



# American Currents

Publication of the North American Native Fishes Association

Volume 48      Number 3      Summer (July) 2023



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# The North American Native Fishes Association

Est. 1972 — John Bondhus, founder

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

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# American Currents

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Nate Cathcart, Bruce Lilyea, Olaf Nelson, John Olson, Bruce Stallsmith, and Tom Watson, *Associate Editors*

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**FRONT COVER:** Greenhead Shiners *Notropis chlorocephalus*, a Bluehead Chub *Nocomis leptcephalus*, and a Rosyside Dace *Clinostomus funduloides* in a tributary of the Catawba River in McDowell County, North Carolina. (Photo by Isaac Szabo)

**BACK COVER:** Ryder and Joshua Porter dipnetting for Blackbanded Sunfish *Enneacanthus chaetodon* at Campbell Lake during the 2023 NANFA Convention in South Carolina. (Photo by Lauren Porter)

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## 50 YEARS OF AMERICAN CURRENTS ON CD OR THUMB DRIVE

Thanks to the efforts of Tom Watson, you can own PDFs of every issue of *American Currents* published from 1972 to the present. Volume #1 contains the years 1972–1988. Volume #2 contains the years 1989 through the current issue. Each volume costs \$20 for members, \$40 for non-members. Postage is \$4.50 for up to 2 volumes. Order online at <http://www.nanfa.org/cart.shtml#aconcd> and pay with Paypal. To order by mail, make check or money order payable to NANFA, indicate what media you are requesting, and send to: NANFA, PO Box 1596, Milton, WA 98354-1596.

# NANFA News

## MEMBERS, EVENTS, ACCOMPLISHMENTS, AND ADMINSTRIVIA

### NEW ADDITIONS TO EDITORIAL STAFF

We have added two new editors to our team: Nate Cathcart and Dr. Bruce Stallsmith. Nate leads the Alaska Freshwater Fish Inventory program and while a relatively new member of NANFA has already written excellent articles for *American Currents*. Bruce is a longtime member of NANFA: he was president for eight years, is Alabama Regional Rep, and hosted the 2003 convention. He is a professor of biology at the University of Alabama in Huntsville.

### Riffles Revival

In addition to joining us as an associate editor, Bruce has also agreed to lead the Riffles revival. Thank you for helping us bring back a popular AC feature, Bruce!

### DR. ED MENHINICK, 1935–2023

Dr. Edward (Ed) Fulton Menhinick passed away on April 19, 2023, at the age of 87. Ed graduated with a Bachelor of Science from Emory University, then went on to earn a master's degree from Cornell University and a PhD in biology from the University of Georgia. He taught at the University of North Carolina at Charlotte for 42 years! Dr. Menhinick loved teaching and had a real concern for his students and a desire to see them succeed in life. He is best known for his 1991 book, *The Freshwater Fishes of North Carolina*. Although not a member of NANFA, Ed donated a number of copies of his book to our convention auctions.

### FISH, FISHING, AND CONSERVATION: A NEW (FREE!) BOOK

A useful new open-access textbook, written for both specialists and non-specialists, *Fish, Fishing, and Conservation* by Donald J. Orth, is available in multiple formats for free. There are even teaching resources to go with it.

Conservation is complicated, but this book breaks it down in various ways, covering such topics as ethics and values, different approaches to management, how to involve stakeholders in decision-making, overfishing and sustainability, current science, recreational fishing, conservation organizations, gender issues in fishing, and much more. It includes case studies, illustrations, and profiles of numerous professionals who work on these issues.

Dr. Orth is the Thomas H. Jones Professor in the Department of Fish and Wildlife Conservation at Virginia Polytechnic Institute and State University.

To download the book as a pdf or ePub, go to: <https://vtechworks.lib.vt.edu/handle/10919/112741>. A print version is also available.

### NATIVE FISH OUTREACH IN TEXAS

Jeremey Jordan



NANFA member Mark Pyle helped spread awareness by showing off his impressive collection of native Texas fishes at the second annual Fort Worth Nature Center and Refuge Nature Con on April 22, 2023. Mark's native fish collection includes species such as the Dusky Darter *Percina sciera* and Plains Darter *Etheostoma pulchellum*.

### THE MOONEYE ROUNDUP

In May 2023, Bernard Sietman (Minnesota Department of Natural Resources) invited Konrad Schmidt and Jenny Kruckenberg along on a boat shocking effort to capture and implant Mooneye for a USGS telemetry study. Mooneye and Goldeye are the most common hosts for the rare Spectaclecase mussel *Cumberlandia monodonta*. Konrad and Jenny were there to photograph large fish using the method Scott Smith and Bryn Tracy demonstrated at the 2023 NANFA convention in South Carolina. Three boats launched



on the St. Croix River near Taylors Falls, MN. Konrad and Jenny followed the boat shocker and were amazed how many Mooneye were buoyed up. They netted several and handed them off to the third boat for surgical implantation of transmitters. Three large Paddlefish also surfaced, and Jenny snapped a photo of Kon with the smallest one. He tried to hoist a much larger one from the water, but his back would have none of it. Konrad and Jenny report success in photographing several species of large fishes, and the photos will be used in the *Fishes of Minnesota* (in progress).



## NATIVE FISH OUTREACH IN SACRAMENTO

Phil Farrell

Over the weekend of June 3–4, 2023, I attended the FIN DIG, a show that we, the Sacramento Aquarium Society, sponsored with other fish clubs. I set up a booth for NANFA. It was smaller than the sellers' tables, but, because I set up a live animal display highlighting fishes from this year's NANFA convention in South Carolina, it was by far the most popular display!

Of course there *were* other live animals there: shrimp, bettas, medaka (lots and lots of medaka), but they were either bagged up or in tiny containers that couldn't compete! A lot of supplies and books were on offer as well. ZooMed had a huge display right next to us, which was nice.

People came from all over: in addition to visitors from the entire state of California, we had attendees from Washington, Oregon, Arizona, and Nevada. The final total was double the anticipated attendance, so people are already working to plan and improve the show for next year. I hope to be able to do it again!

The booth was small, so I set up just one tank—a 20 long—that housed eight Redlip Shiners, a pair each of Saffron and Fieryblack shiners, three Yellowfin Shiners, a Bluehead Chub, and a single Flame Chub (I got up at 4 a.m. to catch the fish; how he got in there is anyone's guess), as well as a few nice plants. The tank was filtered with quite a bit of flow, and on the first day the Saffron Shiners actually spawned. I had actually been hoping the Fieryblacks would spawn at the event, but lots of people saw the Saffrons in their full color.

I didn't get many photos, and unfortunately you can't see the fish in the tank, but here is the NANFA booth. I'll do better next

time! (The water in the tank was crystal clear; the cloudiness in the photo is from glare on the glass.)



## A RETIREE'S SUMMER JOB COLLECTING FISH: THE JOB HE ALWAYS WANTED

In 2017, John Olson retired from a 32-year career as a water quality specialist with the Iowa Department of Natural Resources. In April of that year, he either discarded or packed-up (mostly discarded) 32 years of water quality work and left his 8-foot by 8-foot cubicle in the DNR's office building in Des Moines for the last time. Three months later he was hired by Iowa State University in Ames to conduct stream fish sampling for a long-term biological inventory project: the Multiple Species Inventory Monitoring (MSIM) project. Having worked on a statewide survey of Iowa fishes from 1981–83 and assisted with the initial phases of Iowa DNR's biological (fish and macroinvertebrate) monitoring program in the mid-1990s, he had a good background for this. With the exception of 2020, he has done this summer job every year and plans to do so as long as he is physically able (he notes that, as he is 70, this may not be long). He must enjoy it: as a retiree, if he didn't like the job, he wouldn't do it. He considers it a good retirement side gig.

The job involves sampling fish in streams on state wildlife management (public hunting) areas with one of five crews of field technicians (typically comprised of recently graduated college students with natural resource backgrounds from universities across the US) stationed across the state. Their usual daily task for the MSIM project is to inventory and document a wide range of biota—including plants, insects, freshwater mussels, birds, small mammals (including bats), reptiles, amphibians, and fish—on the state wildlife management areas in their district. John's job is to pick a day to show up at a state wildlife area with two backpack electrofishers; the crew and John then collect, identify, and count the fish seen. Very few of the field techs have electrofished before or have any background in fish ID, but the chance to get away from their daily inventory routines and spend a half-day sampling fish in a stream is very appealing to them. It is interesting how quickly the techs become interested in fish ID when, on a hot summer afternoon, they realize how long it takes John to do the ID and counting by



### NANFA News, continued

himself. The results of the fish sampling—like all the inventory information—are entered into a database.

Iowa's publicly owned wildlife management areas often cover hundreds of acres, and the stream systems in these areas tend to be in better condition than streams in agricultural areas that dominate the Iowa landscape. John and the crews of field techs

have found some interesting fishes over the last five seasons, including several seldom-seen and/or state-listed species such as Pirate Perch *Aphredoderus sayanus*, Freckled Madtom *Noturus nocturnus*, and Western Sand Darter *Ammocrypta clara* (very common in Iowa's segment of the Upper Mississippi River but much less so in its interior waters).



MSIM field techs sampling fish in a stream in northeast Iowa in early October 2022.

### SANDHILLS CHUB MEDIA OUTREACH

NANFA members Riley Phelps and Zach Ramsey, graduate students at Coastal Carolina University, prepared the following media write up. It has been posted on the NANFA Facebook page and Instagram.

#### Meet the Sandhills Chub!

The Sandhills Chub *Semotilus lumbee* is a small stream fish found only in the Sandhills of the Carolinas and nowhere else in the world. Much like many other headwater stream fish species, Sandhills Chubs are found in cool, clear streams, with abundant cover. They prefer stream bottoms that consist of sand and small gravel, which males use to make nests for females to lay their eggs in. Increased land disturbance, specific habitat requirements, and small geographic range make the Sandhills Chub vulnerable to population losses and declines. Unfortunately, Sandhills Chub are considered vulnerable across their range. Often confused with its close relative, the Creek Chub *Semotilus atromaculatus*, little is known about the Sandhills Chub.

Recently, Coastal Carolina University graduate students Zach Ramsey and Riley Phelps and Associate Professor Dr. Derek Crane started a collaborative research project with SCDNR, NCWRC, and the Department of Defense conducting research on Sandhills Chub movement and genetics. Sandhills Chubs are

being implanted with small tags to track their movement, and DNA samples in the form of fin clips are being collected from each fish. DNA samples will be used to determine how closely related individuals are from different streams and determine if human stream alteration, such as construction of dams, is associated with bottlenecks or isolation events. Funding for this research is provided by the US Fish and Wildlife Service's Competitive State Wildlife Grant program.





# MEMORIES OF BRUCE BAUER

**Casper Cox**

Chattanooga, Tennessee

I shared many great times with Bruce Bauer, two of which I will share here. I first got to know Bruce by attending various fishy gatherings such as the annual meetings of the Southeastern Fishes Council and various University of Tennessee/Conservation Fisheries Inc. events. We talked of our various sunfish observations, the UT Fish Lab, Dr. Etnier's contributions, and generally anything fishy.

In 2018, I invited all Tennessee NANFans to aid in the Tennessee River Rescue event held here in Chattanooga on the first Saturday of October each year. Being an active TN NANFA member, he wanted to help, but since he could not make it that Saturday, he came down a week early and helped gather trash in North Chickamauga Creek, a tributary to the Tennessee. It often flows clear during the summer, as it is spring-fed, but it is cold at about 60° F. I had been gathering trash while snorkeling in the creek for several years. Though it was a sunny day, Bruce was soon shivering and relegated himself to above the surface, wading and carrying tires, bags of glass, and trash to the creekside. Though his teeth were chattering, he was in good spirits throughout the day as we jostled, laughed, and heave-hoed. I recall my daughter Cyan, along with her friend Julie, pulling the tethered trash and tires up the steep banks. Afterwards I treated us to a Cajun meal just down the road, funded in part by a gallon jar of found coinage. Late that afternoon we visited my home at Blue Fish Ridge and took a refreshing dip in the cement pond before Bruce returned northward to Knoxville.

Another extended interaction I had with Bruce was as an editor of my *Snorkeling the Hidden Rivers of Southern Appalachia*. He was always keen to offer suggestions. Bruce asked me to remove my spiritual leanings from the guide—I suspect because of his academic viewpoint—but I remained committed to my beliefs. His input, along with that of Konrad Schmidt and Fritz Rohde, made for a better read.

Thank you, Bruce. I enjoyed your productive assistance with my unusual efforts.



A very chilly Bruce ready to hoist one of many soggy creek tires.

**Chris T. McAllister and  
Henry W. “Rob” Robison**

Reno, Texas and Sherwood, Arkansas

It was on an eventful trip on May 25, 2021, to various spring-fed watersheds in the Ouachita Mountains near Mena, Arkansas, where we met Bruce and his longtime friend, Richard T. “Dick” Bryant. Bruce had driven all the way from Knoxville, Tennessee, and Dick from New Mexico. Bruce had asked us to accompany him and Dick in the field as he was in need of professional photographs of some Longear Sunfish *Lepomis megalotis* that he believed to represent a new species. Rob and I enjoyed every minute of this field trip as we shared many Bruce “fish” stories, big and small. His wide knowledge of fish diversity and taxonomy, as well as his background in documenting the occurrence of species of aquatic insects, was impressive. Bruce was also a very good listener and our conversations on this trip and pulling a seine with him all proved to be unforgettable. After a long, hot day of collecting, and after much-needed showers, the group moved to a local restaurant in Mena, the Branding Iron BBQ and Steakhouse. As we recall, Bruce enjoyed a big steak and baked potato with all the fixings. Regrettably, the outing came to an end after dinner. Before leaving we stood for a group photograph, shook hands and hugged, then went our separate ways. This single day with Bruce was memorable in many ways, and we will miss his presence. He was a fine ichthyologist and aquatic ecologist. RIP, Bruce.

His obituary asks that individuals please consider a contribution to the David Etnier Ichthyological Collection, Department of Ecology & Evolutionary Biology, University of Tennessee, 569 Dabney Hall, Knoxville, TN 37996.



From left: Dr. Chris T. McAllister, Richard T. (Dick) Bryant, Dr. Henry W. Robison, and Bruce Bauer in Mena, Arkansas, May 2021.



# THE PASSING OF DR. DAVID ALLEN ETNIER

J.R. Shute

Knoxville, Tennessee

On May 17, 2023, we lost a giant among naturalists. Dr. Etnier, “Ets” to most of us that knew him, was 84 at the time of his passing. He was born and educated in Minnesota. He received his PhD from the University of Minnesota while studying under Dr. Samuel Eddy. He used to say that his dissertation involved mostly fishing for Bluegill, and the finished product was less than 20 pages long...the shortest dissertation from the University. I must take his word on this as I haven’t looked it up!

He began his teaching career at the University of Tennessee in 1965, going on to teach Ichthyology (students were almost always asked to spell this on the final...a large portion missed it!), Aquatic Insects, Ecology and perhaps his most loved class, Regional Faunas!

Over his career, he authored and co-authored over 70 publications, including *The Fishes of Tennessee*; he formally described and named 22 newly discovered animal species, including the Snail Darter, and had nine newly discovered species named in his honor by colleagues.

But this is all old news to many of his colleagues and students. I want to talk about my major professor, mentor, and most of all, friend. Ets was easy to be around. He had a dry, Minnesota humor about him. If you enjoyed going out in the field to look for fish, aquatic insects, mussels or even birds, you’d probably get along just fine. Personally, I learned so much more than fish from Ets. He was literally one of the last great naturalists. So many universities today don’t really teach you about the animals you are studying, at least not from the perspective of a field biologist. And the ones that do are often under the direction of one of his students or students of *those* students. I like to call them Ets’ F-1 and F-2 generations! I know there will be generations to follow! Ets would often say “You don’t know an animal ‘till you’ve eaten it!” I was never quite sure if he

meant this literally or figuratively. I’d kind of like to think he meant that you can’t really know the creatures you’re working with until you get out there and study them. Countless times, when he would be collecting with a group, some novice student would bring some dirt common fish up to him to ask what it was. He almost always acted as if it was a really good find and “here’s what’s special about this fish (or bug, or crayfish, etc.).

Traveling with Ets was *always* an adventure! I can remember more than once not leaving UT until 9:00 PM or later to drive to the western part of Tennessee or beyond. We’d drive all night, maybe even doing a night collection along the way. As morning came, we’d start looking for some hole-in-the-wall place for good biscuits and gravy. If he *knew* of a good place, we might drive 100 miles out of the way to eat there! After breakfast, we’d look for an inviting field or bridge where we could throw down sleeping bags and catch a couple hours sleep. One time we were sleeping under a bridge over the Hatchie River. There was a huge sign under the bridge that said, “NO CAMPING.” We ignored it. Sometime in the middle of the night, a TWRA officer drove up asking who was in charge. Ets rolled out of his old VW bus and said he was. The officer went on to point out that camping wasn’t allowed. Ets came back with “Officer, sir, we’re not camping! You don’t see any tents, do you? We’re just sleeping here.” The officer looked at him for a minute, then said, “Dr. Etnier?” Turns out he was a former student! He came back in the morning and collected fishes with us. We always called this “The Luck of the Etnier.” And this was certainly not the only time this happened. There were cases of arrests being made. I can think of one or two where someone ended up in jail (fortunately, not me).

