American Currents

Publication of the North American Native Fishes Association

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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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FRONT COVER: Longear Sunfish *Lepomis megalotis* from Harpeth drainage, Tennessee. (Photo by Andrew Zimmerman)

BACK COVER: Ouachita Shiner *Lythrurus snelsoni* expertly photographed during the 2024 Oklahoma Convention by Madeline Cleveland.

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NANFA News

MEMBERS, EVENTS, ACCOMPLISHMENTS, AND ADMINISTRIVIA

FISHES OF THE ROOT RIVER

Micaiah (Mike) McNeilus (Lanesboro, Minnesota) is hoping to finish by midsummer a coffee table book for the Root River, showcasing approximately 90 of 110 species reported in the river. The Root River is in southeastern Minnesota's Driftless Area, characterized by scenic towering bluffs and deep stream valleys that very much resembles the landscape found in the Ozarks. It is one of the most diverse stream systems in Minnesota, hosting 15 species listed endangered, threatened, or special concern. The book will include species summaries, images, and distribution maps.

NANFANS AT THE AKA/ALA/IBC CONVENTION

NANFA was well represented at the recent joint American Killifish Association/American Livebearer Association/International Betta Congress Convention held in Tampa, Florida. Organizers included **Charlie Nunziata**, **Doug Dame**, **Bill Shields**, and **Bruce Lilyea**. Past member Brian Skidmore gave a very informative and thorough talk on collecting native fishes, and **Greg Sage** (Select Aquatics) discussed selective breeding. **Stephan Tanner** (Swiss Tropicals) and the always ebullient **Ryan Kinney** were vendors. **Dave Hemmerlein** was one of the effective auctioneers (killifishes, goodeids, and wild livebearers galore), squeezing money from everyone (he should help Phil out at our convention!) **Fritz Bazeley** and **Harry Knaub** won awards for their killifish entries; Harry got best in the Old World Killie class for his *Aplocheilus dayi*. **Scott Smith** entered some Peruvian *Rivulus* but garnered no awards; two undescribed *Rivulus* species that he and Fritz Rohde brought back in 2022 and bred by Ken Normandin got the top prizes for Ken in that category. Also in attendance were **Mike Lucas**, **John Haas**, and **Fritz Rohde**. **Leo Long** provided a beautiful trophy. Although not members (sigh), a number of attendees from our South Carolina convention were also present. And if I (Fritz R.) overlooked anyone, I apologize.

MONDAY COLLECTING AFTER THE CONVENTION

Harry Knaub

After all the festivities of the AKA/ALA/IBC Convention, after the speakers, the banquet, and two large auctions, several of us were treated to three separate collection trips on Monday. I participated in one that led us to three sites in the Ocala National Forest. Our guides were Ken Normandin and John Boylan. Two participants of note were Saturday's keynote speaker, Dr. Francisco Malumbres of Spain, and his wife.

Our first stop was Lake Eustis in Tavares, FL. Using both dipnets and a seine, we found several species of killifish—including Bluefin Killifish *Lucania goodei*—and several livebearer species, including some melanistic Eastern Mosquitofish *Gambusia holbrooki*. Of particular interest were a half dozen male Taillight Shiner *Notropis maculatus* in vibrant breeding colors. We also found several Brown Darter *Etheostoma edwini*.

The second stop was Alexander Creek, a wide shallow stream of very clear water near Altoona, FL. The banks were heavily vegetated, which provided a lot of cover for a diverse collection of species. In addition to many of the same species as Lake Eustis, we collected Okefenokee Pygmy Sunfish *Elassoma okefenokee*, and some brightly colored male Metallic Shiner *Pteronotropis metallicus*, in this case an undescribed species related to the Metallic. We also found a Lesser Siren.

At this point, we broke for lunch while Ken and John separated out the different species for transport in coolers. Over the years, Ken has developed an excellent system of containers and coolers to accommodate the many fishes we collected.

The last stop of the day was "Skinny Dip Pond," a small body of water. The highlight of this site was some colored-up Redface Topminnows *Fundulus rubrifrons*. Conversely, the lowlight there would be, for me, some colored-up Jewel Cichlids *Rubricatochromis bimaculatus*, a fairly common invasive in Florida.

This was a great day with some old hands and some younger folks collecting natives. I like to think this will bode well for future interest in native fishes.

MOLECULAR GENETICS AND PHYLOGENY OF BIGMOUTH SHINER *ERICYMBA DORSALIS*

NANFA member **Bob Hrabik** and seven co-authors recently presented a poster on this fish at the Midwest Ecology and Evolution Conference held in Edwardsville, Illinois, on April 7.

Glaciation creates geographic isolation, which allows for the possibility of genetically distinct lineages among drainage basins. *Ericymba dorsalis*, a northerly distributed species of fish, is a prime example and has a broad distribution exhibiting similar morphologies, but they hypothesized that the separate drainage systems would yield genetically distinct populations.

Their analyses support separate phylogenetic clades corresponding to major drainage basins throughout the *E. dorsalis* distribution. The genetic divergence between Missouri, Mississippi and Illinois River clades is consistent with Pleistocene isolation of those populations. Divergence between the three western clades, the Great Lakes clade, and the Allegheny River clade suggest early Pleistocene or Pliocene divergence for the latter two clades. This level of divergence may require reassessment of the species status of these phylogenetic groups. Previous phylogenetic research on *E. dorsalis* came to the conclusion of three distinct species with one species in the Allegheny River drainages, one located in the Platte River, and another species located in the rest of the species' distribution. Their results support the genetic distinctiveness of the Allegheny but not the Platte River populations.

EASTERN TENNESSEE AQUARIUM SOCIETY'S RIVER DAY

NANFA Board of Directors member **Derek Wheaton** provided his expertise, with help from **Robert Lamb,** to the East Tennessee Aquatic Association's first River Day and Cookout on May 25 on the Little River near Walland, TN.

River Day attendees by the water.

Robert Lamb (blue hat) and Derek Wheaton (dark green shirt) checking the seine.

NANFA 2024 OKLAHOMA CONVENTION A HUGE SUCCESS

Around 90 attendees enjoyed the Oklahoma experience hosted by **Brandon Brown**. Friday was filled with talks, bbq-based banquet, and auction. Saturday and Sunday were field trips ranging from mountain streams, to swamps, to boat electrofishing the Kiamichi River. More information and photographs will be in the next issue of *American Currents*.

The photo below shows over half of the attendees, just prior to heading out for Sunday's field trips. (Photo by Cheryl Cheadle)

NANFA members can help make a great organization and its publication even better.

Contact the editors with ideas for articles you'd like to write and to suggest authors or topics you want to read. • Mention *AC* to people who have interesting things to write about. • Submit your photos and artwork. • Suggest items for Riffles. • **Tell us what you want to see in these pages.**

FOUR DAYS OF FISHING ACROSS CENTRAL BELIZE

Arthur Kosakowski

Davie, Florida

As someone who works five jobs throughout the year varying from very part-time to more than full-time, my time off is very limited and precious. What gets me through the year is having a trip planned that I can look forward to. When I got back from my winter break trip in early January, it didn't take long before I was getting antsy about where I'd go during spring break.

While I had plenty of dream destinations in mind—Japan, South Korea, Mauritius, and Seychelles, to name a few—I wanted to save those for when I had more time off. I didn't want to spend two or three days of my seven-day vacation in airports and on airplanes. That cuts into fishing time, and no one wants that. I decided to focus on something within a three-hour flight of my home airport in Miami. Being the ninth and 26th busiest airport in the United States and the world respectively, MIA gives me plenty of options. After a few days of research, I decided to take my adventure to Belize.

I had been to Belize once before, in 2018, but that wasn't a fishing trip. I spent my four days cave tubing, exploring Mayan ruins, and visiting some other local attractions. This time though, it was going to be all fishing. Being a multispecies fisherman and lifelister, I'm always on the hunt for as many species as possible that I've never caught before. While Belize has some saltwater species that southern Florida doesn't, there is still considerable overlap. Instead of flying to Belize to catch the same Bluestriped Grunt *Haemulon sciurus*, Gray (Mangrove) Snapper *Lutjanus griseus*, and Bermuda Chub *Kyphosus sectatrix* that I regularly catch, I decided to make this a freshwater fishing road trip through Belize.

Information on the freshwater fishes of Belize is lacking, but from what I could tell the diversity wasn't anything to write home about. Despite that, it did seem that, without having to put in too much effort, I could pick up roughly half a dozen new species and still be able to enjoy the time off. Over the next few months I created a rough itinerary, booked my rental car and hotels, purchased my Belizean fishing license, and was ready for Belize. Then March 28th finally came: the day for which I had spent nearly three months planning.

MARCH 28, 2024

I wanted to give myself as much time in Belize as possible, so I booked the earliest nonstop flight from Miami to Belize City, which was scheduled to depart at 10:10 AM. I arrived at the airport ridiculously early, as I normally do, had breakfast, and after a couple of hours, boarded the plane. After sitting on the plane for nearly an hour it was announced that the plane didn't have a co-pilot, and we passengers had to deboard the plane without any new time of departure announced.

Normally I wouldn't be too worried, but I had planned to drive from the airport near Belize City all the way west to San Ignacio, a town near the Guatemalan border. This drive normally takes about two hours, and I was determined to make it before sunset. While I'm not one who usually worries, I had read plenty of advice online not to drive in Belize after dark, that Belize has the fifth highest murder rate in the world, and that a state of emergency due to shootings was issued just days before in an area I'd be driving through: not exactly the most inviting circumstances.

After almost a three-hour delay, we got back on the plane and took off. The flight is a bit over two hours long, so with a two-hour time zone difference, the time on my phone only moved a couple of minutes. I made it through customs, picked up my car, and was off on the Western Highway to San Ignacio.

Given the stereotypes about Belize and news stories I'd read, I was a bit worried, but I was determined to make it to my hotel before sundown without stopping. The highway was one lane in each direction with speed bumps and police checkpoints popping up at irregular intervals. Two hours later, I got to the hotel with roughly 30 minutes to spare before nightfall, walked a few doors down to a restaurant for dinner, then called it a night.

MARCH 29, 2024

Given the two-hour time difference from what my body was accustomed to, I woke up early feeling refreshed and ready to go. I took a walk down to a local park, which was on the Macal River. I immediately spotted some small silvery fish in the calm shallow areas near the bank and walked around a bit to find a more secluded spot where I wouldn't stick out too much.

Figure 1. Bacalar Tetra *Astyanax bacalarensis*

Photos by the author.

Originally from Bayonne, New Jersey, Arthur Kosakowski is a recreational fisherman currently living in Davie, Florida. He has a passion for finding beauty in every fish species no matter the size. Since moving to south Florida four years ago, he has been mesmerized by the vast variety of both native and exotic fish species. You can follow his fishing adventures on his YouTube channel at www.YouTube.com/c/TheFishingNomad.

Figure 2. Sleek Mosquitofish *Gambusia luma*

Figure 3. Yellowbelly Cichlid *Trichromis salvini*

I soon found one of these spots, got my four-piece travel rod set up, rigged up a tanago hook, and put on a small piece of artificially flavored bait. I always like to have some sort of artificial bait with me when I travel because you never know if you're going to be able to find any bait where you go. Prior to my trip, I had tried—and failed—to find places anywhere in the country that might sell fishing bait. I wasn't sure if what I had would work, but as soon as it hit the water a school of small silvery fish were all over it. It wasn't long until I caught my first fish from Belize, some sort of tetra.

I put it in my phototank, took pictures, and looked at it in greater detail. Research before my trip had shown that Belize has three species of tetras (*Astyanax*) that all look nearly identical, so identifying them was going to be a challenge. I remembered that the Macal Tetra *Astyanax macal* was endemic to the Macal River, so I assumed it was that. Unfortunately, this was a perfect example of why making assumptions isn't the best practice. While the Macal Tetra is endemic to the Macal River, its type locality of was listed as the "upper Macal River" (Schmitter-Soto 2017. Journal of Natural History 51(23–24):1331–1424). There was no information as to how far down the river they are found, and even Dr. Schmitter-Soto, the ichthyologist who first described the species, wasn't sure (J. Schmitter-Soto personal communication, 2024). However, after checking some meristics, such as anal fin rays, it turned out that my first species from Belize was a Bacalar Tetra *A. bacalarensis* (Figure 1).

Over the next hour I picked up several more Bacalar Tetras. It was rather easy, as (and I don't think I'm overestimating) there were thousands of them along most of the short stretch of riverbank. Every once in a while, though, I'd see some smaller fish that seemed to be more surface oriented, and I roughly identified them as some sort of mosquitofish. Belize is home to four mosquitofish species, none of which I had caught, so if I could catch one of these, I'd be happy.

The tetras continued to make things difficult. Unbelievably, the tetras were way more aggressive than the mosquitofish, something I don't think I've ever seen before. There were times when the tetras would jump to attack my bait while I was just holding it above the water looking for a mosquitofish to drop it near. Eventually, though, I found a lone mosquitofish away from the tetras and got it to bite. My second species from Belize ended up being the Sleek Mosquitofish *Gambusia luma* (Figure 2).

After a couple more tetras and mosquitofish, I headed back to the hotel, which was about a five-minute walk from the river. It was time to have lunch and relax in the air conditioning for a bit.

In the afternoon I walked back to the Macal River, this time in search of cichlids. While microfishing in the morning, I had spotted a couple juvenile cichlids, but I didn't see any big ones and didn't see too many of them in total, either. I tied on a small one-gram jig with a small one-inch soft plastic stonefly lure and started throwing it around the river.

Rather quickly I had a bite. After pulling it from under a submerged log, my excitement rapidly turned to disappointment. My third species from Belize was a Yellowbelly Cichlid *Trichromis salvini* (Figure 3). Why the disappointment? The Yellowbelly Cichlid is one of the many non-native species that have become established in southern Florida. It is not as widespread or common as some other non-natives, but I've caught a couple dozen of them before this.

After releasing the Yellowbelly, I soon had a much bigger fish take my lure. It was a battle to free it from some sunken branches it wrapped itself up in, but eventually I was able to see it. What I saw here took my disappointment to a whole new level. This fish ended up being a Mayan Cichlid *Mayaheros urophthalmus*. A picture of this individual is not available; Figure 4 shows another Mayan Cichlid I caught later on in the day. The Mayan Cichlid is another one of those non-native species that have become established in Florida. While the Yellowbelly is still somewhat rare, the Mayan is probably the single most common non-native in the state. Oh well.

I fished small lures for a couple more hours and caught another Yellowbelly and a few more Mayans before I had one more hit right before I had decided to call it a day. I was again excited at the prospect of catching a new species, and I was again disappointed. This time it was a Redhead Cichlid *Vieja melanurus* (Figure 5), yet another species that has been introduced to Florida. It is probably even rarer than the Yellowbelly, but it is still one I had caught before.

