OF THE CONTINENT'S NATIVE FISHES

AN INVITATION TO JOIN OR RENEW

The North American Native Fishes Association is a 501(c)(3) not-for-profit, tax-exempt corporation that serves to bring together professional and amateur aquarists, anglers, fisheries biologists, ichthyologists, fish and wildlife officials, educators, and naturalists who share an interest in the conservation, study, and captive husbandry of North America's native fishes. A portion of each member's dues helps support three important initiatives: NANFA's Conservation Research Grant Program, which funds research on the biology and conservation of North America's most neglected and imperiled fishes; the Gerald C. Corcoran Education Grant, which funds educational outreach programs aimed at children and the general public; and the John Bondhus Conservation Grant, which supports organizations and groups working to conserve native fish populations.

MEMBER BENEFITS

- ***AMERICAN CURRENTS,*** a quarterly publication featuring articles and news items on collecting, keeping, observing, conserving, and breeding North American fishes.
- **REGIONAL NANFA CHAPTERS.** State and regional aquarium groups where members may get together to collect and discuss native fishes, remove exotics, and perform conservation and stream restoration work.
- **NEW MEMBER PACKET.** An 8-page newsletter that's sent to new NANFA members introducing them to NANFA, and to the fascinating world of collecting, keeping and conserving North America's native fishes.
- **ANNUAL CONVENTION.** Where NANFA members from around the country meet for lectures, collecting trips, auctions, fun and finship. The 2023 convention will be held in mid-March in South Carolina.
- **GRANT FUNDING.** Only NANFA members can apply for NANFA's Conservation Research Grant and Gerald C. Corcoran Education Grant programs. For details, see NANFA's website (www.nanfa.org), or contact Dr. Bruce Lilyea, Conservation Grant Chair, 863-513-7611, bruce.lilyea@gmail.com, or Scott Schlueter, Education Grant Chair, scott_schlueter@hotmail.com.

DUES: USA, $30/year ◆ CANADA and MÉXICO, $35/year ◆ ALL OTHER COUNTRIES, $44/year (All amounts in US$)

Please renew or begin my NANFA membership, or send a gift membership to the person named below.

Enclosed are dues in the amount of $_____ for _____ year(s). In addition to my dues, I would like to make an additional tax-deductible contribution in the amount of $_____ to help fund NANFA's education and conservation programs.

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or **join online at http://www.nanfa.org/join.shtml**

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Feel free to photocopy this page and share it with other native fish enthusiasts.

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(See Contents page.)