When driving, Ets would usually navigate by the seat of his pants. There were times we had no idea exactly where we were. Ets



Ets with a group of his past students at the USFWS award ceremony.



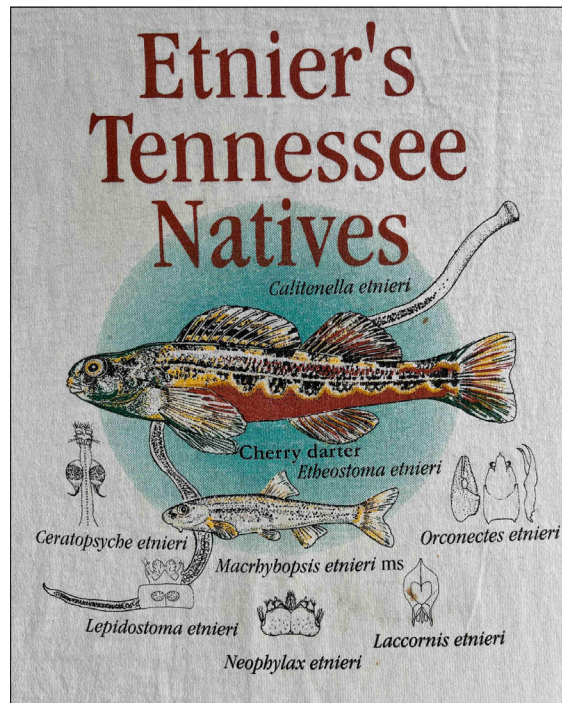
Ets receiving the Lifetime Achievement Award from USFWS director Martha Williams.



would just say, “Well, we’re heading in the right direction and we’re making good time.” We usually got there, eventually.

Ets had a number of quotes he would throw out from time to time: “The sleeping dog fears not the chicken” (yeah, I don’t know either). But the one I remember most was something he said he wanted on his gravestone: “He was good with meat.”

The last time I saw Ets was at a ceremony for the delisting of the Snail Darter. He got up to say a few words, which turned into more than a few and strayed off pretty quickly because of his dementia. In spite of his illness, his intelligence and humor still shone through. It was a difficult but beautiful moment. He was awarded the Lifetime Achievement Award from the US Fish and Wildlife Service, which was presented by the National Director, Martha Williams.



A t-shirt showing species named after David Etnier.

It was such an honor to know this guy. Our work at Conservation Fisheries, Inc. likely never would have begun if it had not been for him. I was asked recently if his legacy was the discovery of the Snail Darter. I said I didn’t believe so. His legacy is his students and their students and the ones that will come after that! The F-1s, F-2s and beyond. And the impact all of them will have on the world.

Rest easy Ets. Thank you for what you did for me and so many others. Yours was a life well lived. I know I will miss you.

**Editor’s Note:** David’s family has asked that individuals please consider a contribution to the David Etnier Ichthyological Collection, Department of Ecology & Evolutionary Biology, University of Tennessee, 569 Dabney Hall, Knoxville, TN 37996 or Conservation Fisheries, Inc., 3424 Division St., Knoxville, TN 37919.

## FOND MEMORIES OF BRUCE BAUER AND DAVID ETNIER

Gerry Dinkins

Knoxville, Tennessee

On September 21, 1978, I was a third-year undergraduate at the University of Tennessee majoring in Wildlife and Fisheries Science, and I had enrolled in Zoology 4200—Ichthyology. It was the first day of the fall quarter, and about 25 of us were sitting in a large classroom on the first floor of the Humanities Complex, eagerly awaiting the arrival of our instructor, Dr. David Etnier. At the time, controversy over the Tennessee Valley Authority’s Tellico Dam project was at its zenith. The project was being held up by the presence of the Snail Darter *Percina tanasi*, which was only known to occur in the lower reach of the Little Tennessee River—a section of river that was to be impounded by Tellico Dam—and had recently been placed on the Endangered Species List by the Department of the Interior. Completion of the dam posed a significant threat to the continued existence of the Snail Darter, and we knew the instructor had discovered and described the species a few years earlier. We were also aware that Dr. Etnier was a notoriously demanding teacher, and Zoology 4200 would be challenging, but a Bachelor of Science degree in Wildlife and Fisheries Science required passing it. Against this backdrop, into the classroom strolled Dr. Etnier and his teaching assistants, Bruce Bauer and John Harris. Bruce was investigating the Longear Sunfish *Lepomis megalotis* and trying to resolve the relationships between the various forms and subspecies within this wide-ranging species. John was examining the systematics, biology, and distribution of

fishes in the genus *Hybopsis*, subgenus *Erimystax*. Both were second year PhD candidates in Dr. Etnier’s laboratory. Together, they guided our class in learning to identify marine and freshwater fishes. For several of us, Bauer, Harris, and Etnier would become parts of our personal and professional lives from that first day forward.

A year later I graduated with my B.S., was accepted into the Ecology graduate program, and joined the Etnier lab on Terrace Avenue. I was part of an incoming cohort consisting of Peggy and J.R. Shute, Rick LeDuc, Steve Layman, Wendell Pennington, Patti Hovater, and Jim Norton, filling spots recently vacated by Noel Burkhead, Jim Beets, and Dick Bryant, and joining the existing Etnier graduate student pool of Jerry Louton, Christine Eason, Andy Haines, Bill Dickinson, John Wojtowicz, Mike Ryon, and, of course, Bruce Bauer and John Harris. Fieldwork and cataloging specimens were the major activities at the lab during the day, and sports were big after hours. Bruce was a central figure in both. He was the organizer, team captain, head of recruiting, and pitcher on our softball team. Harris was our first baseman and our go-to-guy on the basketball team, having played college ball in Arkansas. Etnier excelled at all sports and as fearless in the sports arena as in the field of ichthyology. Life at the lab was never dull, and practical jokes were common. A year or so after Harris left UT to take a job in Arkansas, he mailed Etnier a draft of his dissertation. For a couple weeks, Etnier carried

all 352 pages of the dissertation around with him, and it was in his van when an engine fire destroyed the vehicle. The dissertation survived, although it was completely soaked by the fire hoses. Etnier spread the 352 pages around the lab to dry for a few days, causing them to wrinkle and swell, then completed his review, put the dissertation in a box, and mailed it back to Harris without explaining why it was charred, smelled of smoke, and had doubled in thickness.

Twice a year, Etnier took most of his grad students on an extended field trip, known as "Regional Faunas," to the remote streams and rivers of the central and eastern US, where we spent the days collecting specimens, and the nights eating and standing by a nice campfire before retiring to a sleeping bag under a bridge or in someone's pasture or woods. Our interactions with local authorities were limited and generally went well, but there were a few instances where a "misunderstanding" required us to accompany the local sheriff to town so the issue that had brought us together with the constable could be sorted out. One such "misunderstanding" occurred in the parking lot of a Piggly Wiggly in Holly Springs, Mississippi. After we were interviewed at the police station, the Sheriff instructed our group in general and Bruce in particular that it would be in our collective best interest to soon be on the other side of the "Welcome to Holly Springs" sign. And by soon, he meant in a few minutes.

Bruce grew up on a small farm outside of Cincinnati, Ohio, and graduated in 1973 from Eastern Kentucky University with a B.S. in Fisheries Biology. At ECU he met Branley Branson and was introduced to freshwater fishes, even publishing a paper with Branson on the ecology of the Greenside Darter *Etheostoma blennioides*. From ECU, he proceeded to Tennessee Technology University for his M.S. in Fisheries Biology/Management. Then he came to UT, enrolled in the PhD program, and studied under Etnier. Although Bruce left

before completing his PhD, while at UT he published nine peer-reviewed papers on freshwater fishes and was a founding member and an early president of the Southeastern Fishes Council, a nonprofit scientific organization dedicated to the study and conservation of freshwater and coastal fishes of the southeastern US. After leaving UT, he published a paper with Etnier and Noel Burkhead describing the Cherokee Darter *Etheostoma scotti*, a species endemic to the Etowah River system in north Georgia. Eventually, Bruce resumed his research on the Longear Sunfish complex and near the end of his life began collaborating with Tom Near and Daemin Kim of Yale University. Together, they published a paper on the complex and revealed several undescribed species. Bruce's research will continue.


When Bruce left UT, he began his professional career in the environmental consulting field in Atlanta, and from there he went to Orlando, Florida, where he spent many years working as a consultant and providing services to a number of large clients in central Florida. In the late 1990s, I worked at an environmental consulting company in Knoxville that was looking to add another senior biologist to its staff. Bruce interviewed for the position, was hired, and moved to Knoxville. Over the next 25 years, Bruce and I traveled widely and worked together on a number of projects. When he retired, Bruce began volunteering as an assistant curator in UT's fish and aquatic insect collection, now named after our major professor, David Etnier. Several years ago, Bruce took on the monumental task of digitizing Etnier's field notes and Trichopteran collection, which he had almost completed at the time of his unexpected death.

This year, David Etnier and Bruce Bauer passed away within a few months of each other, but their legacy in the field of freshwater ichthyology and mentoring aspiring aquatic biologists lives on.

## American Currents

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AN UPDATED ANNOTATED  
LIST OF WISCONSIN'S FISHES

John Lyons and Konrad Schmidt

Members received their copies of this special issue of *American Currents* in December, but a limited number are available. Nearly double the usual length, it covers 164 species, with a complete checklist, species profiles, the latest science, current distribution data, name changes, an extensive bibliography, and more.

**\$25 (free shipping)**

<http://www.nanfa.org/cart.shtml#WISC>





# REMEMBERING EDWIN PHILIP “PHIL” PISTER, 1929–2023

Konrad Schmidt

Saint Paul, Minnesota

Wisconsin had Aldo Leopold, who fundamentally changed long-accepted but flawed concepts about wildlife management. California had Phil Pister, who continued and advanced Leopold's philosophy in the desert environments. In 1969, several years before the Endangered Species Act, he single-handedly saved the Owens Pupfish *Cyprinodon radiosus*. Actually, it took both his hands to carry the two buckets containing the last of the species from the rapidly drying pond at Fish Slough, where they would likely have gone extinct.

The first time I met Phil was at a Desert Fishes Council (DFC) meeting in the 1980s. He noticed the new face and made me feel right at home, introducing me to other DFC members who humorously questioned why any fish biologists would work in Minnesota where the field season only lasts for two months. Phil kept checking on me during the entire meeting to make sure I would not miss anything important. We kept in touch and, in the 1990s, he came to Minnesota as a guest speaker for a Department of Natural Resources event internally known as “Fisheries School.” In the evenings he offered optional presentations, which were always packed. The man could tell a story that the audience never wanted to end! His presentations were always filled with Aldo Leopold quotes, and I wondered what the connection was. In researching this remembrance, I found that Phil started college as a pre-med major but was not satisfied with his choice. He enrolled in a wildlife course at U.C. Berkley taught by A. Starker Leopold (son of Aldo), and that course changed his entire career trajectory. Phil took pride in sharing the same birthday as Martin Luther King Jr. and would say, “Perhaps that was a good day for rebels.” He also had a favorite Aldo Leopold quote: “Nonconformity is the highest evolutionary attainment of social animals.”

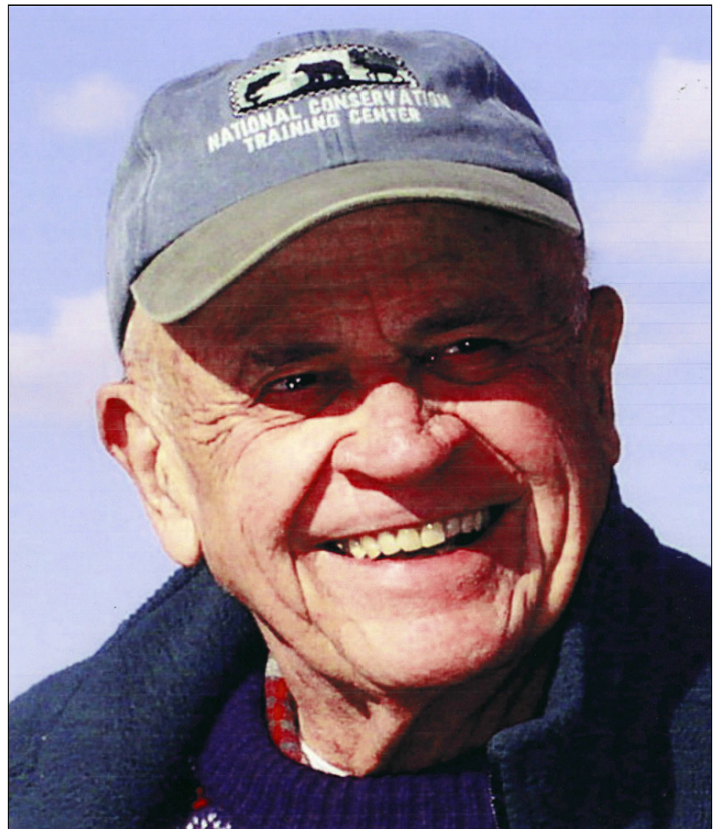
Phil was one of the founding members of the Desert Fishes Council and was involved in many successful efforts protecting and conserving desert fishes. He was active in conservation for 70 years and received countless accolades and awards.

As the co-editor of *American Currents*, I am honored to have reprinted three of his wonderful articles highlighting his impressive accomplishments: “Species in a Bucket” (recounting that night in 1969), “Pure Colorado Trout Saved by California,” and “How I got to where I am today.” All can be accessed in the *American Currents* archives: <http://www.nanfa.org/ac2.shtml>

The impact Phil's lifetime of work toward saving imperiled fishes has had on the field is too vast to cover here. I will simply mention that two species of desert fishes have been named in his honor. In the description of the Palomos Pupfish *Cyprinodon pisteri* Miller & Minckley 2002, found in Chihuahua, Mexico, the authors explain the name thus: “For almost four decades, Phil Pister has unerringly and effectively performed the daunting task of preserving the integrity of natural aquatic habitats and biotas

in North American deserts, along the way teaching others to do the same. His infectious and tireless persistence, enthusiasm, optimistic outlook, and unique capability to redirect conflicting views toward common goals have led to significant and enviable successes in equating science and a strong environmental ethic with political reality.” The second species named for him is a double tribute, recognizing Phil in both its common and scientific names. The Conservationist Killifish *Fundulus philpisteri* García-Ramírez, Contreras-Balderas & Lozano-Vilano 2007 is found in Nuevo León, Mexico. The specific epithet was chosen to highlight Phil's dedication to the field of ichthyology, to teaching, and to promoting and conserving desert fishes and ecosystems.

Phil was a genuine conservation hero, and the internet is full of articles, tributes, videos, and photos. The Aldo Leopold Society posted a remembrance at <https://www.aldoleopold.org/post/remembering-phil-pister/> and a story on National Public Radio features archival audio of Phil: <https://www.npr.org/2023/01/26/1151803330/biologist-phil-pister-who-single-handedly-saved-species-from-extinction-dead-at-9>.



Phil Pister at Fish Slough.



# A RECAP OF THE 2023 NANFA CONVENTION IN SOUTH CAROLINA

After several false starts due to COVID, the 2023 NANFA convention hosted by Dustin Smith was an outstanding success, with over 100 attendees from 24 states. The editors asked Jenny Kruckenberg to provide a summary of the talks, as she has done for previous conventions, and have tried to capture the essence of her extensive work. Dustin would like to thank the following for helping plan and conduct the convention: Stephen Beaman, James Clanton, Matt Knepley, Chip Rinehart, and Fritz Rohde.

## THURSDAY AFTERNOON

Two events were scheduled for the afternoon. Scott Smith and Bryn Tracy, from the NCFishes.com Team, demonstrated how to get superb photos of large riverine fishes (caught from the Congaree River by South Carolina Department of Natural Resources [SCDNR] biologists. Fritz Rohde hosted a visit to the Columbia Dam and its fishway with Shane Boring explaining the project's history.



## FRIDAY PRESENTATIONS

### COLUMBIA DAM FISHWAY

Shane Boring, JMT Inc., Lexington, SC

When this hydroelectric plant was built on the Broad River in Columbia, SC, in 1986, it was the second largest on the East coast. As part of the federal relicensing of the facility in 2005, the city was required to provide upstream passage for migratory fishes such as American Eel, American Shad, and Blueback Herring. As a result, the Columbia Fishway was built in 2007 along the east bank of the river alongside the Columbia Diversion Dam. It is a vertical slot fishway where fish can move upstream through the slots and then rest in the eddies provided before continuing upstream. A viewing window is provided for biologists to count and identify the fishes as they pass upstream. Monitoring is done five days a week from early March to mid-May. There have been challenges. A 2015 flood rendered the hydroelectric plant inoperable and breached the dike of the canal. Such "100-year" floods are occurring more frequently in recent

years. When river levels are high, the viewing window is inundated and the water is extremely turbid.