I couldn't believe it. I caught three different cichlids, and they were all species that I had caught in Florida. What made things worse was that I had seen at least three cichlids that I'd never caught, but those didn't want to bite. I believe they were the Petén Cichlid *Chuco intermedium,* Firemouth Cichlid *Thorichthys meeki,* and Chetumal

Figure 4. Mayan Cichlid *Mayaheros urophthalmus*

Figure 5. Redhead Cichlid *Vieja melanurus*

Figure 6. Macal Tetra *Astyanax macal*

Cichlid *Cryptoheros chetumalensis*. I had four more days in Belize, so I hoped they'd be more cooperative later.

MARCH 30, 2024

Before I checked out of my hotel and moved on to my next stop on the trip, I took one more walk down to the river and fished small soft plastics, hoping to get those other cichlids to bite. Over about an hour and a half, I caught countless Bacalar Tetras and a pair each of Mayan and Redhead cichlids. The action was great, but I was coming up empty handed on the new species again.

After I checked out of my hotel, I had a few hours to kill before I was able to check into the jungle lodge where I would be spending the next night, so I decided to drive even closer to the Guatemalan border and fish the Mopan River near the village of San Jose Succotz. The Mopan and Macal rivers eventually meet to form the Belize River, but it was interesting to see the differences between the two. The Macal was mainly sandy with smaller rocks and somewhat clear water, but the Mopan had larger rocks, solid bedrock ledges, and crystal-clear water. In a couple hours of fishing, I again caught countless Bacalar Tetras but nothing else. I did see what I believe were Petén and Firemouth cichlids, but they wouldn't bite and were beat to any lures or bait by the tetras.

I wrapped things up and drove to the village of Cristo Rey and the somewhat primitive jungle lodge. I got a quick orientation from the lodge host about the Howler Monkeys *Alouatta palliata* in the area and some other unique critters that roam the forest, put my belongings in my room, got a quick lunch at the restaurant next door, which was just someone's house with tables and chairs in the front lawn, then grabbed my gear and headed to the river.

This lodge was situated right on the Macal River, but there were still several new species to be caught. Since it was nearing sunset, the plan was to catch some tetras and use them as bait for catfish. Wouldn't you know it? The one time I actually wanted to catch the tetras, I couldn't. For some reason, in this spot the tetras were on the smaller side. The adults or even medium-sized tetras that I'd seen all over in the previous spots were few and far between here. I ended up only catching three, but I hoped that would be enough. I spent about an hour after sunset dunking chunks of Bacalar Tetra on the bottom of the river and I did have some bites, but hooked nothing. Out of bait and disappointed, I headed back up hill to the lodge.

Being a primitive lodge, there was no air conditioning. I hadn't realized this when I booked my stay, but at this point I was stuck with it. The room was unbearable during the day. Now it was slightly better, but still unbearable. The bed was comfortable, but I didn't even bother getting under any covers. At some point during the night it cooled off and actually got a bit chilly. This and the loud Howler Monkeys and other jungle animal sounds kept waking me up, but soon it was morning and time to get back to fishing.

MARCH 31, 2024

After a day and a half without any new species, I was determined to catch at least one new species today. I decided to drive up into the Maya Mountains and fish the upper stretches of the Macal River. After catching only Bacalar Tetras in the stretches of the river I had fished so far, I wanted to go as far upstream as I could, which I thought would give me a good chance of catching the Macal Tetra.

Google Maps said the 56-kilometer drive—yes, Google Maps uses kilometers when in Belize—should take about an hour and a half. Doing the quick conversion in my head I was confused why it would take so long to go 34 miles. Surely it was a mistake. I was going to drive more than 23 miles per hour, right?

The first part of the drive was smooth. While the Western Highway is only a single lane each way, it is paved and easy to drive. Soon, however, the pavement ended and I was on a bumpy dirt road, which was supposed to be one lane in each direction but was really only wide enough for one car at a time. Now I understood why this seemingly short drive would take so long.

After roughly an hour of uncomfortable driving and two police checkpoints, I arrived at my spot on the upper Macal River.

This stretch of river was different from the lower stretch I had been fishing for several days. The water was clearer, and the topography was rockier. Just as in the lower river, however, tetras were plentiful. It was easy to catch my first and, after doing a quick anal ray count, I confimed I had my first Macal Tetra of the trip (Figure 6).

Over the next two hours, I caught countless Macal Tetras and struck out with everything else I saw. There were a few cichlids: one Yellowbelly and a few that I believe were Chetumal Cichlids. The closest I came to catching either was when the Yellowbelly repeatedly attacked my split-shot sinker and refused to acknowledge the piece of bait next to it. The most frustrating part, though, came when I found a school of some sort of killifish or livebearers. I couldn't get a great look at them, but I spent more time than I'd like to admit trying (and failing) to get them to bite. I could see them picking algae off the rocks and even tried putting some of that on my hook, but that didn't work either. Oh well.

I wrapped it up and headed back out on the dirt roads. The destination this time was Caves Branch River, which was located just south of Belmopan, Belize's capital. The two-hour drive went smoothly once I got onto the paved highways.

Upon arriving, I once again spotted countless tetras. Looking around, I also saw Mountain Mullet *Dajaus monticola* and

Figure 7. Rock Catfish *Rhamdia laticauda*

Figure 8. Petén Cichlid *Chuco intermedium*

Figure 9. Yucatan Mosquitofish *Gambusia yucatana*

Blackbelt Cichlids *Vieja maculicauda*. Both are species I'd never caught, so I was excited to fish. I tied on my one-gram jighead tipped with a small stonefly lure and instantly caught a Bacalar Tetra (should I have expected anything else?) but the commotion of the lure and attacking tetras drew the attention of two catfish. Catching catfish on a lure is tough enough, but it was even harder with all these aggressive tetras around. Somehow, though, my lure sank to the bottom, a catfish slurped it up, and the fight was on. This fish made me work a bit, but after a short fight it was on the rocks. My second new species of the day was a Rock Catfish *Rhamdia laticauda* (Figure 7). I fished for a while longer with a variety of lures and baits but didn't catch anything but more tetras. The Blackbelt Cichlids showed interest once in a while but never committed to anything, while the Mountain Mullet ignored everything I threw at them.

It was getting late, and it was time to drive to my next resting spot, a more modern jungle lodge with TV, air conditioning, and a restaurant. Best of all, it was right on the banks of the Belize River. My original plan was to do some catfishing at night, but since I had already caught a catfish, I decided to call it a night early and relax.

APRIL 1, 2024

I again woke early and walked down to the river to fish. I saw more tetras than I wanted to, but also saw cichlids on the bottom. I tied on a small jig with a one-inch swimbait and started casting. On my second cast I got a good bite and pulled in a beautifully colored Redhead Cichlid. My second fish of the day was a Yellowbelly Cichlid caught on dough bait. I was unable to entice the smaller cichlids on the bottom with dough bait and was getting frustrated with catching the same three cichlids over and over no matter what I tried.

Over the next half hour I caught roughly a half dozen Redhead Cichlids on small lures, and then it happened. I got a good bite right next to a submerged tree where I had caught a couple Redheads. I was sure this was yet another one, but it wasn't. To my amazement, I pulled in my first Petén Cichlid of the trip and added another new species to my lifelist (Figure 8). I fished for a few more minutes and caught a few more Redhead Cichlids before it was time to check out of the lodge and get back in the car.

This was my last full day in Belize. I had booked a hotel in Belize City to be close to the airport. I didn't have a plan for where to fish, so I just started driving toward Belize City, hoping to find some water along the way. I spotted a small roadside ditch near Ladyville, just outside of Belize City and stopped for a quick peek at the water and saw mosquitofish. Knowing there were three mosquitofish species in Belize I hadn't caught, I had to get the rod out and try to catch one.

I tipped my tanago hook with a garlic-scented fly larvae imitation and floated it on the surface. I was looking for larger mosquitofish that could take the bait and hook in their mouths easily, but none seemed to be around. Thankfully, though, these mosquitofish were aggressive enough that even the smaller ones were easy to hook. I quickly pulled in my first Yucatan Mosquitofish *Gambusia yucatana* (Figure 9) of the trip and of my life. In 45 minutes at this spot I caught several more Yucatan Mosquitofish and (of course) a duo of Bacalar Tetras before continuing my drive.

A short drive later I entered Belize City and stopped at a coastal park. I took a quick walk along the rocky shoreline, trying to spot some fish that would make me want to take my rod out of the car, but I couldn't see any. I did see Gray Snapper, Schoolmaster Snapper *Lutjanus apodus,* and French Grunt *Haemulon flavolineatum*. As expected, most of the fish present here were the same ones found in Florida. No, thank you. I headed back to the car, drove a few minutes to my hotel, and spent the rest of the day relaxing.

APRIL 2, 2024

I woke up earlier than I would have liked, but I wanted to make sure I had enough time to return the rental car, check my luggage, and get through airport security. I again greatly overestimated how much time I'd need to accomplish everything, but I'd rather be safe than sorry. Sitting at the gate I had a chance to think about the past several days. I had a rough goal of catching eight new species during my Belize road trip. Though I had caught nine species, only six were new additions to my lifelist. I can't say I was too disappointed, though. I got to spend several days exploring a new country, enjoying nature, and, of course, catching some fish. I'd say any time you can accomplish all three of those things you've succeeded.

Soon enough I boarded the plane, flew back to Miami, and made it home in time to drop off my luggage and change clothes before working an evening shift at one of my five jobs. I have to pay for my travel and fishing addictions somehow, right?

2023 NANFA RESEARCH GRANT REPORT

FRESHWATER MUSSEL SHELLS AND *NOTURUS* MADTOMS IN ONTARIO: A RARE OPPORTUNITY FOR THE CONSERVATION OF TWO AT-RISK GROUPS

Owen Ridgen

Toronto, Ontario

INTRODUCTION

The madtoms, genus *Noturus*, are a large and diverse group of freshwater catfishes endemic to the eastern portions of the United States and Canada. Many species have highly restricted ranges and are significantly specialized for their habitats. This, combined with their secretive nocturnal habits and low tolerance for adverse water conditions, makes them a poorly understood and vulnerable group. In Ontario, five species are known. Of these species, two—the Stonecat *N. flavus* and the Tadpole Madtom *N. gyrinus*—are widespread. The status of another, the Margined Madtom *N. insignis*, is disputed as it is currently unknown whether this species has an extremely limited and fragmented Canadian range, or if it has simply been introduced (Government of Canada 2015). The two species that remain—the Brindled Madtom *N. miurus* and the Northern Madtom *N. stigmosus*—are restricted to the southern parts of the province, including much of the Carolinian zone, and generally rarer. The Northern Madtom, especially, is considered to be one of the rarest fish in Canada and is listed as Endangered in Ontario (Government of Ontario 2014c). These tiny catfishes make up half of the basis of this study.

The other half of this study is represented by the vast assemblage of freshwater mussel (Unionidae) species that inhabit the streams and rivers of Ontario alongside the madtoms. Like the madtoms, these mussels are under-studied and, also like many species of madtoms, they are very sensitive to alterations in their aquatic habitats. In fact, it is believed that a staggering 70% of North America's freshwater mussel species are either officially listed as threatened/endangered or in decline (Salerno et al. 2018) In Ontario alone, 19 species are designated species at risk (Hayward et al. 2022). Nine of these are endangered just like the Northern Madtom. The associations and inter-relationships between these two entities, however, do not end there; they go far deeper.

The idea for this study came from an observation made by the author in 2020 while assessing populations of freshwater mussels in the Thames River, a prominent aquatic feature of south-central Carolinian Ontario (the life zone in southern Ontario characterized by a rich biodiversity). The species targeted in the survey were the Mapleleaf *Quadrula quadrula* and the Threehorn Wartyback Mussel *Obliquaria reflexa*; these species are listed as special concern and as threatened, respectively (Government of Ontario 2014a,b). Though several living Mapleleaf specimens were quickly located, the most significant observation of the day, at least for the purposes of this study, was still to come. A large, dead mussel shell had just been plucked from the sandy river bottom and was being held up to identify it. Upon being opened to observe the interior structures, an adult Brindled Madtom slid out from inside the shell (Figure 1). The relationship between mussels and some larger catfishes, where the fish spread the mussel's parasitic larvae, which have attached to their fins or gills, is well known (Howard 1913; Steingraeber et al. 2007). A relationship between catfishes (specifically, madtoms) and dead mussel shells, however, has been less frequently examined, indeed to the point where it was unclear to the author whether such an interaction had ever been previously recorded. The answer as to why the fish was inside the shell seems obvious in hindsight; however, it is clear that the shell would provide an excellent hiding place and a good source of physical protection. It made perfect sense that a small, vulnerable fish such as a madtom would take shelter in such a tailor-made sanctuary. And if one species of madtom would use such a shell for shelter, could not others do so? How widespread was this behavior? Preliminary research revealed a 2020 study done by Jacob Brumley and

This is an abridged version of the report submitted by Owen for the 2023 NANFA Research Grant he was awarded. For a complete copy, please contact the editors.

Owen Ridgen has a BSc from the University of Toronto in biodiversity and conservation biology. He is a dedicated naturalist with years of field experience in several cross-disciplinary fields, including leading groups through educational biological workshops, surveying and assaying flora and fauna, graphic design, photography, and writing. Owen discovered and documented Canada's first record of the Cranefly Orchid, did botanical inventory work for newly acquired Long Point Basin Land Trust properties, procured specimen vouchers for the poorly known parasitic fungus *Massosporra diceroproctae* in Florida, and did an investigation into communities of aquatic microorganisms along a rural/urban gradient in the Rouge River in Toronto.