Fish counts began in 2007 and, while the emphasis is on shad and herring, all species that pass are enumerated. In 2022, 17 species in six families were observed using the fishway. The data can be highly variable. For instance, in 2021, over 1,000 American Shad were counted while in 2022, only 103 were noted; this was the lowest number of American Shad in the 16 years of data gathering. Environmental factors such as temperature usually influence the numbers. If water temperature is 15–16° C, the shad are there; if it's too cold, they aren't. Gizzard Shad and Threadfin Shad are the most abundant fishes that use the fishway, and a number of sucker species commonly use it.

## DARTER RECOVERY IN OHIO: THANK YOU, CLEAN WATER ACT

Brian Zimmerman, The Ohio State University

Brian talked about the 22 species of darters native to Ohio and the remarkable recovery they are making in Ohio streams. The Clean Water Act, the creation of the Ohio Environmental Agency, concern over non-point sources, and the creation of H2Ohio have all played huge roles in improving water quality. In 1974, eight darters were listed as endangered and four others should have been listed. As of 2022, improvements (higher numbers, range expansions) have been observed in nine of the 12 species.

### Recovery Through Time

Changes in status of Ohio's listed Darter Species...

	1974	1987	1990	1992	1997	2002	2007	2012	2017	2022	
Diamond Darter			ER	ER	ER	ER	ER	ER	ER	ER	
Eastern Sand Darter	E		SC	SC	SC	SC	SC	SC	SC	SC	
Gilt Darter			ER	ER	ER	ER	ER	E	E	E	Extinct EX
Longhead Darter	E	E	ER	ER	ER	ER	ER	ER	ER	ER	Extirpated ER
Channel Darter	E	E	E	E	T	T	T	T	T	T	Endangered E
River Darter	E	E	T	T	T	T	T	T	T	T	Threatened T
Slenderhead Darter	E		SC								Species of Concern SC
Spotted Darter	E	E	E	E	E	E	E	E	E	E	Not Listed/Common
Tippecanoe Darter	E		T	T	T	T	T	T	T	SC	
Bluebreast Darter			T	T	T	T	T				
Iowa Darter	E		SC	SC	SC	SC	SC	E	E	E	
Least Darter					SC	SC	SC	SC	SC	SC	

Brian has been involved in reintroductions of Ohio's fishes in greatest conservation need with a focus on translocation of riverine

species and on captive propagation of wetland/natural lake-oriented species. He has four projects currently underway involving the Bluebreast, Longhead, Variegated, and Tippecanoe darters, and two more projects (Mountain Madtom and Tippecanoe Darters in a different river) planned for 2023. Unlike many states, Ohio does not have a state-funded nongame biologist—it's all on Brian.

There was too much information in this 20-minute talk to capture here, but the future of Ohio's darters is looking better.

#### WHAT IN THE WORLD IS A DARTER HUNT Jen Kruckenberg, Inver Grove Heights, Minnesota

I got started young with fish as my family had a 55-gallon aquarium in our living room. Eventually, we had five tanks around the house. My little brother and I were tasked with cleaning the tanks, etc. In high school, college, and even after I got married and had kids, I always had at least two tanks running. One day at a pet store buying fish supplies I noticed a flyer for a fish show put on by the Minnesota Aquarium Society (MAS) and decided this was a good opportunity for me to get away from my husband and kids and do something I wanted to do. The show was inspiring, with MAS members' tanks bubbling away among the ferns and flowers of the Como Park Conservatory. I joined MAS right away and eventually got sucked into club activities and did artwork for our publication, the *Aqua News*.

Besides the show, another MAS activity that year was an opportunity to collect darters. They had a permit from the DNR to do this, and I joined them with my waders at the Cannon River. My first encounter was with some colorful male darters and I was in awe. When the Darter Hunt needed a new organizer, I volunteered. I applied for the necessary educational permit from the DNR, and it was granted.

The water bodies we went to were always chilly in May, but it was refreshing on a warm day. I was always kind of scared we were going to lose some kids on the darter hunts. Generally, we would keep the kids upstream of the nets, but some were actually excellent swimmers, and it was like being in a wave pool for them.

In addition to the Cannon River, we eventually expanded to include two more sites: Belle Creek, which had beautiful Fantail Darters, and the Old Mill Stream near the tiny town of Marine on St. Croix, which yielded the gorgeous Rainbow Darter. My friend Randy Carey always wanted to call it a "darter collection" versus a "darter hunt," but I liked calling it a "hunt" because, like an Easter egg hunt, we never knew what we were going to get!

NANFA's founder, John Bondhus, and his daughter joined us in 2003. I was able to get a roster of NANFA members and invited them to a "hunt." At this point, I asked DNR for an increase in our quota of darters from 50 to 75. John B. laughed at me and said, "Jenny, do you know how many darters are in any given stretch of the Cannon River?" I just didn't want people taking home too many. At some point, I contacted Konrad for advice about where else we could go. I faithfully gave a report to the DNR every year about where we had gone, who was taking what darters home, and other species we encountered. The DNR would continue granting the permit but over the years it went from one page to seven. It listed which locations were "infested" (e.g., with Zebra Mussels) and which were not, causing us to use separate gear and dictating in what order the sites were sampled ("uninfested" locations before "infested" ones to avoid spreading anything). The DNR also required bringing transport water from home, which was sometimes not the best for the fish.



#### STURGEON IN SOUTH CAROLINA Ellen Waldrop, SCDNR

Ellen's section of the SCDNR, the Diadromous Fish Section, is responsible for managing the five such species found in South Carolina: American Eel, Blueback Herring, American Shad, Atlantic Sturgeon, and Shortnose Sturgeon. The two sturgeon species can be found off the Atlantic coast from Canada to northern Florida; both are on the federal endangered species list. The Shortnose is smaller, weighing less than 50 pounds; the Atlantic is much larger, at up to 14 feet long and 800 pounds. Overfishing (for caviar) has caused a large decline in the numbers of both species, as has habitat loss due to dams that block upstream movement.

SCDNR has been setting nets to capture both species to be weighed, measured, and given an internal acoustic transmitter that can be detected by acoustic receivers. The tags can last from two months to 10 years depending on various factors. SCDNR has receivers spread throughout their rivers. Many of their studies have been funded either by the power companies who operate hydroelectric power plants on the major rivers or by state ports who wish to expand their facilities to attract larger container ships.

For example, Duke Energy is funding spawning habitat, population, and movement studies in the Great Pee Dee River and the Winyah Bay system in northeast SC, even though their hydroelectric plant and dam are upriver in North Carolina, 188 miles from the mouth. Since 2017, they have put transmitters into about 160 large Atlantic Sturgeon. They spawn in the Pee Dee River and, surprisingly, there are two peaks: one cohort spawns in the spring and one in the fall! This dual spawning has only been recently noted in one other southern river. Only one fish went as far as the dam; all the others stayed downstream in South Carolina. Different parts of the river are used by the spring and fall spawners, and genetic analysis has found that the two groups are genetically distinct. (The Shortnose Sturgeon only spawn in the spring.)

A SCDNR study involving the Shortnose Sturgeon population in the Cooper River below Pinopolis Dam, which is part of the Santee Cooper Hydroelectric Project, has been going since 1996. The dam was built to divert the Santee River into the much shorter



and tidal Cooper River, which moved Shortnose Sturgeon from the Santee into the Cooper. The adult population has been hovering around 200 individuals for quite some time and recruitment is low to non-existent. Santee Cooper just renewed their license, and one requirement is to translocate 50 adult Shortnose Sturgeon per year back into the Santee River.



There are a lot of sturgeon studies in the Savannah River, which forms the border between South Carolina and Georgia. Sturgeon movements are being monitored in Savannah Harbor as part of an expansion project, and adults of both species are tracked as they move upriver to spawn. The New Savannah Bluff Lock and Dam at Augusta (187 miles from the mouth) blocks upstream migration.

#### NATIVE FISH FOR TOMORROW

Drew Geving, MN, [Roughfish.com](http://Roughfish.com)

Drew spoke briefly about a new nonprofit organization called Native Fish for Tomorrow (or NF4T for short). Most of their work so far has been in Minnesota, where they have worked with state legislators and the MN DNR to change the way native fishes are treated in laws and regulations. The “No Junk Fish” bill they supported has since passed both houses of the MN legislature and has been signed by the governor. It requires the DNR to figure out how to differentiate native species currently called “rough fish” from non-native and invasive species such as the various carps, and to regulate native species scientifically. NF4T hopes these early successes in MN will help spread the word to other states. Another focus is education. The group intends to provide signage at boat ramps and other places where the public gets into the water clarifying the differences between native and invasive fishes. They are working with scientists to get more research on native fishes off the ground. The group is also working to get better enforcement of existing waste laws so people will stop killing fish and throwing them on the bank or in the trash. See <https://nativefishfortomorrow.org/> for more information.

#### USE OF eDNA FOR BLACKBANDED SUNFISH CONSERVATION IN SOUTH CAROLINA AND GEORGIA

Kevin Kubach, SCDNR

If you Google eDNA you will get many, many obituaries for women named Edna, so search for “environmental DNA” instead. The definition is broad and includes any genetic material that is no longer with the organism. This material can be found in sediments/soil, air, and water. It is a way to look for the presence of rare or elusive fish and for detecting invasive species. Kevin likened it to a crime scene where samples are collected then analyzed.

The species they were looking for was the Blackbanded Sunfish, a small centrarchid, which inhabits backwaters with low pH, black

water, and swampy conditions with heavy vegetation. This species is imperiled over its entire range. It’s doing the best in South Carolina, ranging from abundant in some areas to a very low density in others. It is endangered in Georgia. During the 2000s, Georgia biologists sampled at 350 sites and found Blackbanded Sunfish at only two.

SCDNR chose to sample 30 sites (some random) for eDNA, and nine sites tested positive for the presence of the sunfish. Seven were randomly chosen; two were sites where they had been seen before. SCDNR went back to sample with dipnets, trap nets, and backpack electrofishers and found the sunfish at nine sites. In comparison, Georgia expected to detect Blackbanded Sunfish eDNA at one site and found it at five. Four sites were new: this was huge! In Georgia, despite the positive eDNA results, only one fish was found at one site. They found hundreds of Bluespotted Sunfish but no Blackbanded. Kevin concluded that the eDNA tool is effective, that genetic diversity in Blackbanded Sunfish is low across its range, and that there are conservation implications.

#### A PROGRESS REPORT ON THE DESCRIPTION OF THE THINLIP CHUB *CYPRINELLA* SP.

Bryn Tracy, Apex, NC

Fritz jokingly suggested that this talk should have been called “Why it’s hard to describe a fish.” While the Thinlip Chub has been known to be distinct since the 1970s, it has not been described. It is a species of greatest conservation need in North Carolina but can’t be given more stringent protection until it is described.

The Thinlip Chub, in the genus *Cyprinella*, is around 90 mm long with dark pigment along the top of its back and diamond-shaped scales. Three species of *Cyprinella* in North and South Carolina—Thicklip, Santee, and Thinlip chubs—have barbels at the bottom of the mouth. Using adults of both sexes, Bryn has done extensive meristic counts and morphometric measurements on the three species. In all, he took six pictures each of 120 (a total of 720 images). He has looked at 25–30 landmarks and 10 characteristics, for a total of 4,400 data points. Co-authors are working-up the genetic analyses.

#### PHYLOGENOMIC INVESTIGATIONS OF THE *HYDROPHLOX* GROUP, WITH EMPHASIS ON THE GREENHEAD/YELLOWFIN SHINER COMPLEX

Fritz Rohde, NOAA Fisheries Service

Fritz began by apologizing for any mistakes he would make, since he was presenting on behalf of Zach Alley, who had done the study for his Master’s thesis at the University of West Alabama.

*Hydrophlox* are a group of charismatic minnows endemic to the southeastern US known for their communal spawning behavior, chub mound association, and bright nuptial spawning coloration. Initially, 10 species were included in this genus/subgenus: Rosyface, Highland, Tennessee, Rainbow, Yellowfin, Rough, Greenhead, Saffron, and Redlip shiners, and Ozark Minnow. In her PhD studies, Molly Cashner whittled the group down to five species: Redlip, Saffron, Greenhead, Yellowfin, and Rainbow shiners. Earlier, Wood and Mayden had recognized that the Greenhead Shiner included an undescribed species that was later named the Piedmont Shiner.

Zach’s thesis included the following three objectives: chart the range of the Yellowfin and the Greenhead shiners, determine if his work agreed with Cashner’s, and describe nuptial coloration. He used Diversity Arrays Technology (DART) to assess nucleotide polymorphisms across the range of the *Hydrophlox* group. Looking



at the Greenhead/Piedmont/Yellowfin complex produced these results: Greenhead Shiner is in the Catawba, Piedmont Shiner in the Broad, and Yellowfin Shiner from the Saluda westward.


Zach's findings adequately explained the genetics, but questions remained about the phenotypes (i.e., how they look). There is a lot of plasticity and variability across the Greenhead/Piedmont/Yellowfin complex. Basically, you can't tell by looking at a fish which species it is. You have to know where it came from; even then, identification to species can be difficult. All of the fish in this photograph came from the same creek on the same day and are presumptive Greenhead Shiner from the Lynch's drainage. This work will continue.



### SUCKER DIVERSITY, DISTRIBUTION AND RECOVERY IN WESTERN NORTH CAROLINA


Luke Etchison, NC Wildlife Resources Commission

Luke is the river conservation biologist for western North Carolina. He works with fishes, crayfishes, mussels, and even aquatic snails. Suckers are important in many ways. They have close associations with mussels, some of which are endangered. For example, the Appalachian Elktoe is doing well where suckers are abundant but struggling where they are absent. Suckers are the "salmon of the South": their spawning migrations move nutrients within river ecosystems.



### WNC Sucker Projects

- Sicklefin Redhorse monitoring and restoration
  - Mark Recapture (PIT Tagging)
    - Hiwassee River Basin
    - Little Tennessee River Basin
- Reintroduction of Black Buffalo, Smallmouth Buffalo, and Smallmouth Redhorse in the French Broad River basin



NCFishes.com

Years ago, 50,000 buffalo (plus other suckers) might have made spring spawning runs up streams that are now missing suckers. Why? Factors limiting sucker abundance include land use practices such as logging, physical barriers such as dams, and manipulation such as dredging. Luke is concentrating his efforts on reintroduction of three suckers into the French Broad River basin (Black Buffalo, Smallmouth Buffalo, and Smallmouth Redhorse) and on restoration efforts for the Sicklefin Redhorse, which has not been formally described. The Cherokee people have long known them as "Ugiidatli," which means "wearing a feather," describing the dorsal fin.

Luke uses fyke nets in the Hiwassee River to trap Sicklefins. This method works well in shallow streams, especially in those that they cannot float a boat down easily. Otters are a problem, as the fyke nets provide them a "sucker buffet." Over the past four years they have captured and moved 94 fish; only a couple have been recaptured.

In contrast, on the Little Tennessee River, he can use a boat and electrofishing. They try to do this when the fish are coming together to spawn in order to collect the fish for their eggs and milt. So far, they have tagged 1,233 fish and recaptured 324.

Oxbows that were eliminated in western North Carolina rivers are slowly being restored. Some of these restoration projects were designed to benefit Muskellunge, but the Smallmouth Buffalo will also benefit. Luke is optimistic about the future.

### AN INVASIVE SPECIES IMPERILS THE SAVANNAH RIVER ENDEMIC BARTRAM'S BASS

Mark Scott, SCDNR

There are up to 15 black bass (*Micropterus*) species, at least three of them undescribed. Bartram's Bass is one of the "Redeye Basses" and the only true Redeye Bass inhabiting the upper Mobile Basin.

During the mid-1980s, the Alabama Bass was illegally introduced by anglers into the Savannah River. By the 1990s, biologists were arguing over bass identifications due to introgression and mixed phenotypes. By 2004, hybrids were showing up and by 2010, very few pure Bartram's Bass remained. Alabama Bass now dominate in South Carolina lakes, and there are lots of hybrids in tributaries.



In 2019, a multistate wildlife grant was awarded to study the distribution of Bartram's Bass. The results through 2021 included good and bad news. First, the bad: Alabama Bass (and hybrids) were distributed all over the Bartram's Bass range. The good news: many of the Alabama Bass occur close to reservoirs; populations of Bartram's Bass become less hybridized the farther (upstream) you go. Close to Lake Keowee there were almost all pure Alabama Bass, but further up Eastatoe Creek, a tributary, there were fewer Alabama Bass and a higher concentration of pure Bartram's Bass. There appears to be a correlation between the presence of pure Bartram's Bass and the percentage of impacted land in the watershed. Above about 50% of a watershed being impacted by urban or agricultural land use, the Alabama Bass and hybrid populations are more abundant.

### ADVENTURES IN ETYMOLOGY

Chris Scharpf, Baltimore, Maryland

To end the day, Chris gave such an interesting talk on the origins of fish names that the editors convinced him to write it up for *American Currents* instead of summarizing it here. Stay tuned!





Photo by Magnus Billings



Photo by Joshua Porter



Photo by Don Drife



Photo by Drew Geving



Photo by Drew Ruiz



Photo by Don Drife



Photo by Brian Zimmerman



Photo by Lawrence-Kent



Photo by John Olson



Photo by Ryan Kinney





Photo by Konrad Schmidt



Photo by Konrad Schmidt



Photo by Scott Smith



Photo by Scott Smith



Photo by Lawrence Kent



Photo by Scott Smith



Photo by Billy Woodring



Photo by Harry Knaub



Photo by Don Drife



Photo by Corey Geving



Photo by Jenny Kruckenberg



Photo by Lawrence Kent





Photo by Lawrence Kent



Photo by Jenny Kruckenberg



Photo by Jenny Kruckenberg



Photo by Konrad Schmidt



Photo by Corey Geving



Photo by Konrad Schmidt



Photo by Chris Scharpf



Photo by Drew Ruiz



Photo by Konrad Schmidt





Photo by Scott Smith



Photo by Ryan Kinney



Photo by Chris Scharpf



Photo by Konrad Schmidt



Photo by Joshua Porter



Photo by Ryan Kinney



Photo by Scott Smith



Photo by Fritz Rohde



Photo by Scott Smith



# FROM THE LAND OF ICE & SNOW TO THE PALMETTO STATE: OUR EXPEDITION TO AND FROM SOUTH CAROLINA FOR THE NANFA CONVENTION, MARCH 16–19, 2023

**John Olson**

Ankeny, Iowa

Seven of us upper Midwesterners attended the COVID-delayed 2023 NANFA convention in Columbia, South Carolina. Our traveling crew included long-time NANFA members Ray Katula, Jenny Kruckenberg, and Konrad Schmidt, all of whom were involved in organizing the NANFA 2022 convention held in Winona, MN. Tagging along were four relative newcomers to NANFA: Matthew Kvam (MN), Jonathon Newkirk (MN), Ric Zarwell (IA), and myself (IA).

## TUESDAY, MARCH 14: OUR FIRST TRAVEL DAY

After much e-mailing in February, and after considering several options for a type of vehicle, we had decided that renting a 15-passenger van was our best option. Our travel plan began with meeting at Ray's house in Onalaska, WI, in the late morning of March 14. On my drive from central Iowa to Ray's house, I picked up Ric at his home in Lansing in northeast Iowa along the Upper Mississippi River. As we drove along the river from Lansing to Ray's house in Onalaska, Ric and I noticed people ice fishing on the Mississippi's still-frozen backwater lakes. It was the last ice fishing we would see for the next week.

One might think that seven people traveling in a 15-passenger van would leave ample room for luggage and other gear. This was not the case. In addition to luggage, NANFA members travel to NANFA conventions well-supplied with seines, dip nets, waders, buckets (both minnow and 5-gallon), coolers for transporting fish, and sometimes, a bottle of oxygen to ensure survival of fish during transport (Figure 1).

Despite removing the rear seat of the van, our luggage and gear fully occupied the rear half of the van with very little air space remaining near the ceiling. Seven seats, and only seven seats, remained for the seven in our group. There was some minor stowage of gear (a stack of 5-gallon buckets) by the van side door that needed to be

removed before passengers in the rear two seats could exit the van.

Google Maps shows a drive of about 1,120 miles and nearly 17 hours from Onalaska, WI, to Columbia, SC. The decision was made early on to split the trip to Columbia into two days of travel to make the trip easier on those in our group that are somewhat advanced in years.

After loading the van—and being pleased, and a little surprised, that all of us and our gear/luggage were going to fit in the van—we departed Ray's house at about noon on Tuesday, March 14 and began our long journey to South Carolina. The first leg of our journey lasted about 10 minutes before we stopped for lunch. After this not-so-fast fast-food lunch, we began our expedition in earnest.

As the sun was setting, we decided to overnight at a Super 8 motel in a small town about 15 miles northwest of Indianapolis. At about 8:30 PM, as we pulled into the parking lot of the Super 8, we noticed a Cracker Barrel restaurant across the road, and we decided to have our dinner there. The younger members of our crew, who are far more adept at smart phone operation than the older members, informed us, however, that the Cracker Barrel was closing soon; so, we opted for another restaurant.

## WEDNESDAY, MARCH 15: A LONG DAY OF TRAVEL & A LATE ARRIVAL IN COLUMBIA

Our travel the next day was long but mostly uneventful. After navigating through Indianapolis, we traveled through Louisville, KY, where we crossed the Ohio River and possibly blew through a toll station. The scenic highlight that day, by far, was our drive through the Great Smoky Mountains in eastern Tennessee (Figure 2).

We arrived in Columbia late in the day (again, at about 8:30 PM) and checked into the Hampton Inn/Columbia. We dined at a well-known chain restaurant near the hotel. All agreed that our dining experience at this neighborhood bar and grill was one of the most unusual and frustrating we had ever encountered. Being Midwesterners, howev-

Photos by the author unless otherwise indicated.

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Figure 1. The type of oxygen bottle that our group took along in the van for our trip to NANFA 2023 in Columbia, SC (web photo). The bottle in our van was about 4.5 feet tall. These bottles need to be transported in the upright position.



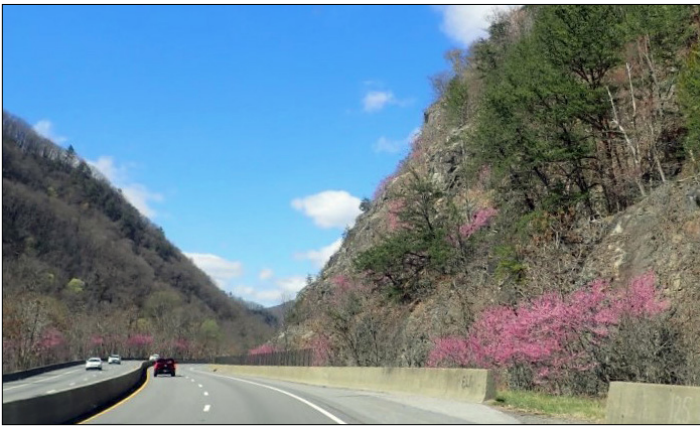


Figure 2. Our drive through the Great Smoky Mountains of eastern Tennessee. (Photo by J. Kruckenberg)

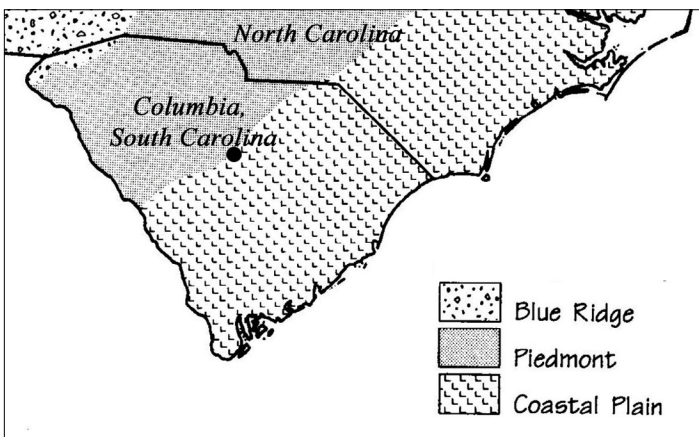


Figure 3. Physiographic provinces in South Carolina. Modified from Rohde et al. 1994.

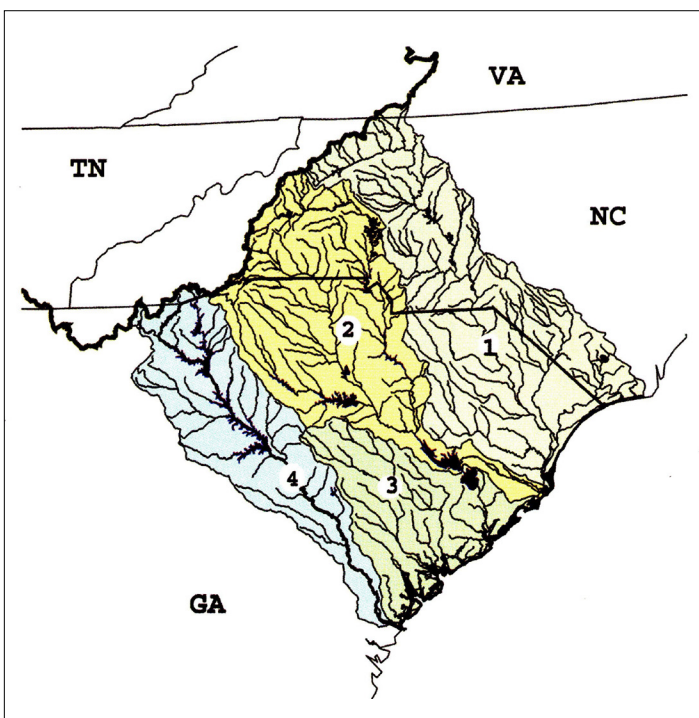


Figure 4. The major river drainages of South Carolina. 1: Pee Dee; 2: Santee; 3: Edisto; 4: Savannah. From Rohde et al. 2009.

er, we maintained our composure and, eventually, we were served our orders.

#### THURSDAY, MARCH 16: RESTED AND READY TO SEE FISH; DAY 1 OF NANFA 2023

Konrad decided to attend the South Carolina DNR's boat electrofishing and fish photography demonstrations on the Congaree River on the south side of Columbia. The rest of us, however, went collecting in northeastern South Carolina at sites recommended by Fritz Rohde. These sites are near the boundary of South Carolina's Coastal Plain and Piedmont physiographic provinces (Figure 3) and are in the Pee Dee River drainage (Figure 4). Ray had collected before in South Carolina, and he led our group. We sampled three streams in Chesterfield County: Thompson Creek, Deep Creek, and Lynches River (Figures 5–7). Figure 8 shows all sites visited by members of our group during NANFA 2023. See Table 1 for the common and scientific names of fish species that were seen at those sites.

#### FRIDAY, MARCH 17: PRESENTATIONS, BANQUET, AND AUCTION

All of our group but two attended the day of presentations at the Saluda Shoals Environmental Center in Columbia (Figure 9).

All the presentations were excellent. Jenny gave a presentation on 30 years of darter hunts in the Minneapolis/St. Paul area that she has organized and led (Figure 10). Her presentation—which she had intended to give at the 2022 NANFA convention in Winona but did not due to time constraints—was very well-received.

Ray and Jonathon, however, having not met several species goals during Thursday's sampling, used recommendations from



Figure 5. Sampling on Thursday at Thompson Creek in Chesterfield County, SC. Top, L-R: Ray, Ric, Jonathon, and Jenny. Bottom: a Redlip Shiner captured at Thompson Creek. Navigating riprap at the bridge resulted in an injury to one in our group.





Figure 6. Sampling on Thursday at Deep Creek, Chesterfield County, SC. Top, L-R: five-sevenths of our crew: Jonathon, Ray, Matthew, Jenny and Ric; bottom: a Carolina Fantail Darter found at Deep Creek.

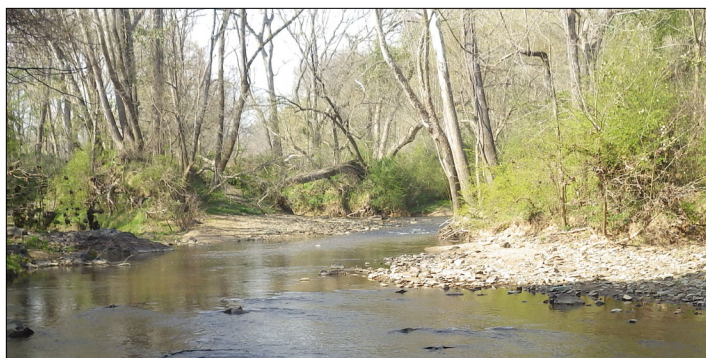


Figure 7. Sampling on Thursday at Lynches River (top) in northern South Carolina. This river is the Lancaster/Chesterfield County line. bottom: Spotted Sucker. This river is named for a signer of the Declaration of Independence.

South Carolina fish experts Dustin Smith and Tim Aldridge to spend the day collecting at sites in the Edisto River and Savannah River drainages south and west of Columbia. Their first site, Upper Three Runs in Aiken County, provided a treasure trove of species. Riffles produced Turquoise Darter, Savannah Darter, and Sooty-banded Darter. Several leuciscid species were found

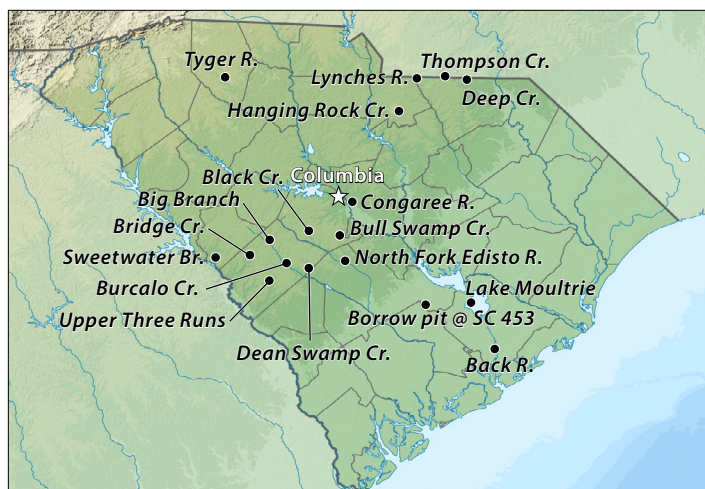


Figure 8. Field trip and other sample sites visited by our group during the NANFA convention in South Carolina.



Figure 9. The Saluda Shoals Environmental Center, Columbia, SC. Photo: S. Taylor in Columbia Living Magazine, May-June 2016.

in pools of this stream, including Dusky Shiner, Lowland Shiner, and Yellowfin Shiner.

Ray and Jonathon encountered a species at Upper Three Runs that was not on their list of collecting goals: a Cottonmouth *Agkistrodon piscivorus* (Figure 11).

As they were walking downstream, Ray noticed a snake swimming from one streambank to the other. A closer look (but not too close) showed that this was a Cottonmouth. The snake seemed aware of Ray and Jonathon, and they gave it plenty of room as they proceeded downstream. On their return trip upstream, Ray rounded a bend and noticed the Cottonmouth, ready to strike, on a log just two feet away. Ray stopped and slowly moved away, and he and Jonathon then proceeded upstream to the bridge. Not to be deterred by the presence of a venomous snake, they continued collecting at the bridge and found several more Savannah Darter as well as Spotted Sunfish and Speckled Madtom.

Ray and Jonathon's next site was on the North Fork of the Edisto River in Orangeburg County. This site—a sand-bottomed stream with areas of logs, driftwood, and numerous gentle riffles—appeared to have great potential for additional species. Intense collecting, however, produced only two species: Eastern Mosquitofish and a few Spotted Sunfish.

Their next site, Sweetwater Branch in Edgefield County, produced several interesting species, but none were on Ray and



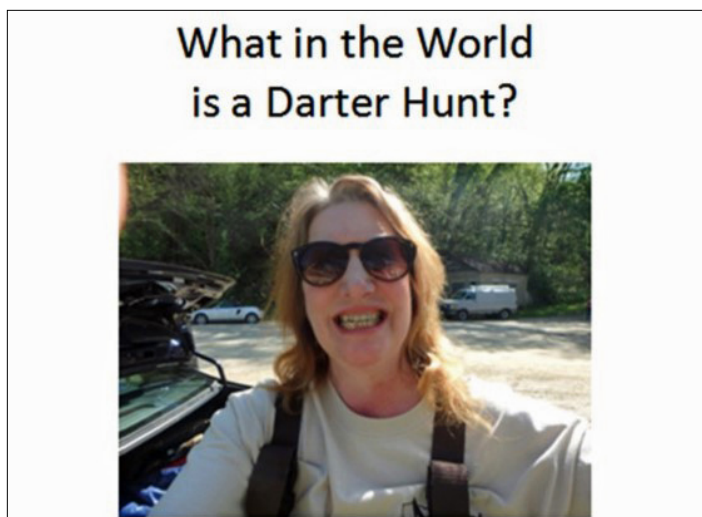


Figure 10. Title slide from Jenny's presentation.



Figure 11. A Cottonmouth (Wikipedia).

Jonathon's list of species goals. They had hoped for Christmas Darter here, but none were seen. The dominant species was Rosyface Chub. They did find a few small Yellowfin Shiner. Ray and Jonathon sampled one last site before heading back to Columbia and the NANFA convention. This site, Bridge Creek in Aiken County, produced Yellowfin Shiner and several small Savannah Darter as well as Sooty-Banded Darter and Speckled Madtom.