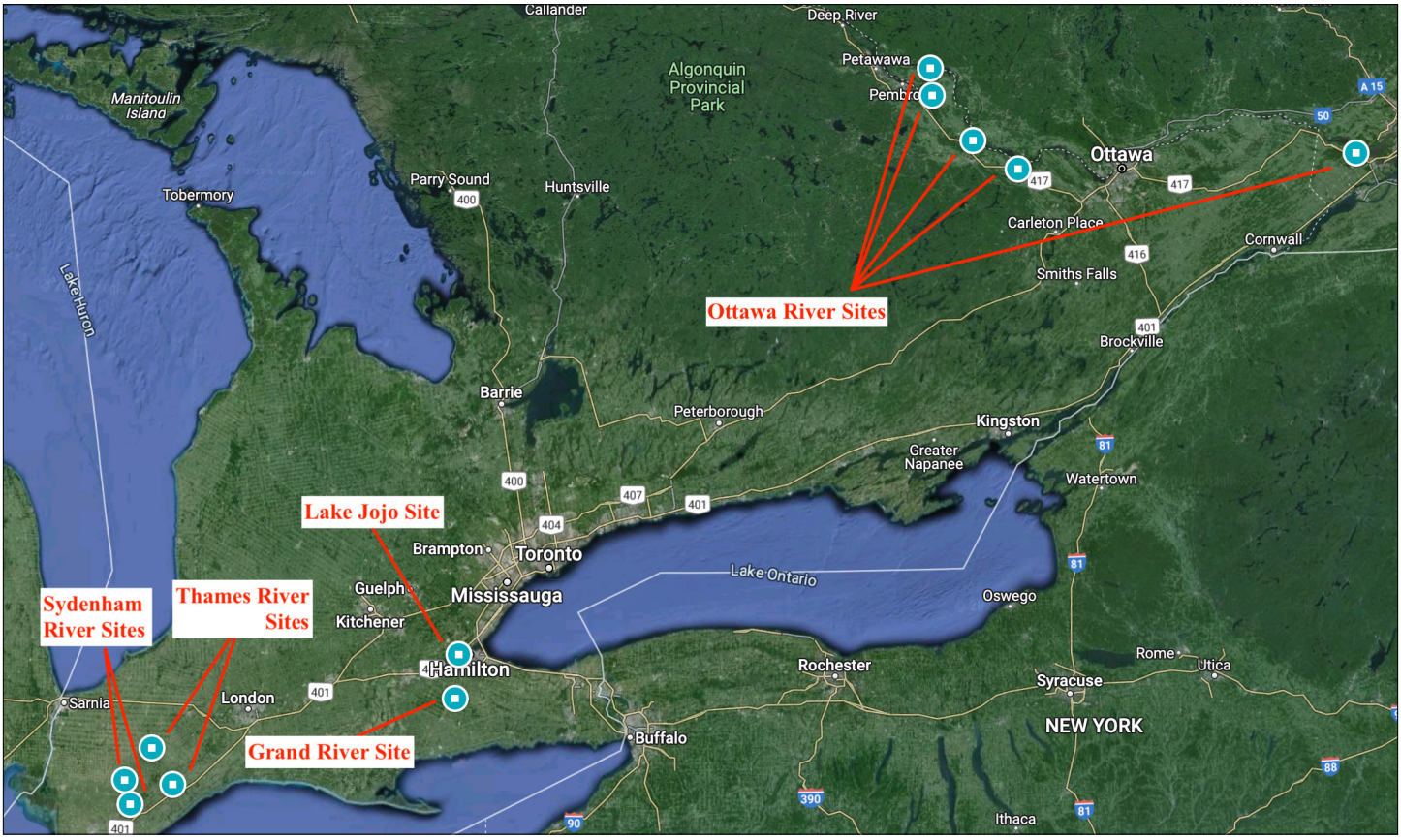

Figure 1. Locations surveyed for madtoms in southern Ontario.

Philip W. Lienesch in Kentucky (Brumley and Lienesch 2020) where they observed madtoms in the Green River using dead mussel shells as cover. They predicted that madtoms would be more willing to utilize mussel shells for cover than other objects such as the river's rock substrate. The results of their study supported their prediction. Furthermore, they postulated that, since mussel shells appeared to play such a vital role in the life history of these madtoms, declines in mussel populations could thus affect madtom populations as well.

But no such study (extensive or otherwise) had been performed in Ontario; so, it was impossible to say if this behavior was widespread here as well. And, if the results of the Lienesch and Brumley study held true in Canada as well, then it is possible that declines in the populations of native mussels here could also account for reductions in the populations of local species of *Noturus*. The central question of this study is then a logical next step: Could the loss of native mussel populations in Ontario be affecting populations of *Noturus* by removing potential homes and/or shelter from their environment as is hypothesized to be occurring in Kentucky?

Figure 2. Brindled Madtom captured at the Alvinston site in 2020.

In order to address this question, and due to a limited budget and lack of a research team, it was necessary to reduce the study to one, far simpler component, which would hopefully act as a stepping stone allowing more research to be done in the future. The more fundamental question was then as follows: **Do the madtoms of Southern Ontario (namely the Stonecat, Tadpole, Brindled, and Northern madtoms) make significant use of mussel shells for shelter in Ontario as they do in Kentucky?** Answering this question would allow for the establishment of a more robust understanding of potential interactions between madtoms and mussels in the province and would provide a jumping off point for assessing whether or not a reduction in freshwater mussel populations and consequently in accumulated dead mussel shells in southern Ontario rivers is a heretofore under-appreciated threat to *Noturus* populations. After all, without knowing whether the behavior recorded at the Thames River in Ontario in 2020 and in the Green River in Kentucky is widespread or commonplace, speculating further will likely be counter productive. The point of this study is not to answer with any certainty whether a loss in what will hereafter be termed "habitat mussels" is affecting populations of at-risk madtoms. Answering that question would require a far longer-term study and likely a budget far greater than a single grant could support. This study instead was designed to provide results and data that can support future research. It is hoped that the results of this study and any that may follow may help us gain a deeper understanding of the larger role of freshwater mussels in the aquatic ecosystem.

STUDY SITES

For this study, 11 river sites in four different southern Ontario watersheds and one isolated small lake (Figure 2) were sampled from May to August 2023 (with one extra day of sampling performed previously in October 2022). The sites were chosen for their accessibility and for their location within river drainages with the largest and most diverse assemblages of both freshwater mussel species and madtoms.

1. **Sydenham River (two sites):** This river is well-known as having the greatest diversity of freshwater mussels anywhere in the country (Metcalfe-Smith et al. 2003) and has significant populations of the Brindled Madtom and Stonecat. It also used to be home to the Northern Madtom, although it is probably extirpated (Government of Canada 2016).
2. **Thames River (two sites):** Like the Sydenham, the Thames once contained a massive assemblage of freshwater mussels, historically containing somewhere around 34 species, although it is now much more degraded than the Sydenham, having lost about one third of its mussel population (Metcalfe-Smith et al. 1999). It is one of the few rivers in Ontario, however, still known to host the Northern Madtom.
3. **Grand River (one site):** The Grand River is less diverse in mussel species than the Sydenham and the Thames but still contains very large populations, including some rare species such as the Threehorn Wartyback (Goguen et al. 2023).
4. **Ottawa River (five sites):** The Ottawa River, being far larger, deeper, and more northerly than any of the other waterways examined, presents distinctly different assemblages of both mussel and madtom species. Brindled and Northern madtoms are not found here, but Stonecat are, and Tadpole and Margined madtoms, which generally do not occur in the other watersheds, can be found in the Ottawa and its tributaries (personal experience). Many of the species of mussel found in the Carolinian Rivers are also absent here, but they are replaced by other at-risk species such as the Hickorynut *Obovaria olivaria* (LeBaron et al. 2018) and the Elephantear *Elliptio crassidens* (personal experience). In addition, the clarity of the water is much greater here than at the other three rivers, making underwater surveying in the area much easier.
5. **Lake Jojo (one site):** In addition to the aforementioned river sites, Lake Jojo, in Dundas, Ontario, was also surveyed. The trip to this site was primarily meant to investigate the status of a transplanted population of the provincially-threatened Lilliput Mussel *Toxolasma parvum* (Campbell 2022), but an eye was kept open for the possibility of any madtoms in the area. The site is a shallow, highly silty small lake with a thick layer of mud/clay as its substrate. The lake tapers to a small, sandy creek at the west end, and its water clarity is much increased compared to the rest of the lake.

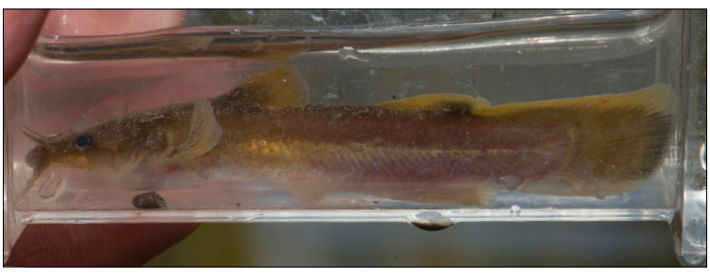

Figure 3. Stonecat captured at the Thamesville site in 2022.

SAMPLING TECHNIQUES

A variety of sampling techniques were employed across the sites. Due to highly variable conditions across these sites such as depth, water clarity, and substrate, not all of these techniques were applicable at every site. The four major sampling strategies employed were as follows:

6. **Snorkeling:** Snorkeling at the study sites was one of the first methods attempted in this study. The idea was to slowly crawl along the bottom of the river or stream in the shallower riffles, carefully and methodically looking for any species of madtom and inspecting large dead mussels on the bottom by slowly lifting them up and determining whether a *Noturus* or other organism was sheltering within.
7. **Camera Trapping:** In order to overcome both the issue of poor water clarity and the possibility of scaring potential subjects by snorkeling, the idea was proposed to leave an underwater camera in a promising location, facing towards one or more large mussel shells on the bottom found in situ with good potential to provide shelter for madtoms.
8. **Dipnetting:** A "last resort" technique, it was hoped that by dipnetting, it might be possible to scoop up large shells along with any potential occupants before they were able to flee. This was, after all, how the Stonecat in the Thames originally observed by the author was discovered.
9. **Visual Surveys:** A blanket method that would be the easiest to employ, but it would consequently provide the least amount of hard data. Any observations made in or out of the water from a position not immersed in the water fall under this category. It was hoped that at sites with water too turbid to survey effectively by snorkeling, looking down from above the water and walking slowly upstream may have been a viable alternative. In addition, examination of shells at the river margins or on the immediate shoreline would be used to assess the viability of mussels in the area as shelter/habitats.

RESULTS

Only two madtoms were observed throughout the entire study: both were Stonecats (Figure 3), both were found at the Thamesville site, and both were caught by dipnet. None were observed during visual surveys, snorkeling surveys, or camera trapping. It is unknown if the two specimens caught were utilizing mussel shells as shelter at the time of capture. Mussel shells of sufficient size and orientation for providing adequate shelter/habitat for madtoms were observed at virtually every location, however, and at several of these sites other species of fish or invertebrates were observed to make use of the shells. Around 23.5 hours were spent on-site surveying across the study locations.

AN OBSERVATION ON INTERACTIONS BETWEEN THE LAKE SPONGE *SPONGILLA LACUSTRIS* AND THE EASTERN ELLIPTIO *ELLIPTIO COMPLANATA*

At both the Westmeath Site and the Sandbar Site, Eastern Elliptio was found encrusted with Lake Sponge (Figure 4), one at

Figure 4. Lake Sponge on Eastern Elliptio.

Westmeath, and three at Sandbar. The first mussel consisted of a dead shell, while the latter three were all alive. These observations raise several questions: does Lake Sponge encrust only the Eastern Elliptio? What is the relationship between the sponge and the mussel? Is it commensal, parasitic. or beneficial? Several studies, including those by Ricciardi et al. (1995) and Lauer and Spacie (2004), recorded that freshwater sponges would encrust and outcompete introduced Zebra and Quagga mussels in the Great Lakes, but no study appears to have made similar observations regarding the interactions between native mussels and the sponges. A potential investigation of this observation might be fairly cost-effective and relatively simple. A comparison of size and growth patterns in live mussels with and without encrusted Lake Sponge would begin to inform whether or not the sponges are having any kind of effect on the mussel's fitness, and more intensive surveying would be sufficient to discover if any other species are selected by the sponges as "hosts." There is certainly much to be learned here, and potential for an informative and unique study abounds.

CONCLUSIONS

No madtoms were observed using mussel shells at any of the 11 surveyed sites. This may seem to support the idea that habitat shell use by madtoms is not widespread. When taking into account the fact that only two madtoms were captured in total (both Stonecat, and both at the Thamesville site), it becomes clear that the central question of this study, "Do the madtoms of southern Ontario make significant use of mussel shells for shelter as they do in Kentucky?" can regrettably not be answered one way or another at this time. However, several other observations made during the course of this study are able to fill in some of the peripheral picture, so to speak. At the Alvinston, Florence, and Caledonia Sites, multiple crayfish, as well as stonefly, beetle, and caddisfly larvae, were found inside mussel shells, showing that the use of such shells as shelter for adult and developing invertebrates is widespread at these sites. In addition, at the Alvinston Site, Johnny Darter *Etheostoma nigrum* were observed laying eggs inside mussel shells. And, at the Caledonia Site, either a darter species or a Round Goby *Neogobius melanostomus* was observed to shelter inside a habitat shell by the Camera Trap. Again, this does not say anything about these species' preference for using shells or other forms of cover, but it shows that the use of habitat shells is occurring in some capacity.

Regardless of the shortcomings of this study, the author's hope is that their efforts will provide a knowledge base for future research. Valuable data on the presence and absence of mussel and fish species at the 11 sites has indeed been obtained, and this data can be put to use in future, more extensive projects. Future researchers will be able to look to this study for reference regarding potential sampling sites or techniques, and they will be able to use this report to foresee and address complications such as heavy turbidity. The possibilities are endless. If nothing else, the results of this study have certainly provided the author with a far greater understanding and appreciation of the riverine habitats he investigated than he ever thought he could have. This study is far from over; the author would like to continue it, and this project should provide a good starting point for future research.

ACKNOWLEDGEMENTS

The author would like to thank his "team," namely David Ridgen and Katherine Kneller, for their invaluable support and assistance with virtually every aspect of this project. It would not have been possible to complete the project without them. The author would also like to extend a sincere thanks to NANFA for sponsoring this project and to the Long Point Basin Land Trust for allocating the funds provided by NANFA.

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(Continued on page 13)

2022 CORCORAN GRANT REPORT

CONNECTING WITH SALMON

Kyle Robillard

Chugiak, Alaska

INTRODUCTION

From July 31 to August 4, 2023, the Land and Environment Department of the Native Village of Eklutna (NVE), Alaska, hosted their annual Culture Camp with several days focused on salmon. The activities of the salmon days were meant to instill an appreciation for the salmon, educate youth on salmon habitat in the aquatic ecosystem and their life cycle, learn identification of adult and juvenile salmon, and learn some traditional harvest and preparation methods from tribal elders. The activities were made possible through a NANFA Gerald C. Corcoran Education Grant and by funding from the Bureau of Indian Affairs Youth Initiative Program and from the US EPA Environmental Indian General Assistance Program.

BACKGROUND

The Native Village of Eklutna is located a short distance north of Anchorage near the Eklutna River and the Knik Arm of the Cook Inlet. The area has been settled for at least 800 years, and the Village was located to take advantage of the once bountiful runs of salmon in the Eklutna River. Unfortunately, the river's hydrology has been disrupted for close to 100 years due to hydroelectric development. The first dam went up in 1929 and cut salmon off from eight miles of river, Eklutna Lake, and its upper tributaries.

Figure 1. Sorting macroinvertebrates.

Photos by the author unless otherwise indicated.

Kyle Robillard is an Environmental Technician in the Land and Environment Department, Native Village of Eklutna, Alaska.

Figure 2. Some of the bugs that were collected.

Figure 3. Net mending demonstration. (Photo by Jeff Chen)

A second dam was placed at the lake's outlet in 1955 and effectively cut off the Eklutna River from its main water source, thus further diminishing the habitat available for its salmon. Most of the remaining flow comes from one large tributary, Thunderbird Creek, located about 2.5 miles upstream from the river's mouth.

The Eklutna People once thrived on the abundant salmon that the river provided. Stories passed down from elders tell of large runs of Chinook *Oncorhynchus tshawytscha*, Coho *O. kisutch*, and Sockeye *O. nerka* salmon, as well as Chum *O. keta* and Pink *O. gorbuscha* salmon. The Eklutna system still harbors these fish but in much diminished numbers due to the low flow levels and resulting lack of habitat. Salmon are still very important to the culture and lifestyle of the people of Eklutna, but harvest takes place elsewhere. An educational fish net permitted through the Alaska Department of Fish and Game provides some local opportunity, but otherwise families often travel hundreds of miles to participate in meaningful fishing opportunities, as Eklutna River salmon are too scarce to support a fishery.

NVE started hosting a weeklong Culture Camp in 2021. Activities have focused on traditional skills and ecological knowledge of culturally important natural resources, such as edible and medicinal plants and, of course, salmon. In 2023, additional focus was devoted to salmon and the Eklutna River. Topics included salmon habitat needs throughout their lifecycle, juvenile identification, macroinvertebrate identification, traditional salmon harvest methods, and preparation/preservation.

SALMON DAYS

The first of the salmon days began with a 1.5-mile hike from the NVE powwow grounds to the Eklutna River. While battling voracious mosquitoes, participants learned about the history of the hydroelectric development impacts on the river and its salmon, as well as some wildlife track and plant identification along the way. Once arriving at the river, salmon habitat needs in fresh water were discussed including requirements and preferences for both rearing and spawning. Once students had a grasp of the habitat requirements for juveniles, we checked the minnow traps that were set the previous night. Before checking each trap, we discussed the positive and negative features of each site from a salmon rearing perspective. We then transferred the fish from the trap to an aerated bucket for processing. The students were able to see Coho and Sockeye salmon juveniles, as well as Threespine Stickleback *Gasterosteus aculeatus*.

After the minnow traps were checked, we turned our attention to macroinvertebrates. We collected leaf packs that had been placed in the river four weeks prior to allow for colonization. While collecting the packs, we were able to observe Pink Salmon spawning nearby. We also collected a few small cobbles from a riffle to examine for macroinvertebrates. The youth enjoyed picking through the leaf packs and discovering the abundance of life the stream holds. They observed mayflies, stoneflies, caddisflies, leeches, and midges. (Figures 1,2)

After we were finished with the macroinvertebrates, we hiked back to the powwow grounds, where Eklutna President Aaron Leggett spoke about traditional activities, including fishing. He showed photos of Dena'ina fish spears and fish traps which were once used to harvest salmon. Next, a net mending demonstration was presented by one of the Eklutna elders (Figure 3). Participants

Figure 4. Some of the salmon harvest. (Top photo by Jeff Chen)

Figure 5. Cut strips of salmon drying. (Photo by Jeff Chen)

learned the mending process and the proper knots to use while they made a new set net for use in the Educational Fish Net Fishery, a program permitted through the Alaska Department of Fish and Game.

Early the next morning, one of the Village elders set the Educational Fish Net during low tide in the Cook Inlet in Eklutna's designated fishery site. In the early afternoon the net was checked, and the fish were harvested; a nice mix of Coho and Sockeye was captured (Figure 4). An elder taught her method of fish cutting and taught how to brine, smoke, and dry the catch (Figures 5 and 6). The meat was stripped, brined, and smoked along with the backbones, and the heads and eggs were set aside to make a traditional fish-head soup, which was served with lunch the following day. After several days of smoking and drying, the strips and backbones were taken home by participants and donated to elders.

CONCLUSION

NVE's 2023 Culture Camp was a great success, and the salmon activities were extremely well-received. It was our most well-attend-

Figure 6. Salmon drying and being smoked. (Photo by Jeff Chen)

ed Camp to date, averaging approximately 60 participants per day. The youth participants came away with increased knowledge and appreciation for salmon and the cultural significance they have for the Eklutna People. It was a great opportunity to connect both youth with elders and the past to the present. We thank NANFA for awarding the Gerald C. Corcoran Grant funds to help facilitate these educational activities, which will be continued and expanded into the future.

If you would like to learn more about the Eklutna River and the ongoing effort to restore flows to save the salmon, please visit eklutnariver.org, and consider pledging your support and raising awareness to this important effort.

(Mussels and Madtoms, continued from page 10)

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ACROSS THE GREAT DIVIDE: FISH MOVEMENTS BETWEEN THE GREAT LAKES AND MISSISSIPPI RIVER BASINS AT PORTAGE, WISCONSIN

John Lyons, Dave Marshall, Tim Larson, Joshua Knuth, Brandon Oberleitner

If you're fascinated by the wonderful variety of fishes found across North America (why else would you be reading this?), it's hard not to be interested in biogeography, the study of the distribution patterns of plants and animals and the processes that determine these patterns. For freshwater fishes, one of the key questions in biogeography is if and how various species have been able to move from one river basin to another. Although the headwaters of two bordering basins may be very close as the crow flies, their mouths could be at different ends of the continent, and moving from one to the other via water would require traveling many miles downstream out of one basin and then many miles upstream into the other, often through long stretches of unsuitable habitat. Consequently, adjacent river basins may have very different fish faunas with little or no overlap in species composition despite close proximity and similar environmental conditions.

Yet, fish do sometimes move directly from one basin to the other through adjacent headwaters without the aid of people, resulting in these basins having multiple species in common and occasional genetic exchange. Typically, this type of fish movement takes place in mountainous areas via "stream capture" caused by erosion and landslides that divert a small stream from one basin into the other and in flatter areas via direct but temporary water connections across low-lying divides during periods of high water. Temporary connections are often a feature of northern regions shaped by the most recent ice ages, where past glaciation has steam-rolled the landscape and sometimes resulted in poorly defined wetland boundaries between watersheds.

Photos by John Lyons.

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THE PORTAGE CONNECTION

An important temporary connection between the Mississippi River Basin and the Great Lakes Basin was, until 73 years ago,

Figure 1. The Wisconsin River near Portage.

Figure 2. The Fox River near Portage.

Figure 3. Map of Wisconsin showing major rivers, lakes, and locations mentioned in the text.

Figure 4. The levee at Portage, started in the 1890s and finalized in the 1930s, which prevents flooding from the Wisconsin River from entering the city and the nearby Fox River.

Figure 5. The Portage Canal, photographed in 2023, linked the Wisconsin and Fox rivers from the 1850s until 1951. The canal, just under two miles in length, is now blocked at the Wisconsin River end, located just behind the view in this photo, but still connects with the Fox River.

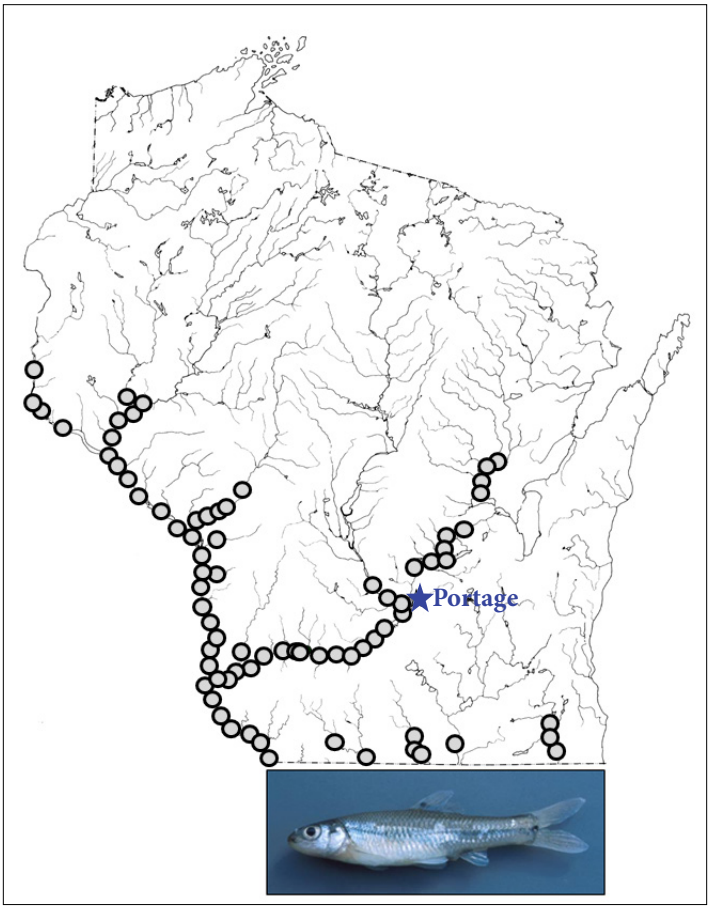

Figure 6. An example of a fish species distribution pattern, for the Bullhead Minnow, that suggests a colonization of the Great Lakes Basin from the Mississippi River Basin via the Portage connection.

found at the small city of Portage in south-central Wisconsin. Here, the mainstem of the Wisconsin River (Figure 1), a major tributary of the Mississippi River, passes about a mile from the headwaters of the Fox River (Figure 2), a major tributary of Green Bay and ultimately Lake Michigan (Figure 3). This area is flat and swampy and appears to have long served as a route for fishes to move between the two basins. The Wisconsin River is situated a few feet higher in elevation than the Fox River, and there are historical accounts of water from the Wisconsin flowing directly into the Fox during floods, an obvious conduit for fishes to move across the divide (Lyons et al. 2000). This flood diversion was a regular event until the first levees were built near Portage in the 1890s and continued sporadically during the largest floods until the levees were raised and strengthened in the 1930s (Figure 4).

The close connection between the Wisconsin and Fox rivers was the reason Portage was founded and given its name. For thousands of years, Native Americans would carry their canoes at this spot when moving between the two river systems. The early French explorers Joliet and Marquette came up the Fox River from Green Bay and first entered the Mississippi River by this route in the 1600s and early 1700s. In the 1850s, the crossover had become important enough for travel and commerce that a canal with locks of almost two miles in length was constructed so that boats could move directly between the two rivers (Figure 5). At about this same time, railroads became widespread in Wisconsin and reduced the demand for water routes to carry people and goods within the state, and Portage never became the transportation hub that city residents had hoped. But the canal remained operational until it was finally closed and sealed off from the Wisconsin River in 1951. In its nearly 100 years of existence, many fish undoubtedly used the canal to move between the Wisconsin and Fox rivers (Becker 1983).

FROM THE WISCONSIN RIVER TO THE FOX RIVER

At least 37 fish species may have colonized part of the Great Lakes Basin from the Mississippi River Basin by crossing over at Portage from the Wisconsin River into the Fox River (Lyons and Schmidt 2022). The evidence for this consists of a broad distribution of these species in the Mississippi River Basin including the Wisconsin River near Portage combined with a more localized distribution in the Great Lakes Basin, often limited to just the Fox River watershed and perhaps a few other nearby tributaries to Green Bay and adjacent Lake Michigan.

For instance, the Bullhead Minnow *Pimephales vigilax* is ubiquitous in the larger rivers of the Mississippi River basin including the Wisconsin River near Portage (Figure 6). However, it is absent from the entire Great Lakes Basin except for the Fox River and its largest tributary the Wolf River, both in Wisconsin, despite the presence of apparently suitable large-river habitats elsewhere in the Great Lakes Basin in Wisconsin, Michigan, Indiana, Ohio, and Ontario. This suggests that the Bullhead Minnow crossed over from the Wisconsin River to the Fox River at Portage relatively recently or at least within the previous 6,000 years. That was when the last of the once multiple post-glacial (i.e., beginning about 12,000 years ago) permanent connections between the Mississippi River Basin and the Great Lakes Basin, which occurred near present-day Chicago between the upper Illinois River and Lake Michigan, finally closed (Bailey and Smith 1981). If Bullhead Minnow had used the Chicago or other earlier connections, they would be expected to be far more broadly distributed within the Great Lakes Basin today.

As another example, the Western Sand Darter *Ammocrypta clara* is also found widely within the larger rivers of the Mississippi River Basin including the Wisconsin River, but it occurs in the Great Lakes Basin only in the Wolf River in Wisconsin and in the Menominee River, another Green Bay tributary on the border of Wisconsin and Michigan, again despite apparently suitable habitat elsewhere in the Great Lakes Basin (Figure 7). The population in the Menominee River occurs upstream of two dams that are impassable to upstream fish movement and that have been in place since the early 1920s, indicating that the colonization of the Great Lakes Basin by this species must have occurred more than 100 years ago but probably less than 6,000 years ago.

FROM THE FOX RIVER TO THE WISCONSIN RIVER?

There is little dispute that many Mississippi River Basin fishes used the Portage connection to gain access to the Great Lakes Basin (Becker 1983; Lyons et al. 2000; Lyons and Schmidt 2022). But did the opposite also occur: did some Great Lakes Basin fishes use the connection to colonize the Mississippi River Basin or at least the Wisconsin River watershed? The evidence for this would be a

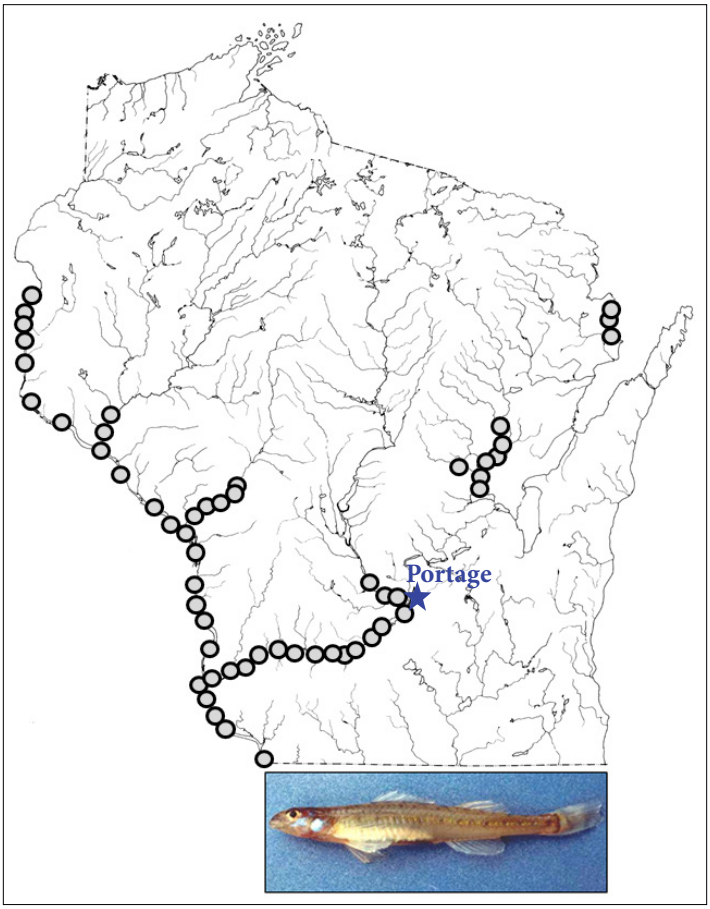

Figure 7. Another example of a fish species distribution pattern, for the Western Sand Darter, that suggests a colonization of the Great Lakes Basin from the Mississippi River Basin via the Portage connection.