In a display of good timing, Ray and Jonathon arrived at the Saluda Shoals Environmental Center just as the NANFA banquet was starting. Despite having spent a full day collecting, searching for their species goals, and avoiding venomous snakes, they both seemed remarkably fresh as they were decked-out in their NANFA 2023 t-shirts.

Several in our group participated in the NANFA auction and, in the process of financially supporting NANFA, acquired several additional fish-related items to cram into the van for transport back home.

#### SATURDAY, MARCH 18: FIELD TRIPS

Ric attended the Coastal Plain field trip led by Stephan Beaman; the sites visited were Back River and Lake Moultrie in Berkeley County, a borrow pit in Dorchester County, and Bull Swamp Creek in Lexington County (Figure 8). Ric saw his first American Eel on this field trip.

Konrad, Matthew, and I attended the Lower Sandhills field trip led by Dustin Smith. The sandhills region in South Carolina and south-central North Carolina is the portion of the Coastal Plain physiographic province farthest from the ocean (Figure 12).

We visited five stream sites in the Lower Sandhills region southwest of Columbia: Big Branch near Aiken, Upper Three Runs near New Ellenton, Burcalo Creek near Aiken (all three sites are in Aiken County), Dean Swamp Creek near Springfield in Orangeburg County, and Black Creek near Pelion in Lexington County (Figure 13). All sites except Upper Three Runs, which is in the Savannah River drainage, were in the Edisto River drainage (Figure 8). Each of these sites produced interesting species (Figures 14–17).

Our field trip leader, Dustin Smith, had planned for the group to have lunch at what he said was his "daughter's favorite restaurant in the world": Mary's County Kitchen in Springfield, a small town in Orangeburg County, SC. Unfortunately, Mary's was closed. Instead, we had a good old fashioned gas station/convenience store lunch at the nearby Springfield Speedstop (Figure 18).

Others in our group attended different field trips on Saturday. Species seen by our group on these field trips included Rosyside Dace and Redlip Shiner (Figure 19).

#### SUNDAY, MARCH 19: OUR LAST DAY IN SOUTH CAROLINA

Because we were facing a long, two-day drive back to our homes in the upper Midwest, we decided to visit only one of the NANFA field trip sites scheduled for Sunday: Tyger River in Spartanburg County. We gained access to the Tyger River at Nesbitt Shoals Nature Park, approximately 70 miles northwest of Columbia (in the general direction of Wisconsin). This beautiful river is popular for kayaking; it was the largest water we sampled during the NANFA convention (Figure 20). Although the Tyger River was a scheduled field trip site for Sunday, we arrived earlier than the NANFA-led field trip group in order to get a good start on our drive back home (and maybe to get first shot at Fieryblack Shiner known to be there).

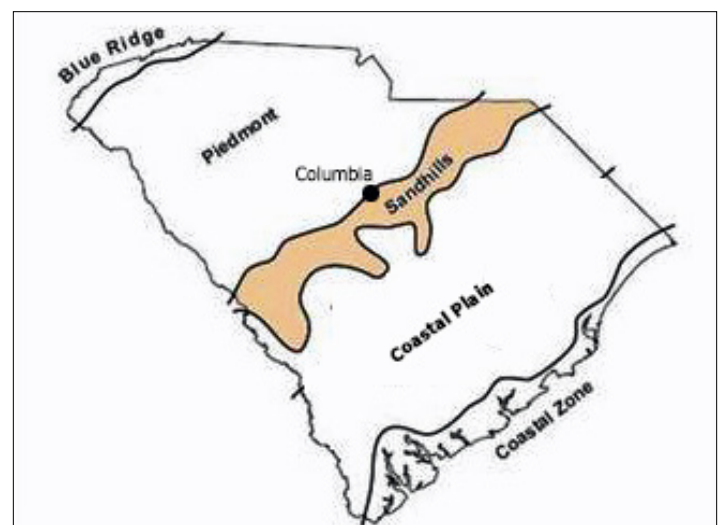


Figure 12. The Sandhills portion of South Carolina's Coastal Plain physiographic province. Image modified from <http://scregions.weebly.com/sandhills.html>.





Figure 13. Big Branch, a stream in Aiken County, SC, on Saturday, March 18, for the Lower Sandhills field trip



Figure 16. Centrarchids from the Lower Sandhills Field trip: top: Dollar Sunfish; bottom: Blackbanded Sunfish.



Figure 14. Leuciscids from NANFA's Lower Sandhills field trip. Top: Yellowfin Shiner; bottom, Coastal Shiner.



Figure 17. Percids from the Lower Sandhills field trip. Top: Sooty-banded Darter; middle: Savannah Darter; bottom: Swamp Darter.



Figure 15. Fish from Saturday's Lower Sandhills field trip: top: Speckled Madtom; bottom: Swampfish.



Table 1. Common and scientific names of fishes from South Carolina waters visited by our group during NANFA 2023.

Anguillidae, freshwater eels	
American Eel	<i>Anguilla rostrata</i>
Lepisosteidae, gars	
Longnose Gar	<i>Lepisosteus osseus</i>
Amiidae, bowfins	
Bowfin	<i>Amia calva</i>
Clupeidae, herrings	
American Shad	<i>Alosa sapidissima</i>
Threadfin Shad	<i>Dorosoma pretense</i>
Leuciscidae, minnows	
Bluehead Chub	<i>Nocomis leptcephalus</i>
Coastal Shiner	<i>Notropis petersoni</i>
Dusky Shiner	<i>Notropis cummingsae</i>
Fieryblack Shiner	<i>Cyprinella pyrrhomelas</i>
Greenfin Shiner	<i>Cyprinella chloristia</i>
Highfin Shiner	<i>Notropis altipinnis</i>
Lowland Shiner	<i>Pteronotropsis stonei</i>
Redlip Shiner	<i>Notropis chiliticus</i>
Rosyface Chub	<i>Hybopsis rubrifrons</i>
Rosyside Dace	<i>Clinostomus funduloides</i>
Sand Shiner	<i>Notropis stramineus</i>
Santee Chub	<i>Cyprinella zanema</i>
Spottail Shiner	<i>Notropis hudsonius</i>
Thicklip Chub	<i>Cyprinella labrosa</i>
Whitefin Shiner	<i>Cyprinella nivea</i>
Yellowfin Shiner	<i>Notropis lutipinnis</i>
Catostomidae, suckers	
"Carolina" Quillback	<i>Carpionodes sp.</i>
Northern Hog Sucker	<i>Hypentelium nigricans</i>
Notchlip Redhorse	<i>Moxostoma collapsum</i>
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>
Spotted Sucker	<i>Minytrema melanops</i>
Ictaluridae, North American catfishes	
Channel Catfish	<i>Ictalurus punctatus</i>
Speckled Madtom	<i>Noturus leptacanthus</i>
Tadpole Madtom	<i>Noturus gyrinus</i>
Esocidae, pikes	
Chain Pickerel	<i>Esox niger</i>
Redfin Pickerel	<i>Esox americanus</i>
Amblyopsidae, cavefishes	
Swampfish	<i>Chologaster cornuta</i>
Atherinopsidae, New World silversides	
Inland Silverside	<i>Menidia beryllina</i>

Fundulidae, topminnows	
Bluefin Killifish	<i>Lucania goodei</i>
Golden Topminnow	<i>Fundulus chrysotus</i>
Lined Topminnow	<i>Fundulus lineolatus</i>
Poeciliidae, livebearers	
Eastern Mosquitofish	<i>Gambusia holbrooki</i>
Least Killifish	<i>Heterandria formosa</i>
Moronidae, temperate basses	
Striped Bass	<i>Morone saxatilis</i>
White Perch	<i>Morone americana</i>
Centrarchidae, sunfishes	
Blackbanded Sunfish	<i>Enneacanthus chaetodon</i>
Bluegill	<i>Lepomis macrochirus</i>
Bluespotted Sunfish	<i>Enneacanthus gloriosus</i>
Dollar Sunfish	<i>Lepomis marginatus</i>
Mud Sunfish	<i>Acantharchus pomotis</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Redbreast Sunfish	<i>Lepomis auritus</i>
Redear Sunfish	<i>Lepomis microlophus</i>
Smallmouth Bass hybrid	<i>Micropterus</i>
Spotted Bass	<i>Micropterus punctulatus</i>
Spotted Sunfish	<i>Lepomis punctatus</i>
Warmouth	<i>Lepomis gulosus</i>
Elassomatidae, pygmy sunfishes	
Banded Pygmy Sunfish	<i>Elassoma zonatum</i>
Everglades Pygmy Sunfish	<i>Elassoma evergladei</i>
Percidae, perches	
Carolina Fantail Darter	<i>Etheostoma brevispinum</i>
Savannah Darter	<i>Etheostoma fricksium</i>
Swamp Darter	<i>Etheostoma fusiforme</i>
Tessellated Darter	<i>Etheostoma olmstedi</i>
Turquoise Darter	<i>Etheostoma inscriptum</i>
Sooty-banded Darter	<i>Percina westfalli</i>
Yellow Perch	<i>Perca flavescens</i>



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Figure 18. Springfield, SC. Top: Mary's County Kitchen, where we *planned* to have lunch; bottom: the Springfield Speedstop, where we actually *had* lunch. (Google Streetview)



Figure 19. Species seen on NANFA's Saturday field trips. Top: Rosyside Dace; bottom: Redlip Shiner from Deep Creek in Chesterfield County. (Photos by J. Kruckenberg)

Sunday was a clear but chilly day in South Carolina. The air temperature in Columbia as we checked out of the hotel about 8:00 AM was in the low 40s F. The Minnesotans and Wisconsinites in our group, however, would not be deterred from collecting on the Tyger River by a bit of chilly weather (Figure 21).

The Tyger River produced several interesting species, including Fieryblack Shiner and two of South Carolina's non-*Cyprinella* looking *Cyprinella* species: a Santee Chub and a Thicklip Chub (Figure 22).

After getting the fish ready for transport, we departed from the Tyger River in late morning and began our long road trip back to the north country.

During the day's long drive, Jenny once again mentioned her childhood dream of having horses in a Kentucky pasture with blue-colored bluegrass. Late in the day, we decided to overnight at a Super 8 motel just south of Indianapolis; we arrived there at about 8:30 PM.

#### MONDAY, MARCH 20: THE HOME STRETCH

We got an early start on the last leg of our journey and were on the road by 8:00 AM. We had an 8-hour drive ahead of us to Ray's house in Onalaska, WI, and the rest of us would have an additional 3 to 5-hour drive from Onalaska to our respective homes.

We arrived at Ray's house in Onalaska in mid-afternoon. After unloading the van, and after replacing the van's rear seat, we said our good-byes (Figure 23).



Figure 20. The Tyger River at Nesbitt Shoals Nature Park, Spartanburg County, SC. The Tyger is a tributary of the Broad River and is in South Carolina's Santee River drainage.



Figure 21 Collecting on Sunday at the Tyger River, Spartanburg Co. Ray and Jenny are holding the seine; Jonathon (holding a minnow bucket) and Pat Johnson (from Ohio) are the fish herders. All are bundled-up against the cool morning air.



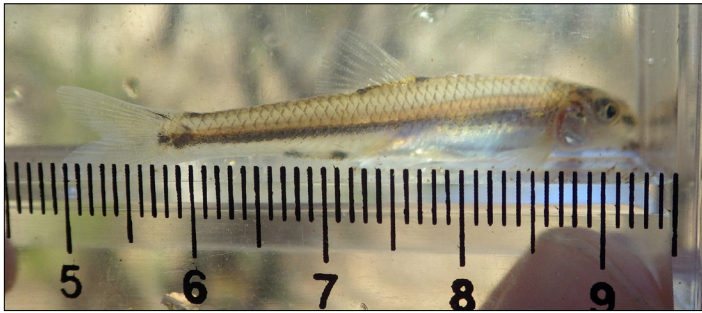


Figure 22. Fishes from the Tyger River, Spartanburg Co., SC. Top: Santee Chub; bottom: Thicklip Chub.

On my late afternoon drive with Ric from Ray's house in Onalaska to Ric's house in Lansing, IA, we noticed the still-frozen backwaters of the Upper Mississippi River and the late season ice fishers.

### EPILOGUE

Our 1,120-mile drive in the van to and from Columbia for NANFA 2023 was more or less of a challenge: more for the older folks in our group (such as myself) and probably less for the younger. Despite the cramped travel conditions, all in our group remained in good spirits.

The NANFA 2023 convention was outstanding, from the presentations, banquet, and auction to the NANFA-led field trips. In addition to seeing and reconnecting with NANFA friends, the upside of our riding for 34 hours in a 15-passenger van was the opportunity to see a number of South Carolina's native fishes that most in our group had never seen. Seeing fishes from the Atlantic Slope that are similar to Upper Mississippi basin fishes—including species in *Nocomis*, *Lepomis*, *Etheostoma*, and *Percina*—was fascinating and was a hands-on lesson in adaptive radiation of species. Prior to NANFA 2023, I had no idea that species in the genus *Cyprinella* could look so non-*Cyprinella*-ish. Seeing the pygmy sunfishes and the *Enneacanthus* sunfishes was great as was seeing my first representative of the cavefish family, Amblyopsidae (Swampfish). The variety of stream/river types in the South Carolina's physiographic provinces—landforms that are geologically much older than those in the upper Midwest—were all very interesting. By nearly overtopping my chest waders twice within five minutes, I gained an intuitive feel for the considerable depth variations possible in South Carolina's blackwater streams of its Sandhills region. Speaking only for myself, the fish fauna and streams of the Upper Mississippi River basin now seem a bit less interesting than they did before the 2023 NANFA convention.

At the end of our trip, as we were unloading the van and preparing to depart from Ray's house in Onalaska, the issue was

raised of whether we would travel to future NANFA conventions in a 15-passenger van. The opinions on this issue ranged from “hell no” to “sure!” with the age of the respondent being a factor in the type of response.

### ACKNOWLEDGEMENTS:

Thanks to Bryn Tracy for providing a species list for Thursday's boat electrofishing demonstration on the Congaree River in Columbia. Thanks also to Stephan Beaman for the species list for Coastal Plain field trip on Saturday. Jay Hatch (St. Paul, MN) generously provided transportation for Konrad and me on Saturday's field trip. Dustin Smith provided fish identification confirmations for several species collected on the Lower Sandhills field trip. And a special thanks to our fellow traveler Jonathon Newkirk who, in addition to renting the van (and getting a good deal on the fee), was the person who had to clean up the van before returning it. After all those miles and munching on snacks, especially the delicious cookies sent along with us by Ray's wife Lisa, I'm sure that the clean-up was quite a chore.

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Figure 23. Back in Wisconsin at Ray's house. L-R: Ray Katula, Ric Zarwell, Konrad Schmidt, John Olson, Matthew Kvam, Jonathon Newkirk, and Jenny Kruckenberg. Everybody's smiling, so it must have been a good trip! (Photo by Lisa Katula)



# COLLECTING NATIVE FISHES 101

## Konrad Schmidt

St. Paul, Minnesota

### INTRODUCTION

Native fishes are sought for many reasons. Armies of traditional recreational anglers seek larger species, categorized as game or sport fishes (e.g., bass, sunfish, trout, perch, pike, etc.), for either catch and release or table fare. As described by Buffler and Dickson (2009), however, the ranks of traditional anglers have recently been infiltrated by more broad-minded anglers who also seek historically disdained species that have been categorized as rough fish (e.g., gars, suckers, buffalo, carpsuckers, etc.). The unofficial label for these species is “non-traditional sport fishes.” Yes, many of these species are sometimes consumed like sport fishes, but these anglers usually practice catch and release, and some maintain life lists very much like avid birders do. The popularity of this pursuit has grown immensely, and likeminded anglers “school” to Roughfish.com, where members post fishing trip reports, share angling techniques, and discuss conservation issues.

Even more recently, a rapidly spreading fringe group known as microfishers (Figure 2) has finessed these angling techniques to an extreme, targeting much smaller fishes (e.g., minnows, killifish, sculpin, darters, etc.). Their angling gear consists of the bare essentials: an ultralight telescoping pole, three or four feet of 2–4-pound test line, and pre-snelled hooks so tiny they cannot be tied by hand (Aldridge 2018). Again, catch and release is the prevailing practice, but almost all microfishers pack their phone cameras and pocket-sized photo tanks for social media posts, later species identification, and to have a record of the catch.

A third recreational focus group is aquarium hobbyists, who typically collect species categorized as bait fish and enjoy keeping, photographing, and spawning different species in captivity just as much as those in the huge tropical fish hobby do (Figure 3). NANFA was founded in 1972 by members who shared a unique interest of collecting and keeping native fishes in home aquariums. This focus has since evolved into areas like microfishing and snorkeling (Cox 2003, 2013).

Native fishes are also collected for educational purposes like exhibits in zoos and aquariums, nature center displays, and, last



A much younger author wielding his mighty dipnet. (Photo by Mary Stefansky)

Photos by the author unless otherwise indicated.