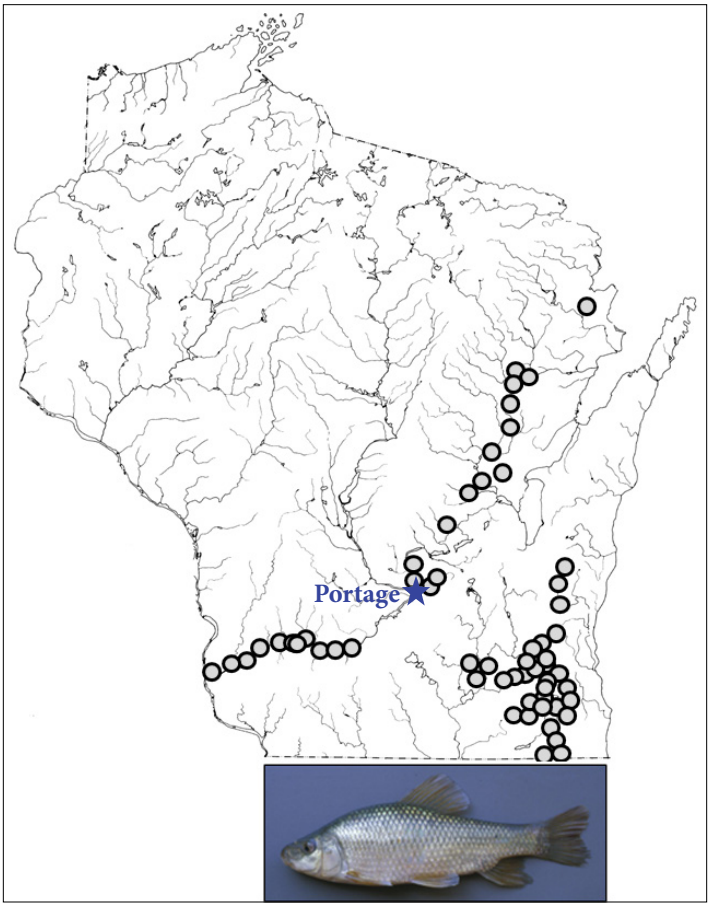

Figure 8. An example of a fish distribution pattern, for the Lake Chubsucker, that suggests a colonization of the Wisconsin River watershed from the Fox River via the Portage connection.

broad distribution in the Fox River watershed near Portage and elsewhere in the Great Lakes Basin and a more limited distribution in the adjacent Wisconsin River and points downstream. To our knowledge, no one has really considered this question, but as we have studied the biogeography of Wisconsin fishes, we have wondered whether this movement may have occurred for a few species. Let's delve into this in more detail for the four species that are most likely.

Lake Chubsucker *Erimyzon sucetta* (Figure 8):

Lyons and Schmidt (2022) felt that the Lake Chubsucker had colonized the Fox River from the Wisconsin River, but in doing more collecting and examination of distribution records in both systems, we are now not so sure. This species occurs in the upper part of the Fox River watershed and its major tributary the Wolf River and also elsewhere in the Great Lakes Basin in Wisconsin, Michigan, Indiana, Ohio, and Ontario. However, it is uncommon and localized in the Wisconsin River downstream of Portage. Although Lake Chubsucker is widespread in the Mississippi River Basin in the Rock River and Fox-Illinois River drainages in southeastern Wisconsin, these systems enter the Mississippi River in central Illinois far south of Wisconsin. Other than the Wisconsin River, there are no other records of established Lake Chubsucker populations in the Mississippi River Basin upstream from the Rock River watershed in northwestern Illinois (Metzke et al. 2022), which enters the Mississippi River more than 120 river miles downstream of the mouth of the Wisconsin River. We attribute a 2012 record of a single Lake Chubsucker in the mainstem of the Mississippi River about 10 miles downstream from the mouth of the Wisconsin River to a stray from the Wisconsin River. While we cannot rule out the possibility that the Lake Chubsucker swam up the Mississippi River mainstem from the Rock River to colonize the lower part of the Wisconsin River or that historically there was a more continuous distribution of Lake Chubsucker between the mouth of the Rock River and the mouth of the Wisconsin River, a simpler explanation is that the species moved from the Fox River into the Wisconsin River at Portage and then was carried or swam with the current downstream.

Blackstripe Topminnow *Fundulus notatus* (Figure 9):

Like Lake Chubsucker, Lyons and Schmidt (2022) considered Blackstripe Topminnow to have moved from the Wisconsin River into the Fox River, but now we think that the opposite may have occurred. The Blackstripe Topminnow is common in the upper Fox River watershed and in other areas of the Great Lakes Basin in Wisconsin, Michigan, Indiana, Ohio, and Ontario, but present at only a few scattered spots in the Wisconsin River watershed downstream of Portage. The Blackstripe Topminnow is widespread in the Rock River and Fox-Illinois River drainages, but except for the Wisconsin River it is unknown in

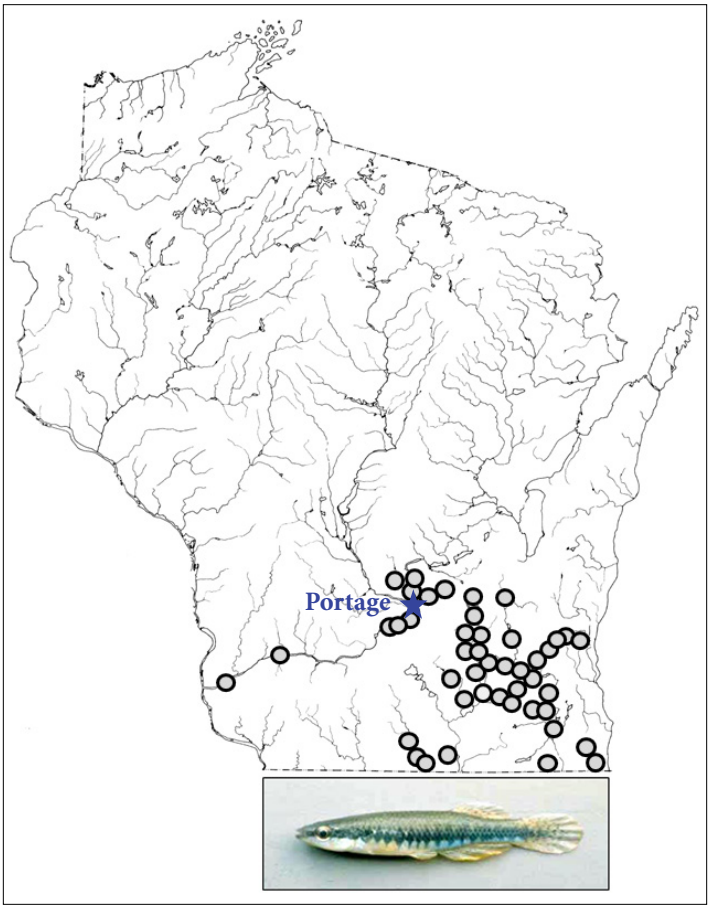

Figure 9. Another example of a fish distribution pattern, for the Blackstripe Topminnow, that suggests a colonization of the Wisconsin River watershed from the Fox River via the Portage connection, or, alternatively, of a human introduction from the Fox River into the Wisconsin River via a bait-bucket release.

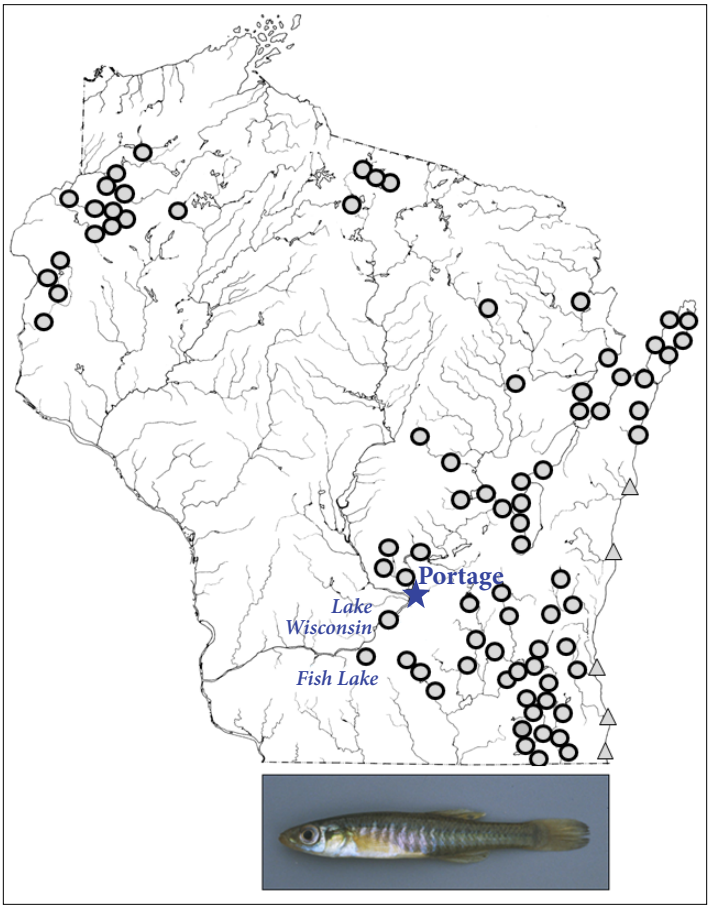

Figure 10. A fish distribution pattern, for the Western Banded Killifish (circles), that suggests a bait-bucket release for creating the only Wisconsin River drainage populations in Lake Wisconsin and maybe in Fish Lake, the killifish possibly originating from the nearby Fox River. (Triangles denote Eastern Banded Killifish.)

the upper Mississippi River Basin upstream of the Apple River in northwestern Illinois (Metzke et al. 2022), which enters the Mississippi River about 50 miles downstream of the mouth of the Wisconsin River. Like Lake Chubsucker, the simplest explanation for this pattern is that Blackstripe Topminnow entered the Wisconsin River at Portage and moved downstream, although the shorter distance from the Apple River to the Wisconsin River makes upstream movement or a more contiguous historical distribution in the Mississippi River more plausible for Blackstripe Topminnow.

Unlike Lake Chubsucker, which is an inconspicuous species that hides within aquatic vegetation and can be difficult to capture even in targeted surveys, the Blackstripe Topminnow swims in relatively obvious aggregations in open water near the surface and can be caught easily with dip nets or small seines. In the Fox River near Portage, Blackstripe Topminnows can be observed at almost any point along the stream. They and other larger topminnows and killifishes are also known to be sometimes captured and used as bait by anglers. This suggests that perhaps Blackstripe Topminnows were moved from the Fox River into the Wisconsin River via releases from bait buckets. The Wisconsin River near Portage is very popular for fishing, so this idea is conceivable. However, we have not found Blackstripe Topminnow in many nearby lakes and smaller rivers also popular for fishing, making this option perhaps less likely than a direct movement of fish from the Fox River, either through the canal or during a flood.

Western Banded Killifish *Fundulus diaphanus menona* (Figure 10):

In contrast to Blackstripe Topminnow, for Western Banded Killifish, the bait bucket option is perhaps the most likely scenario for movement from the Fox River into the Wisconsin River. This species has a unique distribution pattern. It is widespread in eastern Wisconsin throughout much of the Lake Michigan Basin including the upper Fox River watershed and much of the Mississippi River basin in the Rock and Fox-Illinois River drainages and extending into northeastern Illinois. It is also known from the Great Lakes Basin in Illinois, Michigan, Indiana, Ohio, and Ontario. Elsewhere in the Mississippi River Basin it is locally common in Minnesota and in northern Wisconsin, there in the upper St. Croix River and Chippewa-Flambeau River drainages. However, except for two populations downstream of Portage, it is completely absent from the Wisconsin River watershed, which is located between the northern and eastern portions of Wisconsin. No other fish species has this "gap" in distribution, which cannot be readily explained.

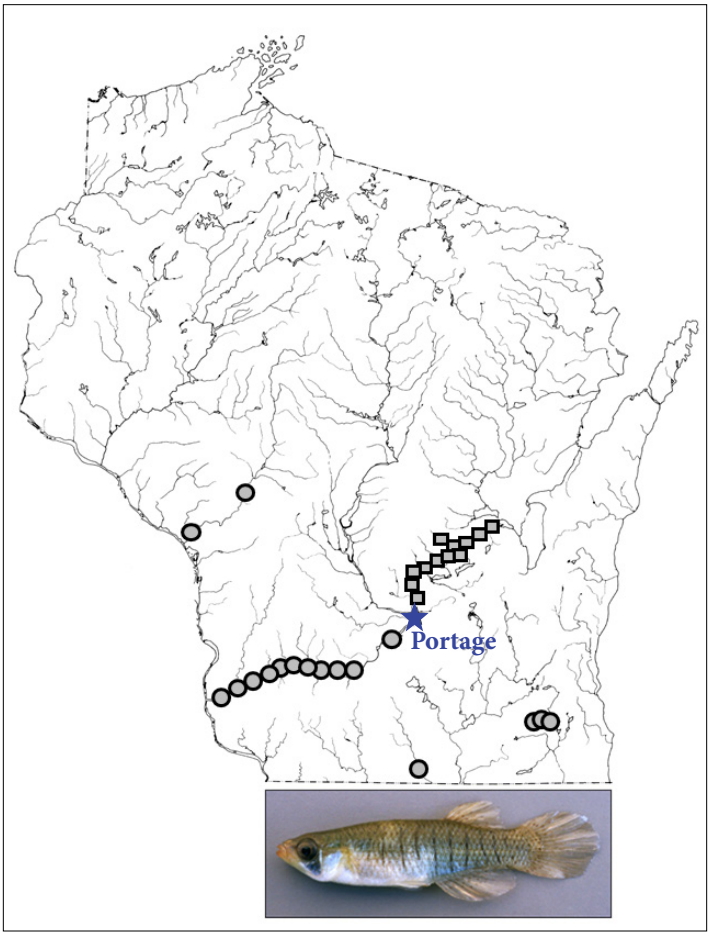

Figure 11. A fish distribution pattern, for the Starhead Topminnow, that cannot be easily explained. If the recently discovered Fox River populations (squares) originated within the last 25 years, then a bait-bucket or aquarium release seems possible as a source, but the rarity of the species in Wisconsin makes this improbable. If the species has long been present in the Fox River but was missed up until recently, then the Portage connection may have allowed movement between the Fox and Wisconsin rivers, but the direction of the movement is uncertain.

One of the Wisconsin River records for Western Banded Killifish is from Lake Wisconsin, an impoundment of the Wisconsin River located about 10 miles downstream of Portage formed by the Prairie du Sac Dam, which dates from 1914 and is impassable to fish moving upstream. The species was first collected from Lake Wisconsin in 2009 and occurs in three nearby bays in the middle portion of the lake (Lyons et al. 2022). It has not been found elsewhere in the Wisconsin River despite extensive sampling over the last 100 years, including several surveys of Lake Wisconsin before 2009. It has not expanded its range within the lake since 2009 even though other bays both upstream and downstream appear to have suitable habitat, similar to where it currently occurs. Although we cannot be certain, we attribute the Lake Wisconsin population of Western Banded Killifish to a relatively recent and inadvertent introduction by anglers using it for bait. If the species had colonized the Wisconsin River naturally through the Portage connection sometime before it was closed in 1951 or if it had always been present in the Wisconsin River, we would expect it to be far more widespread in the Wisconsin River system. We would also expect that it would have been found before 2009. The upper Fox River is by far the closest and thus most likely source of Western Banded Killifish for bait.

The other Wisconsin River drainage record is from Fish Lake, located about 30 miles southwest of Portage and three miles from the Wisconsin River. Although it is in the Wisconsin River watershed, this lake does not have an inlet or outlet connecting it to the Wisconsin River or any other bodies of water. All fishes there today had to have either colonized soon after the glaciers receded when the lake did have water connections to other lakes and rivers, or they had to have been brought there much more recently by people. The first collection of Western Banded Killifish from the lake was in the early 1990s, although few surveys of the smaller fishes in the lake had been conducted before then and the species may have been present earlier. It is conceivable that the Western Banded Killifish has always been in the lake, but it is also plausible that the species is a relatively recent introduction by anglers, perhaps from the upper Fox River, one of the nearest sources. The lake is very popular for fishing. But it is certain that the Western Banded Killifish did not enter the lake on its own from the Wisconsin River in recent times.

Starhead Topminnow *Fundulus dispar* (Figure 11):

The origins of the Starhead Topminnow in the Wisconsin and Fox rivers are unclear. The species is rare in Wisconsin and listed as an endangered species in the state. Until quite recently, it was thought to be found only in four areas in Wisconsin, all in the Mississippi River basin: localized portions of the Rock River, Fox-Illinois, and Black River watersheds, and a more extensive stretch of sloughs and backwaters along the Lower Wisconsin River below the Prairie du Sac Dam. The Lower Wisconsin River is considered the stronghold of the species in the state. Since 2018, the first three authors have successfully reintroduced Starhead Topminnows into their historical range in the Wisconsin River upstream of the Prairie du Sac Dam (Lyons et al. 2021, 2022; Marshall et al. 2021). The Starhead Topminnow was not thought to occur in the Great Lakes Basin in Wisconsin although it is found in the Lake Michigan Basin of southern Michigan.

Recently, the fourth and fifth authors made the exciting and completely unexpected discovery that the Starhead Topminnow is currently widespread and thriving in the upper Fox River watershed. Their first collection was from 2005, and they have now found the species at multiple locations spanning over 45 miles of the Fox River downstream of Portage and over 10 miles up a tributary, the White River. The origin of Starhead Topminnow in the Fox River is a mystery with two potential explanations, neither completely satisfactory.

One possibility is that the Starhead Topminnow has long been present in the Fox River watershed and was simply missed in past surveys. But this explanation seems improbable to us. At present, Starhead Topminnows are common and easily observed at many places on the Fox River, and it seems that if their abundance and distribution had been similar in the past then they would have been captured in at least one of the many collections made in the upper Fox River drainage from the 1920s through 2004 (Greene 1935; Becker 1983; Lyons et al. 2000; Lyons and Schmidt 2022).

Perhaps they were much scarcer in the past and not nearly as likely to be encountered as now. But why would that be, and why have they apparently surged in numbers and extent in recent years?

The other possibility is that the Starhead Topminnow has been recently introduced into the Fox River from a population in the Mississippi River Basin, perhaps the closest one in the Lower Wisconsin River. In theory, the source could be an angler's bait bucket or a release by an aquarium hobbyist. However, neither explanation seems very plausible to us. Starhead Topminnows are quite rare in Wisconsin, illegal to possess, and too small and fragile to make good bait, so their collection, use, and spread by anglers strikes us as highly improbable. The species is somewhat popular among native-fish aquarium hobbyists, but again its scarcity and legal status suggest that few if any Wisconsinites would have ever collected it locally for their tanks. Wisconsin native-fish hobbyists do obtain fish from outside the state, so the species could have arrived from a region where it is more common. But that still presupposes that a hobbyist would have released their unwanted Starhead Topminnows in the Fox River. Not impossible but requiring an unlikely sequence of steps.

If the Starhead Topminnow has long been in the Fox River and was not introduced by people (the first possibility), then its distribution pattern does not unambiguously indicate whether it used the Portage connection to colonize the Fox River from the Wisconsin River of vice versa. The current distribution of Starhead Topminnow outside the Fox and Wisconsin rivers is too spotty to infer its direction of movement. Conceivably, it could have come up the Mississippi River from the south and into the Wisconsin River and then crossed over to the Fox River at Portage. The presence of Starhead Topminnow further upstream in the Mississippi River Basin in the Black River supports this option, but the nearest source population to the south would be in the Rock River watershed (Metzke et al. 2022), a long swim away. Conversely, Starhead Topminnows from Michigan could have moved along the Lake Michigan shoreline and into Green Bay and then up the Fox River to Portage. But that would entail a great journey within a large, cold, and generally unsuitable lake before even getting to the mouth of the Fox River, and then an upstream migration of over 150 miles to the upper Fox River. If we had to choose, we think that the Starhead Topminnow probably entered the Fox River from the Wisconsin River via the Portage crossover rather than the other way around, but we have doubts about both alternatives.

CONCLUSIONS

Understanding and reconstructing how current fish distributions came about, while fundamental to biogeography, is always a challenging process. And almost inevitably, human activities like canal building, bait-bucket transfers, and aquarium releases complicate the analysis. The Portage connection has played an important role in determining the current distribution of fishes in Wisconsin and more generally in their movement between the Mississippi River Basin and the Great Lakes Basin. However, the details of approximately when, how, and in what direction these movements took place for individual species are often uncertain. Yet, it is that very uncertainty and the detective work necessary to try and resolve it that is one of the appeals of the study of biogeography.

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AN ECOLOGICAL ACCOUNT OF THE GREAT SCULPIN, WITH ANECDOTES FROM ALASKA

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An epiphany struck me while bobbing in a packraft on glassy swells in Resurrection Bay, Alaska, jigging off the sea bottom. Sculpin stories must be told. The first Great Sculpin *Myoxocephalus polyacanthocephalus* I caught in September 2019 puked the remains of a Dungeness Crab *Cancer magister* all over me. The next Great Sculpin I caught in November 2020 had a mouth overflowing with Pacific Sand Lance *Ammodytes hexapterus* (Figure 1). I've seen them puke shrimps *Pandalus* spp. and Walleye Pollock *Theragra chalcogramma*. They've shown me their Southern Rock Sole *Lepidopsetta bilineata* lunch like a nasty child (Figure 2). But beyond the vomit, there is much to appreciate about the Great Sculpin.

As the largest member of their genus, the Great Sculpin is one of dozens of sculpin species that call the north Pacific Ocean home (Figure 3). Their looks impress with a wide mouth in an armored face with spiny cheeks and soulful, bulbous eyes (Figure 4). Front-loaded, heavy-headed, and mottled bodies taper to a squared caudal fin. They even lack a gas bladder, so forget barotrauma. Though there is some mystery to its name (see Scharpf 2024), the genus fits a Greek derivative for muscly or beefy (*Myoxo-*) with head, *-cephalus*. The species name refers to the several (*poly*, many) preopercular and opercular spines (*-acantho-*, thorny) about the head (*-cephalus*). If I could be Linnaeus for a day, I hope this essay's opening vignette sells the

Figure 1: Great Sculpin with a mouthful of Pacific Sand Lance on a snowy November 27, 2020, on Resurrection Bay, Alaska.

Photos by the author unless otherwise indicated.

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Figure 2: Jig-caught Great Sculpin with a sole and kelp frond in its gullet on May 7, 2023, from Resurrection Bay, Alaska.

Figure 3: Great Sculpin caught January 11, 2022, in Resurrection Bay, Alaska.

Figure 4: Great Sculpin caught on jig from Kachemak Bay, Alaska, July 11, 2020.

Figure 5: Great Sculpin nest guarding in Auke Bay, just offshore of Juneau, Alaska. (Photo by Annette E. G. Smith)

Figure 6: Great Sculpin head and entrails from Derby Cove in Resurrection Bay, Alaska on October 24, 2021.

reader on a less redundant and more fun species name for Great Sculpin: *hyperemesis*, or "super vomit."

Great Sculpin biology is not well defined, but we know some basics (e.g., TenBrink and Aydin 2009; Tokranova and Orlov 2013). Their range wraps around the north Pacific Ocean from Washington to Alaska as far north as the Bering Strait, then westward toward Siberia, Kamchatka, and the Sea of Japan. Typical Great Sculpin habitat associations involve mud, sand, and rocky bottoms from the intertidal zone to 250 m depths. They grow to 90 cm and 10 kg, exhibiting strong sexual dimorphism with females much larger than males that are generally under 52 cm long and weigh less than 3 kg. Individuals mature at 5–8 years. Females will, on average, release 250,000 eggs during wintertime crevice-spawning events followed by parental nest guarding (Figure 5). Otolith aging suggests Great Sculpin live up to 17 years. My accounts of Great Sculpin diets corroborate other findings: juvenile Walleye Pollock in summer, spawning flatfishes in late-winter, and crabs or fish offal year-round. Indeed, my most effective Great Sculpin fishing hole is next to Resurrection Bay Seafoods, a fish processor in Seward, AK.

Great Sculpin are more than hungry fish. They are eaten by pinnipeds (fancy word for seals), Pacific Cod *Gadus macrocephalus*, and Pacific Halibut *Hippoglossus stenolepis* (Spies et al. 2014). I found a disembodied head onshore after an apparent River Otter *Lontra canadensis* kill was scavenged by Ravens *Corvus corax* (Figure 6). The roles of Great Sculpin as predator and prey adjust with their seasonal bathymetric migrations between shallower

Figure 7. A Great Sculpin bites a Pacific Staghorn Sculpin *Leptocottus armatus* at the edge of a seagrass meadow off Prince of Wales Island near Craig, Alaska. (Photo by Lia Domke)

Figure 8. Still life with fillet knife: Great Sculpin and Red Irish Lord *Hemilepidotus hemilepidotus* harvested from Resurrection Bay in January 2022.

coastal habitats and deeper continental slope areas (Tokranov and Orlov 2013). Other species in the genus *Myoxocephalus* move more in the summer compared to winter yet generally remain in areas less than 25 km² (Hermann et al. 2023). A hypothesis that Great Sculpin do not migrate long distances may help explain why they have antifreeze proteins in their blood as a cold-water adaptation (Yamazaki et al. 2019).

Given their benthic orientation, Great Sculpin are bycatch in bottom fisheries. From my halibut fishing experiences, charter fishing captains collectively refer to sculpins, usually Great Sculpin or Irish lords *Hemilepidotus* spp., as "mother-in-law" fish. This derogatory colloquialism may insult fish and mothers-in-law. Worse yet, it suggests the fishing community lacks identification skills. At least they release the sculpins. Similar to sport fisheries, Great Sculpin are one of the most commonly caught sculpins in commercial trawl fisheries but in another magnitude, sometimes exceeding 2,000 metric tons per year

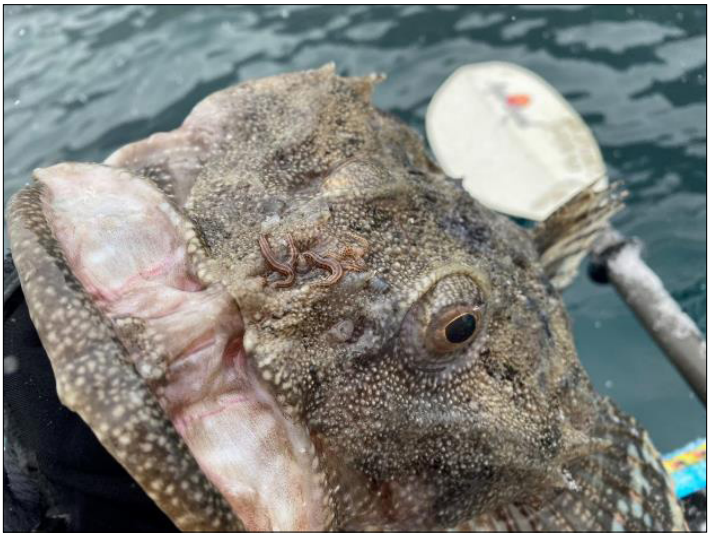

Figure 9: Great Sculpin face infested with Striped Sea Leeches on March 15, 2023, in Resurrection Bay, Alaska.

(TenBrink and Aydin 2009). Though bycatch could support untapped consumer markets with cheap protein, the Great Sculpin has little commercial value. If Great Sculpin overcome the current aversion by catchers and consumers, their flavor will be a reason it reaches your plate.

Sculpins taste great. Anglers from California to British Columbia who catch and eat Cabezon *Scorpaenichthys marmoratus* know, and to them I preach to the choir. Heck, even Great Sculpins don't turn down an opportunity to eat another sculpin (Figure 7). Sculpin meat flavor, texture, and appearance rival those of Pacific Cod and Rockfish *Sebastes* spp. (Vandever 2012). My taste tests of Great Sculpin and other species confirm this (Figure 8). Consumer beware, Great Sculpin can contain mercury levels exceeding the US Environmental Protection Agency guideline depending on their size, age, and location (Jewett and Duffy 2007). But for what it's worth, the McFish, I mean Walleye Pollock, can as well.

Aside from their contributions to my angling and eating behaviors, Great Sculpin taught me new facets of marine biology. I now know their parasites, such as leech and louse. The Striped Sea Leech *Notostomum cyclostomum* sucks blood from Great Sculpin faces, among other spots (Figure 9). Copepods, *Lepeoptheirus* spp., latch onto cheeks or inside gills to feast (Figure 10). Bright rusty- or red-colored patches on Great Sculpin have also caught my eye (Figure 11). These patches range from one to several blotches of varying sizes and may just be color variations. Other hypotheses are that they are spawning colors or an encrusting sponge. As a stream fish ecologist, I am out of my element here and welcome any input.

A vomiting mother-in-law sounds more repellant than inspiring, but catching Great Sculpin has led to more than a lapful of puked crab parts. I've learned about their biology, ecology, and role in fisheries. I hope you learned something too. Better yet, much remains to be discovered about Great Sculpin and their community ecology, life history patterns, and fisheries potential. Perhaps an inspired intrepid scientist will one day answer questions that further enlighten us to the ways of the Great Sculpin.

Figure 10. Great Sculpin with copepods sticking out of gills on January 11, 2022, from Resurrection Bay, Alaska.

Figure 11: Blotchy bright-rust pattern on Great Sculpin head, note the parasitic copepod attached to the preopercle area in the bottom center of the image. Sculpin is from Thumb Cove, on the east side of Resurrection Bay, outside Seward, Alaska.

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CHOUPIQUET ROYALE: THE BOWFIN CAVIAR CONNECTION

Konrad Schmidt

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INTRODUCTION

The Bowfin *Amia calva* is one of several species descended from ancient lineages (e.g., sturgeon and gar) that are often labeled "living fossils" because they were present during the time dinosaurs roamed the Earth (Figure 1). *A. calva* was believed to be the only species surviving in the genus. However, the Emerald Bowfin *A. ocellicauda* (Figure 2) was recently accepted as a second valid species (Page et al. 2023), and the research suggests there may be more species yet to discover (Wright et al. 2022).