NOTE: The author has collected in many states from Alaska to Florida and in Canada and Mexico. However, this article will focus primarily on the author's half-century of collecting experience in Minnesota using either angling licenses as a recreational pursuit for his very early aquarium hobby or collecting permits for educational and scientific purposes (Figure 1). However, many of his lessons learned here are applicable to other states and provinces as well.

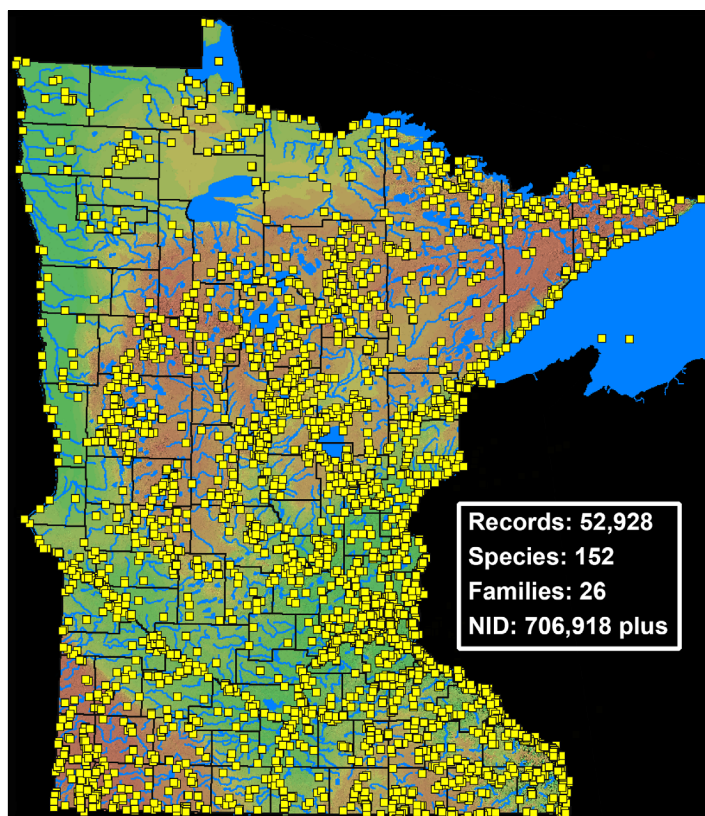


Figure 1. The author's fish collection records in Minnesota since 1974.





Figure 2. The author microfishing in the Boundary Waters Canoe Area Wilderness. (Photo by John Olson)



Figure 4. Brook Trout *Salvelinus fontinalis* and Longnose Sucker *Catostomus catostomus* at Great Lakes Aquarium in Duluth, MN (top). Elementary students learning about native fishes in classroom aquarium (bottom).



Figure 3. Father and son enjoying watching native fishes in their home aquarium.

but not least, classrooms of students of all ages (Figure 4). Even a small aquarium attracts students like a magnet and may be an inspiration to future scientists, politicians, and policy makers. Natives are also the subjects in myriad research studies, such as cataloging voucher specimens in museum collections (Figure 5), life history cycles, genetic analyses, determining temperature and dissolved oxygen thresholds, measuring contaminant exposure, and developing aquaculture methods and techniques for restoring extirpated populations. Conservation Fisheries, Inc. (CFI) of Knoxville, Tennessee, has been a successful leader in this area, culturing federal and state listed species for reintroduction. Sometimes a species is so rare that a more common surrogate species is used instead to avoid harming the few of the target species remaining in the wild, as in the case of the federally listed Diamond Darter *Crystallaria cincotta* where the Crystal Darter *C. asprella* (Figure 6) is the surrogate (CFI 2023). Developing aquaculture protocols was very challenging for CFI staff, but they were successful, and what they learned could be valuable for future restoration efforts in states where Crystal Darters are endangered or threatened. When culturing is not an option, translocations from disjunct donor populations are used to restore extirpated species to former habitats (Bland 2013, Nelson 2013, Schmidt 2014).

#### ANGLING REGULATIONS AND COLLECTING PERMIT CONDITIONS AND STIPULATIONS

This section may be dry, but it is essential to ensuring enjoyable and rewarding collecting experiences. Always remember, possessing an angling license or collecting permit is not *carte blanche* to keep an entire day's catch or to utilize any gear and method desired. Ignorance of laws is no defense when a conservation officer issues a citation or makes an arrest. It is imperative to search the current angling regulations every year for keywords such as rough fish, bait, legal methods and gear, transporting live fish, infested waters, endangered and threatened species, and trespass laws. The Minnesota Department of Natural Resources (MDNR 2023a) Section of Fisheries provides the bulk of this information in their annual summary of Minnesota Fishing Regulations.

**LICENSE:** An angling license is by far the easiest path to follow for those collecting native fishes as a recreational pursuit. This includes hobby aquarists who keep only species classified as bait in compliance with daily limits and legal means. Unfortunately, darters and several other small non-game fishes missed the boat when these regulations were written long ago and are not classified as bait or in any other category. Unless the bait category is revised in the future to include them, they cannot be kept under the provisions of an angling license. There is one option available via educational permits, which will be discussed later. Game fish species may only be kept in home





Figure 5. University of Minnesota Bell Museum of Natural History Fish Collection. (Photo by Jay Hatch)



Figure 6. Diamond Darter (top) (Photo by CFI). Crystal Darter (bottom).

aquariums when purchased from a MDNR licensed aquaculture facility, which does include some pet stores. For anglers under 16, specific game species with possession and size limits may also be kept in aquariums. Only fish from non-infested waters and transported in tap, bottled, or well water can be kept in aquariums (MDNR 2023b). Care must be taken to remove chlorine from municipal water and to acclimate fish to changes in temperature and pH.

**SCIENTIFIC AND EDUCATIONAL COLLECTING PERMITS:** Fifty years ago, Minnesota collecting permits were issued to almost anyone who requested them, including one 15-year-old kid from St. Paul with an interest in collecting and keeping darters. The old permits were beautifully simple: a half-page in length, statewide coverage including designated trout streams, requiring no prior notification of collecting locations to MDNR conservation officers and fisheries managers and no annual reports at the end of the field season. Oh, how times have changed! Permits have morphed into small tomes loaded with conditions and stipulations (mostly prohibited activities and adherence to invasive species protocols). That kid's (now a senior citizen) present-day inventory includes two separate MDNR permits from Fisheries (MDNR 2023c) and one for state parks (MDNR 2023d). Additional permits for current field work and gear used are also issued from the Wisconsin Department of Natural Resources (WDNR 2023), St. Croix National Scenic Riverway (RPRS 2023), Boundary Waters Canoe Area Wilderness, and Three Rivers Parks District (Figure 7). Most applications are now available on the web, but others require contacting the agencies' staff directly. There are permit applications for conducting research on state and federally listed endangered and threatened species, but the application processes are lengthy with no guarantee that permits will be issued, and sometimes come with so many conditions and stipulations that the issued permit is unusable.

Collecting permits are generally only granted for scientific and educational purposes. Scientific Collecting permits are available to researchers and biologists affiliated with post-secondary schools, non-MDNR agencies, consulting firms, and sponsors of bioblitz events (e.g., Kruckenberg et al. 2014). Educational permits are most often issued to classroom teachers, naturalists, and organizations.

Figure 7. Example of one of the author's permits.





**Figure 8. MAS Darter Hunt: collecting and viewing catch.**  
(Photo by MAS)

The latter type of permit is currently the only way some small non-game fishes not defined as bait may be collected and kept in home aquariums. For over 30 years, the Minnesota Aquarium Society (MAS) has hosted annual darter hunts at streams and lakes where adults and children get wet seining and kick-netting fish that are temporarily displayed in critter tanks before participants select their keepers (Figure 8) (Kruckenberg 2012). Most participants are there for the darters, but others are also interested in keeping bait species such as madtoms and several minnow species. MAS members have always informed participants that any fish kept from an outing can never be returned to any lake or stream, including the original waterbody. Again, fish can only be transported in water brought from home, not in surface water from the collecting site. All permits list stipulations and conditions regarding target species, sampling gear, area coverage, and invasive species protocols. It is extremely important that permits be thoroughly reviewed for errors or omissions before heading into the field.

When collecting under the authority of permits, all stipulations must be followed. However, providing prior notification to conservation officers and fisheries managers and submitting annual reports are paramount. Violating either of these stipulations can result in immediate revocation of permits, fines, and denial of renewals. Over 50 years of collecting under permits, the author has had many positive encounters with conservation officers (Figure 9) and a few that were...not so great. One encounter, however, resulted in a citation and a fine, although he was confident no laws or stipulations



**Figure 9. A perfect encounter with Minnesota's finest (full disclosure: the author and conservation officer were roommates in college).** (Photo by Jenny Kruckenberg)



**Figure 10. Public watercraft access.**

in the permit had been violated. It is difficult to remain calm and think rationally under stress. Please heed this advice! DO NOT file a complaint against the conservation officer who issued the citation while the case winds its way through the judicial system. This only results in kicking a hornet's nest that can result in federal law enforcement launching an investigation with a potential outcome of not only an additional fine, but also a prison sentence. In this case, during the pre-trial hearing, the county attorney dismissed the citation, agreeing that the permit holder was in full compliance with the permit's conditions and stipulations. Despite this resolution in his favor, however, the author still experienced temporary bureaucratic hurdles renewing permits from two states and the national wildlife refuge where the citation was issued.

### WHERE AND WHEN TO COLLECT

Minnesota has more than 10,000 lakes and thousands have public watercraft accesses (MDNR 2023e) (Figure 10). Collecting can occur anywhere in these lakes as long as private lands are not crossed where property owner permission is required. Although only a few acres or less in size, these access points provide opportunities for collecting without the need for a boat or canoe. Lakes should be avoided on weekends and holidays when boat traffic generates constant waves





Figure 11. Electrofishing examples. Boat (aka boom) shocker (top). Backpack shocker (bottom).



Figure 12. Seine examples. Drag seine (top) (Photo by Jenny Kruckenberg). Riffle seine (bottom).

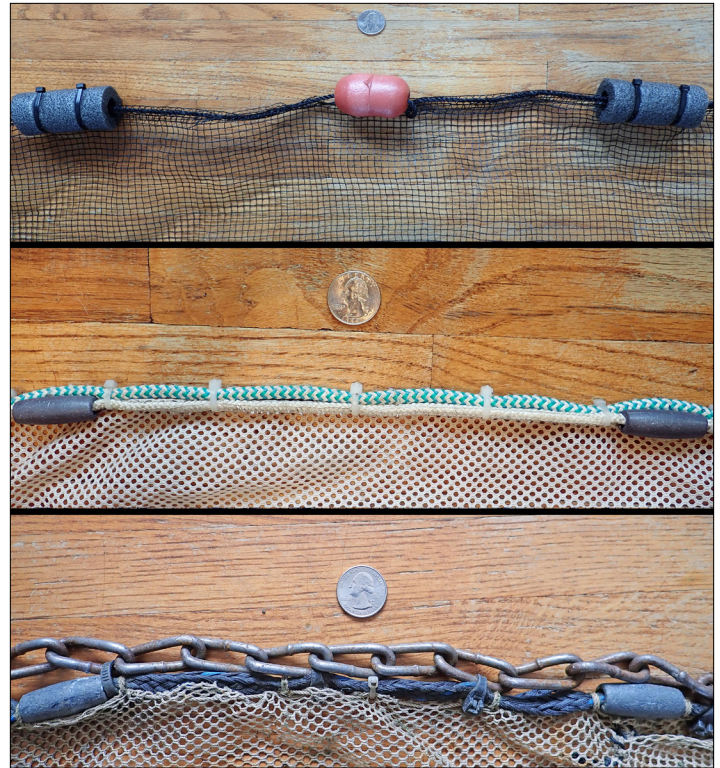


Figure 13. Seine modifications to improve capture effectiveness: From top: additional floats. Additional weight using lead-core rope for long seines. Large chain for short seines.

that scare fish from shallow water. On days with high winds, the prevailing winds are usually out of the south or northwest. Under these conditions avoid accesses on north and southeast shores. There are also thousands of miles of state water trails on streams navigable by boat or canoe (MDNR 2023f). Again, collecting opportunities are available at access sites or during a float between two accesses. Large rivers should also be avoided during high traffic periods. On lakes and streams without designated accesses it is legal to collect from a public road right-of-way that abuts or crosses the waterbody, but collectors must always remain in the water once leaving the right-of-way and return to the same point without crossing private property overland. There are many resources available that will be extremely helpful in planning a route of localities to try. The *Minnesota DeLorme Atlas & Gazetteer* (MDAG) is a tried-and-true reference that shows public accesses on lakes and streams, hunting and fishing areas, and roads crossing streams. *Google Earth Pro* is an excellent and free web source which provides geo-referenced aerial photos and optional layers similar to public access features in MDAG. For driving to collecting sites, latitude and longitude coordinates can be exported to Garmin Navigators or smartphones. Finally, if you are looking for specific species try the online *Fishes of Minnesota Mapper*, which provides location records, species lists for lakes and streams, and generates custom distribution maps (MDNR 2023g).

### HOW TO COLLECT

They are many ways to collect small native fishes, and the most advanced methods such as electrofishing are not always the most effective (Figure 11). Because of their prohibitive cost, electrofishers will only be briefly covered here. The electric field these units create does very well at drawing large fish in shallow water to a waiting





**Figure 14. Dip net techniques. Left: scooping minnow schools from above (top) and below (bottom) (photo by Jenny Kruckenberg). Right: scooping overhanging vegetation (top) and kicknetting riffles (bottom).**

netter and are unbeatable at pulling fish from root wads and rock crevices and coaxing lamprey ammocoetes (larval stage) from soft substrates, but they do not perform as well on benthic fishes that can remain stunned on the bottom invisible to the netter.

Seines, dipnets, minnow traps, and microfishing are all legal methods under an angling license, but each is most effective on certain species. Generally, all these methods are used in wadable depths. Minnow traps can also be tethered to floats in deeper water, and microfishing is possible from shore.

**SEINES** (aka beach or drag seines) may be up to 25 feet long, but legal depths from the float to lead (rhymes with red, as in the element Pb) lines are determined by mesh size. Seines of 10–15 feet are much easier to manage in areas of dense vegetation, snags, and boulders (Figure 12). A wooden brail or dowel about five feet long tied to each end helps keep seines fully deployed. Seines can be easily modified to minimize fish escapes—under or over—by adding additional flotation and weight (Figure 13). The lead line should be in contact with the bottom and the float line should never be submerged. A small chain running the length of the lead line greatly improves catches of darters and other benthic species that hug the bottom. Hauls are more effective when there is an open area of stream bank or shoreline to land the seine. Farther from shore, a haul can be made where one seiner circles back to the other closing the loop and then slowly retrieving the mesh, which corrals the catch into the middle of the net. The two seiners then gently pull the net from opposing sides,

raising the catch near the surface where they can be hand-scooped out of the net. To avoid making trips to shore, fish can be kept in a flow-thru minnow bucket tethered to a seiner's waders or belt loop or in a wide-mouth plastic bottle using a shoulder or waist harness. Seining downstream with the current in streams is much easier than the opposite. Seines will also work as riffle nets when held stationary by two people while a third (or more) kicks in a zig-zag pattern downstream through the riffle, chasing fish into the net. The lead line is then lifted, rolling the catch toward the float line.

Seines can be deployed by one person, but this is never as effective as having a helper. Solo seining works best with longer seines in waters free of obstructions. A metal rod is attached to the bottom of one brail and is driven into soft substrates as an anchor. The seine is stretched full-length along the shoreline and a 180-degree sweep is made around the anchored brail and landed. The seiner then carefully retrieves this end of the seine making sure the lead line remains on the bottom until the catch is concentrated into a small area, then lifted on to shore. Another variation is a push seine (Schmidt 1992), which can be used alone in lakes by driving schools of fish into shore. Push nets can also be used to sample pools of small streams or as riffle nets. In riffle-run habitats, holding the brails apart with both hands, downstream of your body, and kicking into the seine can be very effective on darters. One devout user regularly sampled Crystal Darter with this method, albeit only capturing one or two specimens over several hours (Ray Katula personal communication).



Nocturnal seining will capture many species rarely seen during the day when fish are hiding in cover to avoid predators. Safety precautions should always be kept in mind when night seining, including scouting areas during the day for hazards such as logs, boulders, and drop-offs. Head lamps are a wonderful accessory that frees both hands to maneuver the seine and work up the catch.

**DIPNETS**, aka kicknets (Figure 14), are the author's gear of choice (Schmidt 1991). It is a simple, effective, and versatile collecting gear and can be wielded alone. A dipnet can be used in many ways. Hiding fishes can be found by scooping upward through overhanging vegetation along stream banks or by raking through submergent vegetation. Schooling fishes can be netted with either a downward plunge from above or a rapid-fire pool cue shot under a school and an upward scoop. Either way, the school breaks in all directions and very often several fish are captured. One try is all you get, though. You will have to move a short distance to undisturbed habitat to hunt for a new, unsuspecting school.