In January 1992, I had a unique opportunity to join Dave Mueller (River of Life Hatchery) on an aquaculture adventure to Louisiana for bowfin broodstock. Dave was already very successful in culturing Lake Sturgeon *Acipenser fulvescens*, Shovelnose Sturgeon *Scaphirhynchus platorynchus*, and Paddlefish *Polyodon spathula* for the aquarium trade in southeast Asia. He routinely had survival rates of all three species to saleable sizes exceeding 90%, and the wholesale prices he got were insanely profitable. A joint venture with Gary Richmond (Kinni River Fish Farm) had similar success culturing all five species of North American gar (Schmidt 2015). The internet was still in its infancy, without Facebook or even Google to search the web, but Dave had the uncanny ability to find, by relentlessly making phone calls, very fruitful connections around the world that immensely expanded his hatchery operations. He doggedly pursued all tips and rumors, but the end results were always far more misses than hits. I have long wondered how much he spent on phone bills! Dave's dialing diligence did eventually find John Burke, who owned the Louisiana Caviar Company in Baton Rouge.

Figure 1. A replica cast from a bowfin fossil.

Figure 2. Emerald Bowfin from Long Meadow Lake (Hennepin County, MN) 28 May 2006.

Although the species discussed in this article is the Emerald Bowfin, the editors have used "bowfin" to avoid any confusion. Photos by the author unless otherwise indicated.

John had found a niche demand for bowfin caviar (Bourg 1988; Cotton 1990). He knew an Acadian family along Bayou Teche that had been making bowfin caviar using a traditional Russian recipe for sturgeon caviar handed down for generations, but the demand never grew beyond local consumption. John started promoting his product as "Cajun Caviar" to restaurants in New Orleans. Chefs were at first reluctant to try it, but after a taste test, they loved it! The flavor has been described as not too fishy or salty; it does not clump and is not filmy. One chef thought it was better than Beluga caviar. In 1989, John changed the caviar's name to Choupiquet Royale (Fig-

Figure 3. Processed and packaged bowfin caviar ready for sale.

Figure 4. John Burke (left) and Dave Mueller (right) sampling bowfin caviar (background).

ure 3) and sold about 5000 pounds to restaurants and caterers in Los Angeles, New York, Tokyo, and Australia. It was a very lucrative product: it retailed for $28 per 4-ounce tin and was much more affordable than any of the three Russian sturgeon caviars. Choupique (sounds like "shoe pick") is the Cajun name for bowfin, and comes from *shupik*, a Choctaw word that translates as "mudfish." Bowfin is also known as cypress trout in some areas.

A FISHY—BUT TRUE—"TAIL"

Entrepreneurs are always trying to turn a profit by improving old products or inventing entirely new ones, and fish-related products are no exception. I was aware for some time that the aquarium trade was interested in the bowfin (Katula 1984) but was astonished to learn that the roe was also being marketed as a new source of caviar. In 1992, both camps became aware of each other and believed there was promise in exploring some common ground. Up to this time, both depended on harvesting wild populations, which were subject to major fluctuations or restrictive rules and regulations. Culturing the species would, in the long run, provide a constant and reliable source. My only connection to this scheme was knowing Dave Mueller. It seemed like an intriguing adventure, and he needed someone to help drive, so we were Baton Rouge bound,

We met with John at his company office, and he was extremely pleased at the growth of his business and booming sales. He was convinced, however, that the state was going to shut the entire industry down due to fears that the wild populations of bowfin were in jeopardy. He added that many unscrupulous commercial roe harvesters were littering landings with large rotting piles of bowfin carcasses, and public complaints were mounting. He gave us a tour of his operation, offered us a generous sampling of his product on crackers and cream cheese, and encouraged us to wash it down with a traditional swig of Stoli Russian Vodka (Figure 4). The aftertaste was…"unique"; an hour later something still lingered. Experiencing the culinary delight of this fine cuisine once in my lifetime was quite enough for me, thank you very much! John had made arrangements with some local commercial fishermen to catch broodstock for Dave. It was going to take a few days, so we decided to do some traveling and fish collecting along the way.

Our first destination was southern Louisiana, where Louisiana Department of Fisheries biologist Mike Walker had studied and co-authored a report on the bowfin (Davidson et al. 1991). He was definitely a different breed. One of his favorite pastimes was fishing for Alligator Gar *Atractosteus spatula*, but he seemed somewhat embarrassed to admit it. He did find something very interesting about bowfin that I hope someone will study further. Adult males and females are supposed to be sexually dimorphic and very easy to distinguish by the absence or presence of an ocellus (i.e., black eyespot) on the upper caudal fin. Both sexes exhibit this trait early in life. The eyespot is lost in adult females; males retain it and exhibit an orange-yellow ring around it during the spawning season. Mike originally used this characteristic to determine sex ratios in his study, but while examining ovaries and testes he found females that were externally sorted as males and vice-versa. Does this long-cited trait apply to some populations and not others? More research may answer this question. We also asked if he felt the bowfin populations were really at any risk of being wiped out from the caviar industry. He replied, "I really doubt it," but added a half-hearted challenge, "Let 'em try!"

Our next stop was the bayou country near Lake Verret, a 14,080-acre natural lake in Assumption Parish (Wikipedia contributors 2024) where we hoped to find the Banded Pygmy Sunfish *Elassoma zonatum*. From a bridge over a small stream feeding the lake, we scanned the water, which was littered with washing machines, tires, and even a fake Christmas tree—nice structure and cover! Someone had also cleaned countless fish there, and large areas of the stream bottom were carpeted with fins and entrails. In this rotting mess we saw several female bowfin carcasses with their bellies slit open, and we knew who was responsible. As awful as this was, Banded Pygmy Sunfish were all over this carnage, but our nets and waders reeked of dead fish and really stunk up the car.

The commercial fishermen came through, and we started packing bowfin for the trip home (Figure 5). All Dave had was tropical fish shipping boxes, which could each hold one large or two medium-sized bowfin, but he had to bend some into a half circles for a proper fit. The bags lining the boxes were sealed with oxygen. They had several beautiful females but came up short on males.

John knew of one other source, which led us deep into Cajun country. Near the town of Pierre Part, there was a roadside vegetable stand, which had a small sign advertising "LIVE CHOUPIC." There were several males, and the vendor was very happy to sell them but was puzzled that we didn't want him to clean them for us. Bowfin is a highly valued delicacy in this part of Louisiana, and someday I may be brave enough to try it. I learned this later from NANFA member Bernard Sietman, who would often eat them growing up in Missouri and fished for them frequently. He said they were delicious every time he cooked them fresh from the water on the riverbank, but they would go "bad" quickly if he waited to clean them at home.

We finally headed North and hit a major blizzard in Arkansas, where no one knows how to drive in snow. There were an incredible number of accidents and ditch "landings." Despite Dave's bald tires that were useless against a patch of black ice on I-35 in Iowa, we finally arrived home 22 hours later with the loss of only two bowfin. The bowfins were injected with ovulating hormones, but hatching success was poor and only produced about 50 young on the first attempt. He kept trying with local broodstock but could not solve this species' secrets for mass production (Figure 6). It was also bad news for the caviar industry, because Louisiana did close the commercial

Figure 5. Packing Bowfin broodstock. Top: female (above) and male (below; note that sex was determined solely on presence or absence of ocellus). Center: preparing shipping boxes. Bottom: a two-bowfin box prior to sealing with oxygen.

Figure 6. First Bowfin culture attempt. Above: harvesting eggs. Below: The eggs were "silted" to reduce adhesion prior to rolling in hatchery jar.

season on bowfin the following year. More recently, the 2024 commercial regulations do include a season with a minimum size limit of 22 inches (TL), but 5% of the catch can be less than the minimum size. The season is also closed December through February (i.e., the spawning season) but is permitted in seven parishes and several water bodies (Louisiana Department of Wildlife and Fisheries 2024).

ALTERNATIVE METHODS

It is unfortunate that the bowfin aquaculture venture did not succeed. Culturing fish has major advantages, like scheduling spawning in a controlled hatchery environment and reducing or eliminating pressure on wild populations. I am aware of two alternative attempts where wild-caught fry were reared in large aquariums or hatchery tanks. I witnessed the first effort in Bald Eagle Lake (Ramsey County, MN) on June 30, 1988. Eric Lindberg was a childhood friend and had been a high school science teacher, but he found that career was not for him. He dabbled in native fishes for the aquarium trade, hoping to eke out a living, but what he enjoyed most was the research and development part of learning everything he could about a species. His bowfin study site was a cattail bay of Bald Eagle Lake. Starting in early spring, soon after ice out, he canoed through the cattails searching for bowfin activity. He frequently observed male bowfins creating nests, spawning, and guarding the nests.

Eric was aware of my interest in native fishes and invited me to try to harvest fry off the nests (Figure 7). At the first nest, he knew the fry were now about 10 days old. As he started dip netting through the nest, he began giggling. I asked what was so funny. He said the male had just latched on to the net and would not let go. I had a

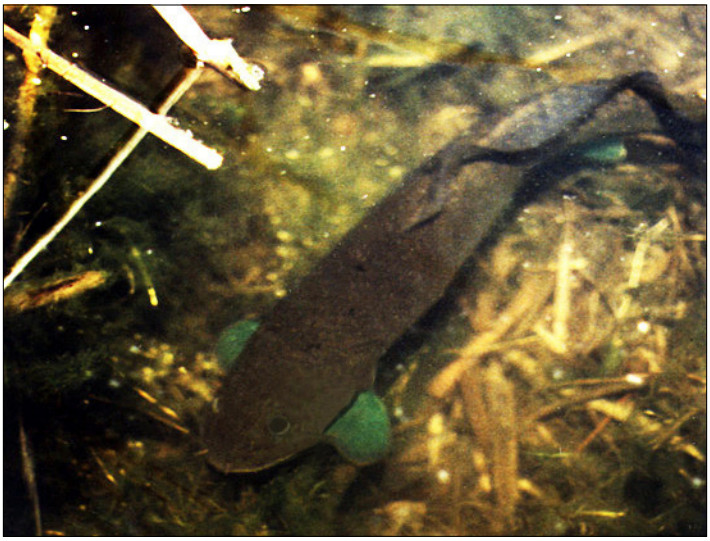

Figure 7. Collecting Bowfin fry in Bald Eagle Lake on June 30, 1988. Top, left to right: Eric Lindberg standing over a Bowfin nest; Eric laughing over male attacking his dip net. Center: a wary male Bowfin guarding nest. Bottom: Bald Eagle Lake Bowfin fry at about ten-days old.

wonderful photo, sadly lost in the mail, of Eric lifting the bowfin out of the water with its jaws still locked on the dip net's frame. He returned the fish to the water away from the nest and netted what he could find. We moved to a second nest and started again. Luckily, Eric checked on the first batch just in time to find them suffocating

Figure 8. Wild-caught, captive-reared Emerald Bowfin. Top: June. Bottom: October.

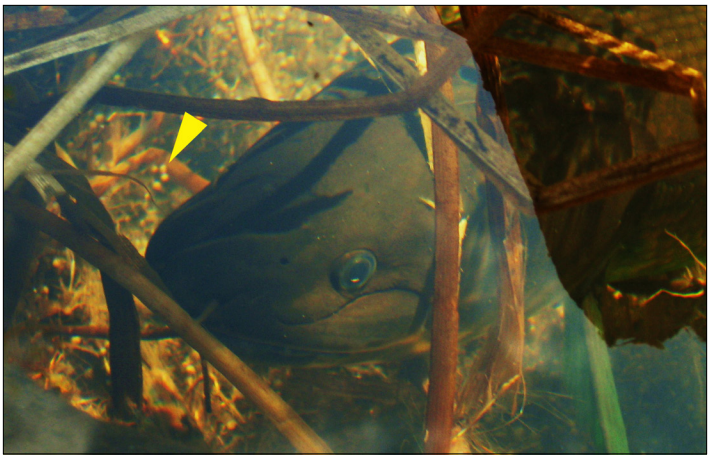

Figure 9. Male Emerald Bowfin guarding nest in May. Yellow arrow shows some of many visible eggs. (Photo by Ray Katula)

in the bucket. He grabbed an air pump and after a few suspenseful moments, all were swimming upright again. The lesson learned was that 10-day-old baby bowfin cannot yet gulp in air to supplement their oxygen needs. Eric estimated that between the two nests he had collected approximately 1,200 fish. The little guys proved to be voracious feeders, grew at stunning speed, and dramatically changed in appearance over their first summer (Figure 8.).

The second bowfin culture attempt was made by NANFA member Ray Katula of Onalaska, Wisconsin. Ray is a fish culturist extraordinaire and has published many articles on the subject in *American Currents* and elsewhere. Ray grew up on the Mississippi River and spent a great deal of his childhood on the river and its backwaters. He learned many things about native fishes in his private outdoor lab, including a very intimate understanding of the bowfin (Katula 1998). He was well aware male bowfins not only guard the eggs and fry in the nest (Figure 9) but continue to shepherd their free-swimming offspring, which school in close-knit bowfin balls for several weeks after hatching (Figure 10). The timing of the bowfin spawn and the best time to collect fry vary year to year. Fluctuations in spring temperatures and water levels

can accelerate or delay spawning periods for many species. The odds are better than being a mega-winner in a lottery, but finding fry to collect requires constantly returning to the bowfin's haunts.

Ray also made an attempt at pond culturing bowfin. In the early 1970s, the Muséum-Aquarium de Nancy in France was looking for bowfin specimens for a new exhibit. John Bondhus (NANFA's founder), with the help of Ray's uncle, who was a commercial fisherman, captured several juveniles. Ray held them temporarily in a fiberglass pool at his home until they could be shipped to France. When the order from the museum was cancelled, Ray had to move them ASAP. There was a pond down the hill from his home in Bluff Siding, Wisconsin about three to four feet deep (Figure 11). Winter kills would occur in the pond from time to time, but he never saw any bowfin in it alive or dead. Before construction of road and railroad dikes, the Mississippi River regularly flooded the pond but now had been cut off from the intermittent highwater connections. Ray drilled a hole through the ice and stocked 12 bowfin about 12–16 inches long. The following spring, he found a bowfin nest with eggs and, later, fry. He kept checking the pond for years but never saw any bowfin again. Ray emphasizes that what he did in his youth he would never do today, because both stocking fish and aquaculture are now tightly regulated in Wisconsin. He does feel pond culture has great potential for supplying the aquarium and caviar trade if the demand persists. However, state-sanctioned research to develop culture techniques that are effective and affordable must be done before entrepreneurs can supply the demand of profitable markets. These entrepreneurs also will be required to comply with state, and possibly national and international, regulations. It just may be more rewarding panning for gold or playing the lottery.

Figure 10. Emerald Bowfin balls. Top: Mississippi River backwater (Buffalo County, WI; photo by Ray Katula). Center: Lower Balsam Lake (Itasca County, MN, July 2, 2008). Bottom: a member of a Emerald Bowfin ball seined in a St. Croix River backwater (St. Croix County, WI, June 16, 2022; photo by Jenny Kruckenberg).