In water too deep to wade, dip nets can be deployed off the sides of boats with outboards or trolling motors. This method requires two to three people, one running the motor and one or two netters seated sideways on the boat's bench seats with one hand holding the end of the handle and one leg draped over the side of the boat along the net's shaft as a brace to keep its vertical orientation through the "canopy" of the vegetation as the boat slowly moves over the bed. About every 30 feet, the net is raised to check for fish. This technique also works well by cutting the motor and coasting into a weed bed. Netters can then rake the vegetation. The pseudo-paddling and even a gentle breeze will keep the boat in motion. The tops of weed beds are sometimes well below the surface, but fish have been collected as deep as 12 feet by using handle extensions.

A variation of this method is using a dipnet while snorkeling. When a snorkeler moves slowly through the water, most small fishes will remain within an arm's reach and sometimes even approach out of what appears to be curiosity. Short-handled dip nets with smaller frames are essential for quickly scooping these fish. Aquarium dipnets from pet stores work for netting fish in the water column and trapping darters on the streambed under the net.

Dipnets are just as effective when used as kicknets. Along lake shorelines, the user can plunge the net to the bottom in thick vegetation and then stomp a foot or two in front of the frame. In streams, the author's favorite technique is kicknetting riffles and rapids for benthic fishes. Productive catches have also been made "side-kicking" with a foot placed in undercut banks. Kicknetting minnows is likewise possible, especially in small streams. Starting at the downstream end of a pool with the net at arm's length out from one side, walk slowly upstream. The large shadow and threat visible against the sky will move the school toward the upstream riffle, which serves as a barrier. Keep looking for the stream's thalweg (deepest chute) to place the net when the school turns and flees downstream. At first, only a small vanguard of minnows will appear. Use this as a cue to lean on the handle for balance and make a rapid circular kick, first upstream and then downstream into the net. Very often, this yields a surprising number of minnow species. Again, a minnow bucket tethered to waders or a belt loop is a convenient way to temporarily hold fish instead of leap-frogging constantly to holding containers left in a downstream pool. Like seining, dipnetting at night will find species not encountered during the day. Good dipnets can be made by replacing the bag of landing nets with  $\frac{1}{8}$ -inch mesh, but this does

require some sewing. High-quality dipnets can also be purchased ready-made from several online sources; one of the best is the Perfect Dipnet available from Jonah's Aquarium.

**MINNOW TRAPS** are another versatile and effective collecting gear for targeted species and habitats. The most common design is a double-funnel metal mesh trap that separates into halves that nest together, greatly reducing storage space in a car or boat. There is also a collapsible design made of nylon mesh that is even more compact (Figure 15). Minnow traps are passive gear because fish are self-captured through a behavior known as positive thigmotaxis (aka wall-hugging) where organisms avoid open areas and seek edges and corners (such as minnow trap funnels) for cover from predators (Benno-Rochow 2018; Warny 1985). Some of the author's largest catches (e.g., over 400 Northern Redbelly Dace *Chrosomus eos* in a single trap) were made with bare traps without any kind of bait. Most minnow trappers hedge their bets and add a favorite bait, such as bread crumbs, dog food, aquarium fish food, or even Ivory soap (Schmidt 1996; Williams 1986). They are most effective on minnows, unsurprisingly, but will also catch suckers, mudminnows, sticklebacks, killifish, sculpin, sunfish, and darters. The best habitats for minnow traps are shallow water (e.g., less than three feet) in ponds, wetlands, small- to moderate-sized streams near boulders, woody snags, or edges of submerged vegetation. As long as the funnel throats are submerged, the traps will catch fish. Sets in large lakes and rivers typically produce very small catches. Traps are tethered to a float using five to six feet of braided fishing line. To prevent theft, traps should not be visible from the surface, and the floats should be concealed or camouflaged using a stick or a chunk of gray Styrofoam. Minnow traps are also effective on Slimy Sculpin *Cottus cognatus* and Deepwater Sculpin *Myoxocephalus thompsonii* in deep, cold lakes. Traps for sculpins are baited with green glow sticks or battery-powered drop lights and are set overnight at depths of 50–75 feet (Schmidt 2013). The best metal traps are made of galvanized steel mesh by Gee. Frabill makes both a vinyl-dipped steel trap and a galvanized model. For durability, galvanized traps are the better choice.

**MICROFISHING TACKLE** varies depending on the angler's species preferences and habitat conditions. In clear water where individual fish can be targeted by sight, a telescoping ultralight rod with a short length of line and a hook generally no larger than size 10, and often *much* smaller than that, will catch many species of small fishes. The hook by itself may provide enough weight on light line, but a tiny split shot sinker may be required to help guide the bait toward the fish. In turbid water, an ultralight rod and reel work for casting from shore as a bottom set. Darters can be very challenging to hook because of their generally small mouths and the difficulty seeing them camouflaged among the rocks on the streambed (Aldridge 2019), but snorkeling to locate darters and then using a much shorter rod greatly improves the chances of success.

Even though microfishing gear appears to be primitive (akin to a cane pole) and inefficient (just one fish at a time), do not underestimate its potential. For example, a group of NANFA members surveyed a short reach of a Missouri Ozarks stream with backpack electroshockers, seines, and dipnets. The survey also included a lone microfisher, who stuck to quiet waters away from the mob. At the end of the survey, the mob had found over 20 species. The microfisher's list was considerably shorter but included three species the mob had failed to catch. Microfishing has also incidentally found





Figure 16: Significant finds from microfishing. From top: Gravel Chub *Erimystax x-punctata*. Crystal Darter (photo by John Lyons). Lake Chub *Couesius plumbeus*. Northern Sunfish *Lepomis peltastes* (photo by John Olson).



Figure 15: Minnow trapping examples. From top: nested galvanized and vinyl coated steel. Pulling trap. Baiting collapsible design with glow sticks for a sculpin survey. Pulling trap with Slimy Sculpin (photo by John Olson).

noteworthy species rarely sampled with other gear (Figure 16).

SNORKELING has been mentioned in conjunction with dipnetting and microfishing. However, this is also a very rewarding means of observing native fishes up close and personal. Some snorkelers have described the experience as being like swimming in an aquarium. Snorkeling gear consists of mask, snorkel, tennis shoes or wading boots (for water of wadable depths) or fins (only in deeper water). Clear streams and lakes are the best places to enjoy snorkeling, as high water transparencies provide greater viewing distances; snorkeling should not be planned following rains or during weekends and holidays with heavy boat traffic that reduces water clarity. There is generally a great abundance and diversity of small fishes in waters of wadable depths. Larger species are more often found in deeper habitats but are fewer in number. There are many waterproof cameras available that take high quality photos and videos to preserve snorkeling memories, post on social media, provide photo vouchers of rare fishes encountered, or get images of unknown species that can be shared with ichthyologists and fish biologists for identification. Snorkeling is also effective for monitoring the re-establishment





Figure 17. The author and son looking for and finding translocated Rainbow Darters *Etheostoma caeruleum* a year following his Eagle Scout project. (Photo by Mary Stefansky)

of extirpated species in former habitats (Schmidt 2013b) (Figure 17).

**MINI-FYKE NETS** are smaller versions of trap nets with  $\frac{1}{8}$ -inch mesh (Figure 18). The opening at the end of the throat going into the codend should not be larger than about two inches in diameter. Larger diameters will give predators access to the last compartment, where smaller species congregate. Mini-fykes will work in streams, but securing them in place can be difficult in swift current. They are much better suited for lakes and backwaters of rivers.

The lead of a single mini-fyke can be anchored near shore with a metal stake or tied to a submerged log and pulled perpendicular from shore. An anchor or stake on the codend keeps the net stretched and prevents collapsing forward on itself. Generally, tandem sets produce better catches. The leads of two nets are staked together and the codends are stretched tight and anchored. Tandem nets can be set either perpendicular or parallel to shore. Mini-fykes are generally set overnight and retrieved from the lead end to prevent fish escaping from the front compartment. Two people grab opposing sides of the frame and shake the catch toward the codend, which is then untied and opened. Shaking continues into a shallow live well. Mini-fykes are magnets for young of the year sunfish but very often catch a surprising diversity of minnows. Although never captured in large numbers, new localities of rare and sensitive species such as Pugnose Shiner *Notropis anogenus*, Northern Sunfish, and Least Darter *Etheostoma microperca* have been taken with mini-fyke nets in high-quality lakes.

To prevent drowning turtles, waterfowl, muskrats, and beavers care should be taken that the front compartment of the trap is not submerged below the surface when setting nets. Slipping one or two swimming noodles inside the front compartment will create air spaces for these animals to breathe until they can be released. One safety issue for collectors is that large snapping turtles get trapped in the front compartment. They are always difficult to remove and present a constant threat of being bitten. It took just one bite for the author to design an effective turtle excluder for this species. A four-inch nylon mesh across the opening of the net solved the problem yet still allowed the passage of small fish. Commercially sold nets are available but expensive. The author made a small model with a front compartment about two-feet-square for a fraction of the cost, and it works just as well as the commercial ones. Making the frames and sewing the material is a tedious, time-consuming chore, however.

**BENTHIC TRAWLS** hug the streambed and are towed off the bow of a boat moving downstream in reverse (Schmidt 2012). **Please note:**



Figure 18. Mini-fyke examples and a very crabby catch. From top: commercial tandem set. DIY versions. Snapping turtle removed from mini-fyke. Set net with turtle excluder and pool noodles to create air pockets (photo by Jenny Kruckenberg).



boats may swamp if a trawl is towed off the stern moving forward! The parts of a trawl are the net, tow lines, otter boards, and float. Depending on the outboard and boat used, trawls can have a mouth ranging from 8–24 feet wide that quickly tapers toward the codend. A tickle chain runs the length of the mouth's lower lip to flush fish off the bottom. Otter boards keep the trawl's mouth spread open. A large float is attached to the codend and is retrieved to dislodge it if the trawl snags. Trawls designed to catch small fishes are constructed with two nets, one inside the other. The inner net is a coarse mesh large enough to allow minnows and darters to pass through to the outer net made of finer mesh. The purpose of this design is to grade the fish into two separate parts of the net and prevent large species from crushing smaller ones. The author has only used the smallest trawls, and catching any large fish is extremely rare. Even though trawls are also shaken down like mini-fykes, many fish get stuck between the two layers far from the codend and are only detected when the net is inverted to dry or when a pungent odor begins wafting from decomposing fish. The author has since removed the inner net from his trawls and the smaller target species are captured alive and unharmed.

Trawls are most effective on species with no or poorly developed swim bladders. They typically do not capture a high species diversity or large numbers of fish but *have* collected rarely seen species such as Shoal Chub *Macrhybopsis hyostoma*, Spoonhead Sculpin *C. ricei*, Deepwater Sculpin, and Crystal Darter. With very long tow lines, trawls can sample depths well over 100 feet in lakes and rivers, but they are more effective at depths from just beyond wadable to about 15–25 feet. They are most often deployed off the bow in deep water. However, the net may roll on itself while sinking to the bottom. This can be avoided by first deploying the trawl on a bank and towing it into deeper water (Figure 19). Boulders and snags can be so numerous in some rivers that it is simply not worth the effort of surveying them because of the time spent recovering snagged trawls. The author's preferred habitats are navigation channels of large rivers or streams comprised mostly of gravel and sand substrates. Like snorkeling, trawls can be an effective tool to confirm the establishment of translocated species. For a few years following the release of several hundred Least Darter in a lake, none could be found with seines and dip nets. However, the species preferred habitat of submergent vegetation that was just beyond wadable depth. One trawl haul towed out from shore to a depth of about 7–8 feet captured several specimens. Trawls are available from commercial vendors but are pricey. Like mini-fykes, they can be handmade for very little expense.

### TRANSPORTING FISH

After all the time and effort expended collecting fish, it is very important to reduce stress on them in transit and get them home healthy. Avoid collecting trips on hot days. Even brief exposure to high temperatures can cause mortality. Some species, such as Gizzard Shad *Dorosoma cepedianum*, Emerald Shiner *N. atherinoides*, Brook Silverside *Labidesthes sicculus*, and many darters, are extremely sensitive to heat and will exhibit immediate death throes after simply being transferred from the net to the container. Avoid thermal shock by cooling water with ice on hot days; during cold months do not raise the temperature too rapidly. In the latter case, leave fish in coolers with aeration, allowing temperatures to gradually rise over about 24 hours before releasing them in aquariums. During warm months, fish will appear healthy after acclimating to

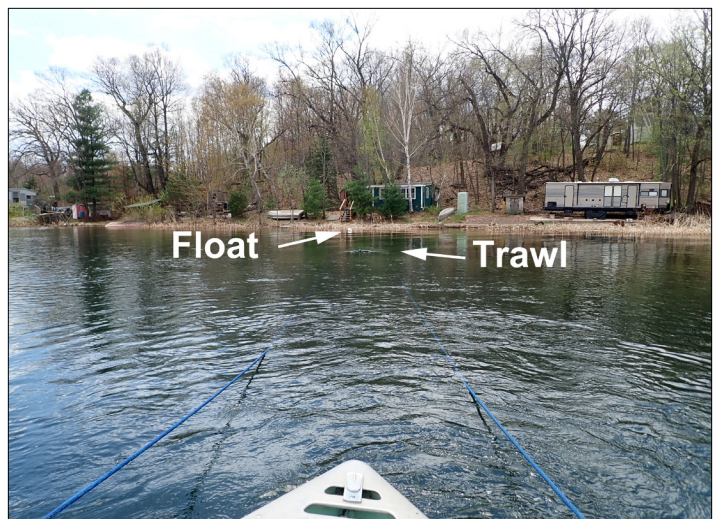
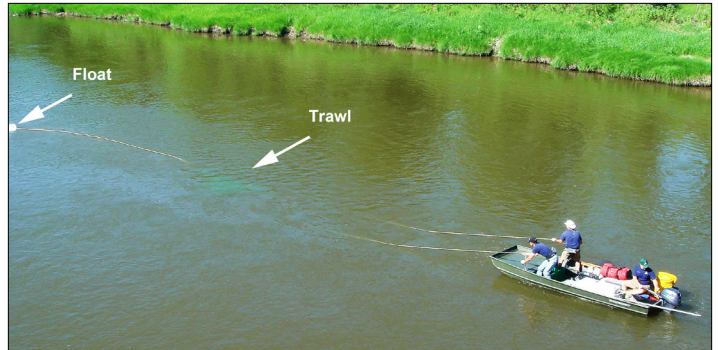


Figure 19. Benthic trawl examples. Top two photos: deployed in deep water from bow. Bottom photos: shallow water from stream bank or lakeshore (photo by Jenny Kruckenberg).



aquariums but develop fatal fungal or bacterial infections within a day or two. The daily limit of bait species for personal, non-commercial use is 12 dozen, which will be impossible for most anglers to keep alive without major losses on the way home and long-term in

aquariums. Even with good filtration, aquariums have a limited carrying capacity. A safe guideline is one to two inches of fish per gallon in an aquarium (e.g., 10–20 inches of fish in a ten-gallon aquarium). The more fish, the more water changes are required to maintain water quality. The author's preferred transport containers are insulated food coolers. No aeration is required while the vehicle is moving, but if there is a lunch stop or a breakdown, then a DC air pump is required to maintain adequate dissolved oxygen (DO) levels. Another option is plastic bags placed in coolers to keep water temperature stable (Figure 20). When sealing the bags, it is very important to leave approximately a 25:75 ratio of air to water. Again, as long as there are no extended stops, the sloshing of the water in transit will provide sufficient DO for the fish.

### PHOTOGRAPHY

These days, the state-of-the-art technology crammed into digital cameras and smartphones means everyone has gear that can take great photos. Recreational microfishers “cataloging” their life lists and biologists both benefit from good voucher photos, but fish may not always cooperate in handheld shots, as by displaying clamped fins. A “splash” technique used on darters solves this issue with stunning results (Goodale 2017). Snorkelers can capture high resolution photos and videos of fishes in their underwater habitats that rival the work of professionals. Scientific and educational applications include catch-and-release evidence of rare species or first known occurrences in a state or drainage as well as images for presentations, articles, or posting on sites such as iNaturalist, FishBase, and the NANFA Photo Galley (Schmidt 2023).

Fish can be photographed in home and public aquariums, but capturing a shot with good depth of field is challenging when the subject is not close to and parallel with the front of the tank, resulting in many images with blurry heads or tails. Small photo tanks with back plates that keep fish at the front help immensely. The author's preference is to provide a natural background using rocks or plastic plants that are difficult to discern from native vegetation. Unfortunately, post-processing with photo editing software, such as removing minute specks of debris spread throughout the background, can be very tedious. An easier method is shooting fish in a bare tank with a dark background. Even then, however, post-processing is still required to isolate the body of the fish and place it over a blank, black background (Figure 21).



Figure 20. Transport containers. Insulated food coolers (left). Plastic bags (right) (photo by Jenny Kruckenberg).



Figure 21. Redside Dace *Clinostomus elongatus* on natural background (left). Mud Darter *E. asprigene* on black background (right).