Figure 11. Top: the yellow arrow on the aerial photo indicates the pond where Ray Katula stocked Bowfin to culture. Bottom: Ray next to the same pond 50 years later.

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Hanging Lake, Garfield County, CO (Adam Johnson)

IT'S TRUE, GARS REALLY ARE LIVING FOSSILS

This is a hybrid offspring of an Alligator Gar and a Spotted Gar. (Photo by Solomon R. David)

The term "living fossil," coined by Charles Darwin, sometimes bugs me as one used too easily, often with little meaning. However, recent research and observation has shown living gars of the genera *Atractosteus* and *Lepisosteus* deserve that term, more than any other living vertebrate animals. Observationally, unusual gar hybrids found in Texas and Oklahoma turn out to be fertile hybrids of Alligator Gar *Atractosteus spatula* and Spotted Gar *Lepisosteus oculatus*, impressive since their last shared ancestor lived approximately 105 million years ago. What enables this unusual successful hybridization is the extremely slow rate of gar mutations, changes in their DNA, so that these two species are much more similar in their genomes than might be expected. The rate of gar DNA mutations is several orders of magnitude slower than other animals often referred to as living fossils. The second lowest mutation rate was found in sturgeons, another ancient group of fishes. Factors hypothesized to shape gars' low mutation rate include efficient DNA repair mechanisms, slow metabolic rate, and long generational time. So, I approve of the term living fossils for gars and for that matter sturgeons.

See "The genomic signature of evolutionary stasis" by Brownstein et al. in the journal *Evolution,* March 2024.

IMPERILED FRESHWATER ORGANISMS OF NORTH AMERICA WEBSITE

The American Fisheries Society (AFS) and the US Geological Survey (USGS) recently renewed an agreement to host a website listing the imperiled fish, crayfish, snails, and mollusks of North America. Since 1972, the AFS Endangered Species Committee has been tracking the status of imperiled fishes and aquatic invertebrates in North America, with revised lists printed periodically in the AFS publication *Fisheries*. The Imperiled Freshwater Organisms of North America website (https://www.usgs.gov/search?keywords=Imperiled%20Freshwater%20Organisms) now provides an outlet for these lists so they can be accessed by scientists, stakeholders, and the public.

"This is a natural collaboration because both organizations have the goal of sharing information about imperiled aquatic fauna in North America," said Howard Jelks, chair of the AFS Endangered Species Committee and a fish biologist with the USGS in Gainesville, Florida. "Increased awareness helps benefit those resources at risk, and stakeholders now have easy access to up-to-date scientific information." The status lists reveal some striking statistics about the state of North America's freshwater species. Nearly 40 percent of freshwater fish species in North American streams, rivers, and lakes are now in jeopardy, while 74 percent of freshwater snail and 48 percent of crayfish species are declining or at risk. Currently, the fish, crayfish, and snail subcommittees have provided revised status lists of at-risk taxa, and the mussel subcommittee is completing a similar revision.

The renewed Memorandum of Understanding will keep this vital information available through USGS for another five years. "In the past, I have found the faunal declines documented in the lists published in *Fisheries* by the AFS Endangered Species Committee disturbing, but incredibly useful in my writings," said AFS President Bob Hughes, who is with the Amnis Opes Institute in Bend, Oregon. "Now this information is updated and easily available on a joint AFS-USGS website."

SUPPOSE YOU'RE LOOKING FOR A POSSIBLY EXTINCT SNAIL (OR FISH) IN ITS LAST KNOWN HABITAT: WHAT IS THE BEST SEARCH METHODOLOGY?

What led me to write this short piece is the case of the Big Black Rocksnail *Lithasia hubrichti*, historically known from a short stretch of the lower Big Black River in Mississippi. Freshwater gastropods are one of the most imperiled groups globally, so how to assess a species' status is important for conservation. The Big Black Rocksnail was last seen in 1965 at a single site and rediscovered in 2022, with a further survey in 2023 confirming a slightly larger range. The crew responsible for this fieldwork and follow up lab work wrote a recently published paper describing what

they found to be the most effective ways to search for a poorly known and maybe extinct species (Rezac et al. 2024). Deciding on a search pattern is a form of game theory—should a search intensively examine a few likely sites, or visit a larger number of sites but less intensively? Limited time and resources make this an important decision. Rezac et al. followed the second course, visiting 16 sites along 25 river km. Key to their success was getting the cooperation of landowners who allowed access. Follow-up DNA work found that the snail's population was reasonably large and stable and had been for thousands of years. So, inadequate sampling could lead to the conclusion that this species was extinct when in truth it's not. Given current threats to many freshwater taxa this is an important lesson for similar searches as the current mass extinction event unfolds.

Scientists look for the Big Black Rocksnail in September 2023. (Photo by Calvin Rezac/Mississippi Museum of Natural Science, Copyrighted, All Rights Reserved, Used by Permission.)

Citation: Rezac, C.R., Ellwanger, R.J., Donohoo, S.A. *et al.* Surveys that prioritize site number over time per site will result in better gastropod status assessments: a case study on the rediscovery of Big Black Rocksnail. *Biodivers Conserv* 33, 1811–1825 (2024). https://doi.org/10.1007/s10531-024-02829-6)

THE ALABAMA HICKORYNUT PERSISTS IN THE EAST AND WEST FORKS OF THE AMITE RIVER IN MISSISSIPPI

The Amite River mussel survey team with some of the Alabama Hickorynuts they found. (Photo by Matt Wagner)

Many freshwater mussel species in North America have gone extinct or become rare from human pollution or alteration of their habitat. The Alabama Hickorynut, *Obovaria unicolor* is one such species. It's native to Gulf drainages in Louisiana, Mississippi, and Alabama. The species has disappeared from much of its range due to impoundment and channelization of many of its native rivers with attendant degradation of water quality. The US Fish and Wildlife Service (USFWS) has been petitioned to list the species for protection under the Endangered Species Act. The USFWS has been surveying native rivers of the species to determine its current range and population status. One such recent survey of the West and East Forks of the Amite River in southwest Mississippi down to the Louisiana border was carried out by the USFWS along with the Mississippi Department of Wildlife, Fisheries, and Parks and the Louisiana Department of Wildlife and Fisheries. The mussel hasn't been seen in the East Fork since the 1970s and the West Fork since the 1990s. Matt Wagner [NANFA member] of the USFWS reports on Facebook that ten miles of the Forks were examined through a floating survey. The survey found populations of the Alabama Hickorynut in both streams in stable gravel shoals, but at low densities. Both streams suffer from headcutting caused by extensive gravel mining just downstream in Louisiana, collapsing banks and causing the streams to become wider and shallower. Even so there's hope for this species in the Amite.

LAKE STURGEON DENIED ESA PROTECTION BY THE US FISH AND WILDLIFE SERV

Lake Sturgeon. (Photo courtesy of Wisconsin Department of Natural Resources [CC-BY-ND])

The United States Fish and Wildlife Service (FWS) has denied a petition submitted by the Center for Biological Diversity (CBD) to list and protect Lake Sturgeon *Acipenser fulvescens* under the Endangered Species Act (ESA). The species can reach six feet in length, and because it may take 30 years to reach sexual maturity populations cannot grow quickly. This is a bad decision [opinion of Riffles Editor; NANFA has taken no position] given that the species populations have declined steeply across most of its range of the Great Lakes and the Mississippi River system. A spokesman for the FWS defended the decision saying that lo-

cal management and hatchery stocking have strengthened remaining populations, along with efforts to repair damage from human activities such as dams and chemical dumping over the last 150 years. In contrast, a CBD spokesman pointed out that even in the Great Lakes, where some populations have stabilized, Lake Sturgeon population may be only about 1% of their historic number. The CBD is likely to appeal the decision in a federal district court, a common step in petitioning the FWS for ESA protection. I should point out that like all sturgeons, Lake Sturgeons are "living fossils" relatively unchanged over 150 million years of existence.

WARMING WATER TEMPERATURES IN VIRGINIA AFFECT AQUATIC ECOSYSTEMS IN VIRGINIA

The Eastern Hellbender. (Photo by Brian Gratwicke)

Everyone reading this knows that aquatic communities are shaped largely by water temperature and seasonal patterns of water temperature. Both marine and freshwater systems are now warming, and those in Virginia are no exception. This can affect the timing of events such as river herring *Alosa* species and American Shad *Alosa sapidissima* spawning runs from coastal Atlantic waters into freshwater rivers. One such change that has been observed in Virginia is that shad and herring runs are now three weeks earlier than they were as recently as 1998, according to a long-term study conducted by the Virginia Institute of Marine Science (VIMS) now led by Dr. Eric Hilton [NANFA member]. One obvious effect is the historically large American Shad run in the James River may have disappeared, in spite of both a fishing moratorium on the species and the stocking of over 100 million juveniles. Not a single American Shad was found last year in surveys. Many freshwater species face an uncertain future if inland streams continue to warm. Virginia's only native trout, the Brook Trout *Salvelinus fontinalis,* is found in coldwater streams in the mountains, and their only option to survive warmer waters is moving to higher elevation or further north. North America's largest salamander, the Hellbender *Cryptobranchus alleganiensis,* is found in the Virginia mountains and requires cold streams even in summer because they're very sensitive to the lower dissolved oxygen levels in warmer waters. With all that, Virginia isn't exceptional; similar changes can be found across North America with uncertain outcomes.

(*Virginia Mercury,* April 15, 2024)

PETITION FILED TO PROTEC THE STIPPLED STUDFISH *FUNDULUS BIFAX*

A female Stippled Studfish from Emuckfaw Creek in Tallapoosa County, Alabama, in June 2008. (Photo by Phil Gentry)

Fundulus bifax. Josie Leg Creek, Alabama. (Photo by Scott Smith)

Many aquatic species in the United States are known to be vulnerable but lack adequate protection. The process of obtaining federal protection for a species under the Endangered Species Act is long and slow, but such protection from being listed Threatened or Endangered is the best available. The process begins with filing a petition with the US Fish and Wildlife Service (FWS) requesting such protection with an explanation of why it's needed. Such a petition was filed on July 1, 2024, on behalf of a killifish now found only in eastern Alabama, the Stippled Studfish *Fundulus bifax*.

This studfish once lived throughout the Tallapoosa River system of the Alabama River basin across both Alabama and Georgia, but is now considered extirpated in Georgia and is extremely rare in Alabama, restricted to only a handful of tributary streams within the Tallapoosa River basin and one tributary to the Coosa River. The Stippled Studfish faces a significant risk of extinction due to many threats to its existence, including residential and industrial development, agriculture (especially poultry farming), timber extraction, pipelines, dams, and climate change.

The six known populations are vulnerable to diminished gene flow due to low genetic diversity within each population. A 2013 survey determined that the studfish was relatively easy to catch in four streams but that there was little genetic diversity within these populations. This low diversity makes the studfish's few populations less able to respond to random events and habitat disturbances. The threat to the studfish from low genetic diversity is

even greater because these populations are now either largely or entirely isolated through habitat fragmentation caused by the impoundment of the Tallapoosa River, which historically connected most Stippled Studfish populations.

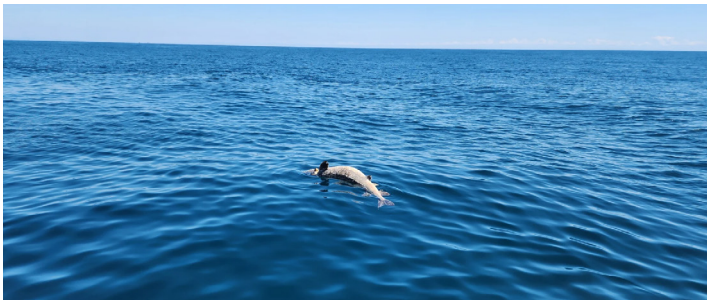
This petition will likely be rejected by FWS. If that happens, it will be necessary to file a lawsuit in a US District Court asking for an injunction to compel FWS to investigate the species' status. Like I said, it's a long and slow process.

DEAD LAKE STURGEON MISTAKEN FOR HUMAN BODY IN LAKE MICHIGAN

The dead sturgeon. (Photo by Capt. Ernesto Amparan)

Anglers fishing aboard a charter boat in Lake Michigan off the northern suburbs of Chicago in early July had a tense, though ultimately positive experience.

"I could see a large object floating in the water with a white shirt approximately 300 to 400 yards south from me and in close proximity to the recovery of the first body," Capt. Ernesto Amparan of Thin Blue Line Fishing told Chicago *Sun-Times* outdoor columnist Dale Bowman, referring to the body of a swimmer that had been found by another charter boat a few days earlier.



A scary sight from a distance. (Photo by Capt. Ernesto Amparan)

Amparan notified the Coast Guard, pulled in all his lines, and approached the floating object. "My customers all believed it was a person floating, but to our surprise it was an approximately five-foot dead sturgeon. I have seen one in Lake Michigan before, and it was interesting to see a dead one floating around. My customers were relieved it wasn't a body and were excited to see the sturgeon," he said.

Bowman added, "They should be. Lake Sturgeon are very rare in the Chicago area."

The Lake Sturgeon *Acipenser fulvescens* is listed as endangered in Illinois, and reintroduction work is ongoing. They are spotted occasionally in Lake Michigan and almost never caught by anglers.

"Updating Sturgeon Story by Giving a Sense of where They Fit Around Chicago and Illinois," Chicago *Sun-Times*, July 9, 2024

WELCOME, NEW MEMBERS!

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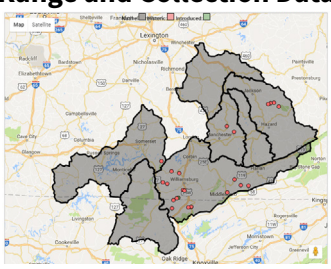
FishMap.org

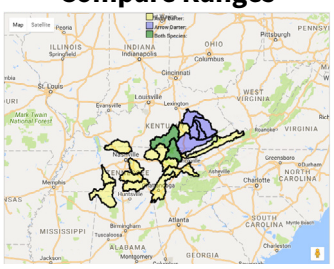
NORTH AMERICAN NATIVE FISHES ASSOCIATION

FishMap lets anglers, aquarium hobbyists, researchers, or anyone with a passion for fishes visually explore species' ranges or learn what species are in their local waters. The site is dedicated to spreading knowledge and respect for all fish species. **FishMap** combines numerous data sources (NatureServe, the National Atlas, the USGS water resources and Nonindigenous Aquatic Species programs, FishNet2, iNaturalist.org, GBIF, and iDigBio) to provide a better view and more complete understanding of fish species distribution. **FishMap** is sponsored by NANFA. Users can submit their own data to the portal to help map species distribution, so FishMap.org has been working with NANFA members to create an additional database of fish sightings and collections (currently nearly 30,000 records and growing).

Range and Collection Data



Compare Ranges



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.

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- *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 2025 convention will be held in early June. The location will be announced soon.**
- **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.

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(See Contents page.)