Photographs of large species can be very problematic. All too often “artifacts” such as hands holding fish steady for the camera mar the final results. It is also extremely challenging to shoot good images photographing fishes in public aquariums and zoos. At the 2023 NANFA convention in South Carolina, Scott Smith demonstrated a “dry” technique where a plexiglass sheet was placed on buckets and a white background was laid on the ground under the sheet. The space between the acrylic sheet and the background eliminates the shadow that occurs when laying fish directly on a surface. All the photo subjects remained surprisingly calm and “cooperative” on the plexiglass. Scott also suggested using small rods with hooks to elevate fins and later remove them using image editing software. The author, soon after returning to Minnesota, tried this technique with impressive initial results (Figure 22).

#### VOUCHER SPECIMEN AND TISSUE PRESERVATION AND CURATION

Due to limited funding, space, and staff, it is difficult to find fish collections affiliated with museums and academic institutions that are actively expanding their holdings. The author began depositing preserved specimens in the late 1980s at the University of Minnesota’s Bell Museum of Natural History in St. Paul (Figure 5), but his “zealous” efforts have resulted in an overrepresentation of Minnesota species in the collection’s holdings, and no more specimens are being accepted. Thankfully, the University of Wisconsin Zoological Museum in Madison and the University of Tennessee Etnier Ichthyological Collection in Knoxville will still curate a limited number of specimens annually from his surveys.

However, the carrot that provides the incentive to add specimens today is the continuing advancement in genetic analysis methods and an increasing demand for tissue samples to sequence for research studies. Two types of preservatives are needed to achieve these objectives: formalin and ethyl alcohol. The concentration of “pure” formalin is about 37 percent and is used to preserve and fix whole bodies. However, this concentration would be wasteful to use and is diluted to formalin at about a 10 percent concentration. Since formaldehyde/formalin is a carcinogen, care must be taken to use it in well-ventilated areas like the outdoors to prevent inhaling fumes. The chemical is also used in mortuaries to preserve human bodies, and accidental spills of formaldehyde on skin and in eyes must be avoided and rinsed with water immediately.

Generally, a tissue sample preserved for genetic analysis consists of a fin clip from a paired fin (e.g., pelvic), but tissue plugs and whole bodies are also used. Tissue samples or whole-bodied fish are not placed in formalin but are preserved in 95 percent ethyl alcohol. Once the fin clip is removed and placed in a vial of 95 percent ethyl alcohol, the body is then preserved in a specimen jar of formalin (Figure 23). Both the tissue sample and the body are tagged with the same number just in case the species identification is in doubt and requires an independent verification. The fish collections (e.g., the Etnier Ichthyological Collection) furnish the required chemicals and supplies. Genetic studies are used to identify new species, which is often called “splitting” species from formerly “lumped” species complexes. These studies also reveal “clades” (groups) in the same species distributed across a wide geographic area.

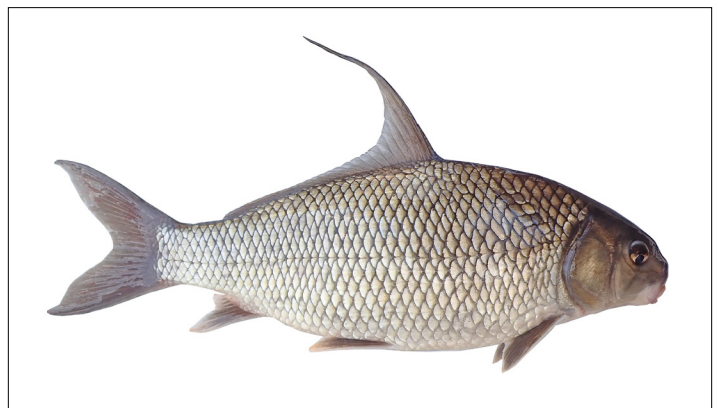


Figure 22. Top: Scott Smith demonstrating dry method for large species. Middle: author’s first try with technique, using a hooked rod to elevate dorsal fin. Bottom: edited image of Quillback *Carpiodes cyprinus*.



## CONCLUSIONS

This article teaches how to fish for natives to fill a lifetime of enjoyable and memorable experiences. The author also hopes some readers give back by turning kids on to natives and contribute to furthering our knowledge about so many overlooked and poorly understood species. Most of all, have fun!



Figure 23. Tissue kit: vials, whole body specimen bottle, scissors, field notebook, tags, and alcohol swabs to clean scissors between species (top). Tagged Slimy Sculpin for specimen bottle (bottom) (photo by John Olson).

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*Continued on page 40*



# BOOK REVIEW: AN ATLAS OF ILLINOIS FISHES: 150 YEARS OF CHANGE

Phil Nixon

Tolono, Illinois

Published in 2022 by the University of Illinois Press, *An Atlas of Illinois Fishes: 150 Years of Change* is the most recent of the various books published on the fishes of Illinois. Like most other state fish books, this is more a reference book (hardcover, approximately 8.5 x 11 inches, 424 pages) than a field guide (Figure 1), but there are reasons to have it close at hand when conducting fish activities in Illinois and nearby states.

The authors have spent many years studying Illinois fishes. Brian A. Metzke is State Aquatic Ecologist for the Illinois Department of Natural Resources, Brooks M. Burr is Emeritus Professor of Zoology at Southern Illinois University Carbondale, and Leon C. Hinz Jr. is the Wildlife Action Plan Coordinator for the Illinois Department of Natural Resources. Lawrence M. Page is Curator of Fishes at the Florida Museum of Natural History (and a longtime NANFA member) and retired from the Illinois Natural History Survey, and Christopher A. Taylor is an aquatic biologist and Curator of Fishes and Crustaceans with the Illinois Natural History Survey at the Prairie Research Institute at the University of Illinois.

Drs. Burr and Page should be recognizable to NANFA members as authors of the *Peterson Field Guide to Freshwater Fishes of North America North of Mexico*. It is the go-to book for many of us to identify the fish we encounter while seining, dip netting, snorkeling, microfishing, and fish watching.

The *Atlas* is typical of state fish books, with its 217 fish species grouped alphabetically to species in families arranged in evolutionary order. Information on identification, habitat, and distribution within the state is provided for each species. Similar to the *Peterson Field Guide*, there is a section in each species' account to help distinguish it from similar fishes, primarily using field characteristics such as fin and eye placement, fin ray numbers, and coloration.

A state distribution map for each species—filling almost half the page (Figure 2)—allows one to pinpoint collection locations within counties. Different colored circles and squares are used to indicate whether the records are from before 1910 (the Forbes and Richardson era), 1910–1978 (the Smith era), or after 1978 (Metzke et al.). The

large state maps and the use of color allow the reader to distinguish one group of collections from another. This makes it easy to see Illinois fish distribution trends over time and to get a sense of where a fisher or fish watcher is likely to be successful.

Other features on the species pages are less common in state fish books. There is a clear, high quality, full color photograph of *every* fish (six of these are on the book's front cover), many of which were provided by NANFA members, particularly Illinois residents Lance Merry and Uland Thomas. Thirty-one species have two photos, with the second one being a young fish or a female where there is considerable variability. Another feature is that each species is given one (and only one) entire page, allowing the reader to easily find information (Figure 2).

A pictorial key at the beginning of each fish family uses primarily field characters that are pointed out on excellent halftone illustrations (Figure 3). These keys will be very useful to microfishers, seiners, and others in NANFA in determining which fish they have, either in the field or a photograph. As with other state fish books, the keys are easier to use with similar out-of-state fish species not included in the key. The book's index includes both scientific and common names of the fish.

The subtitle, *150 Years of Change*, refers to the long history of ichthyologists studying Illinois fishes, particularly those working for the Illinois Natural History Survey. The Illinois Natural History Survey was a state agency that is now part of the Illinois Prairie Institute of the University of Illinois. It worked closely with the Il-

linois Department of Conservation, now the Illinois Department of Natural Resources. Being housed on the University of Illinois campus, the Illinois Natural History Survey also has been closely allied with ichthyologists at the University of Illinois through the decades.

The first scientific inventories of Illinois fishes were published in the mid-1800s and the first statewide treatment was published in 1909 as the *Fishes of Illinois* by Stephen A. Forbes and Robert E. Richardson. The next major statewide work was *The Fishes of Illinois* by Philip W. Smith in 1979. This new book represents the third major statewide compilation of Illinois fishes. It is based on 12 million

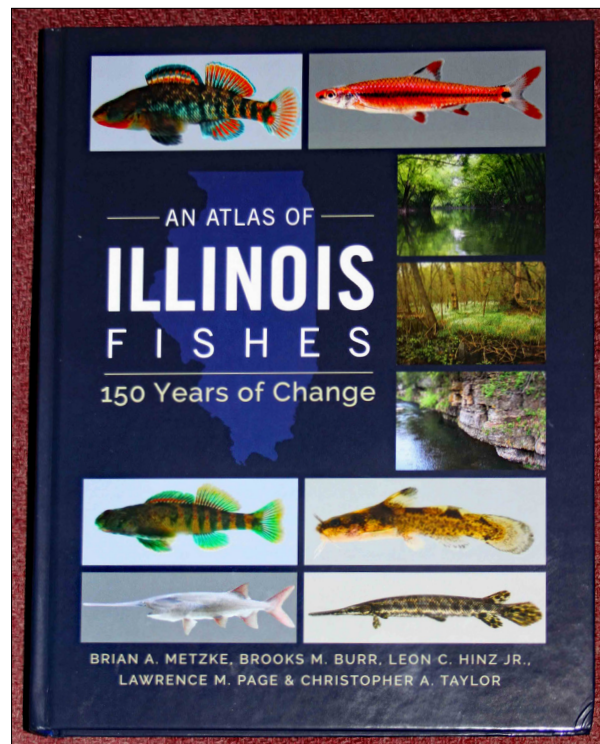


Figure 1. Front cover.



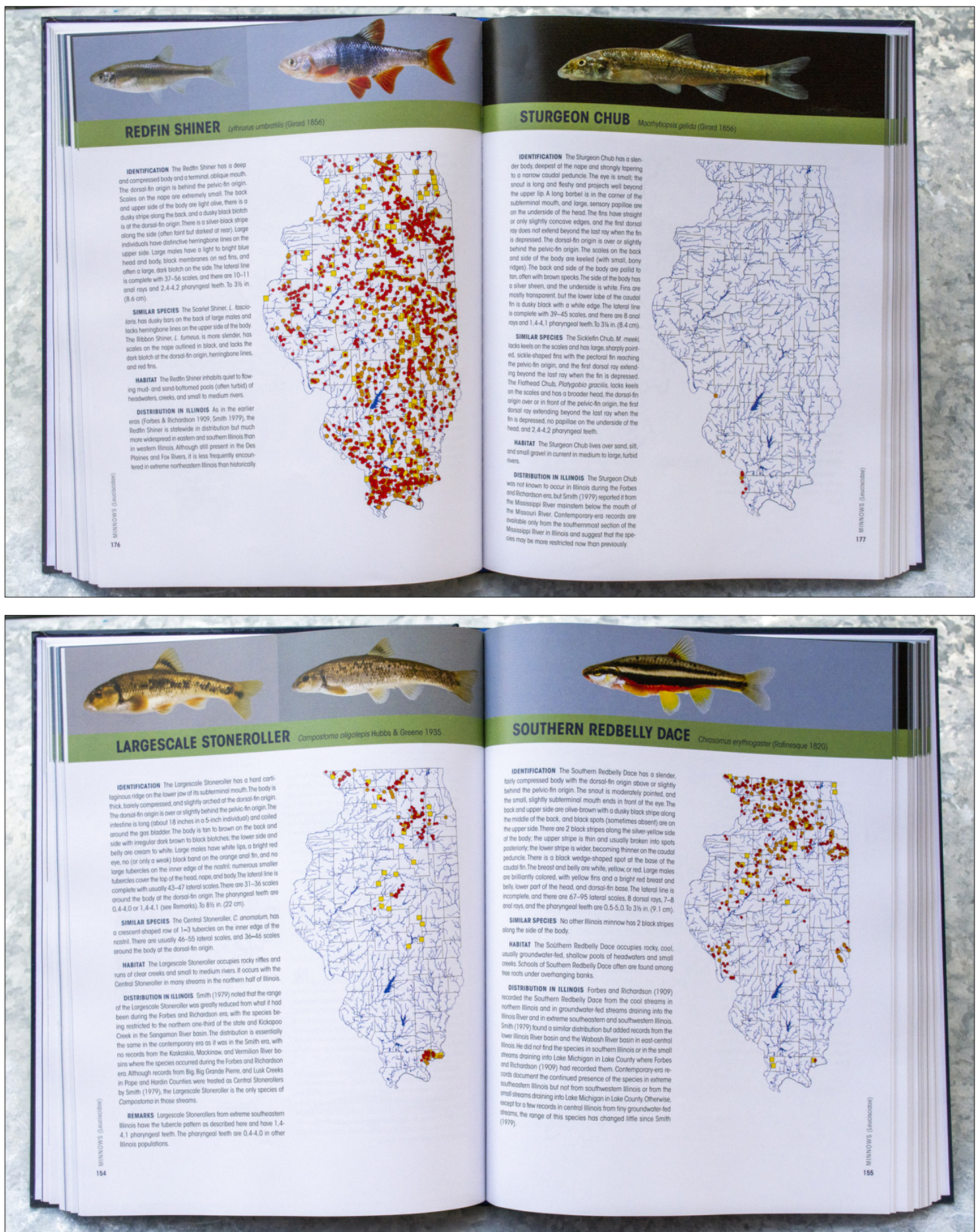
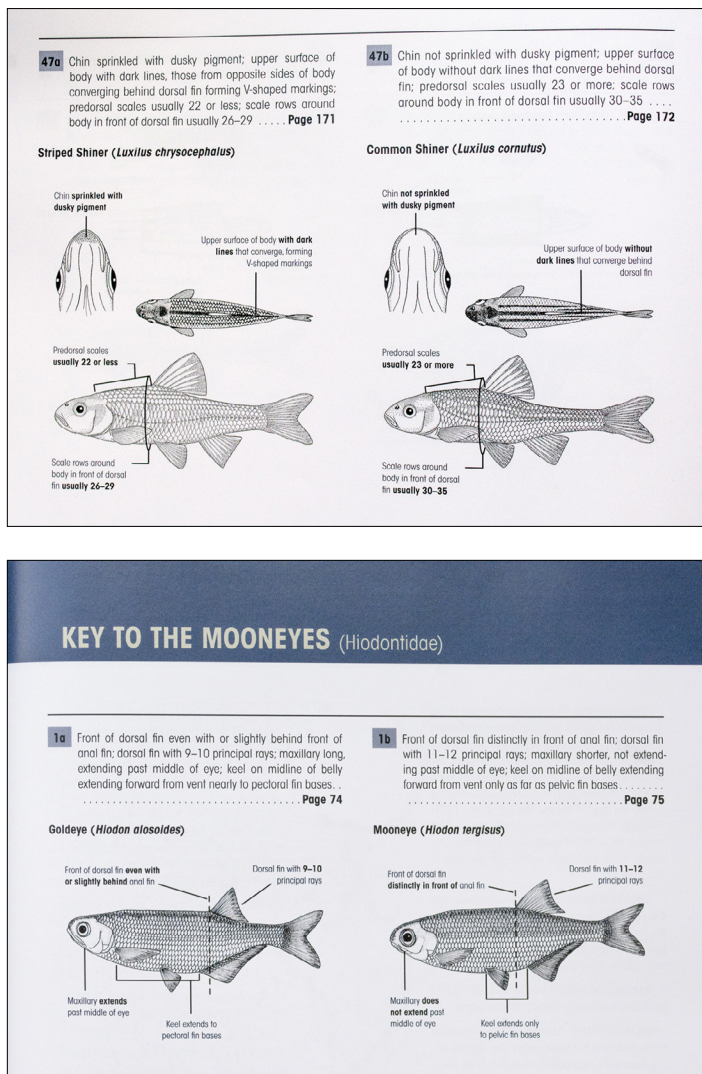


Figure 2. Every fish gets a page with quality photo(s), a readable map, and clear, concise text.





**Figure 3.** Examples of keys, showing some of the ways that relevant details are highlighted and explained.

fish collected during 166 years of surveys from about 15,200 localities within the state.

The historical distribution of fishes in this diverse state is interesting. Stretching 400 miles north to south, Illinois ranges from USDA Planting Zone 5a to 7a. Habitats range from the unglaciated far northwest to the unglaciated cypress swamps in the far south. Most of the state was covered in glaciers repeatedly to various degrees, resulting in multiple moraines and natural ponds affecting fish distribution. Much of the state has been altered by agriculture and urbanization, but the western and southern portions are more pristine.

Although this book is best suited for those conducting fish-related activities in Illinois or surrounding states, several of its features make it useful for many others. Its excellent photographs of every fish species will help with identification of fish in other states. The large number of key character illustrations also make it desirable.

*An Atlas of Illinois Fishes: 150 Years of Change* is available from the University of Illinois Press, in cloth binding for \$50.00 and as an eBook for \$24.95: <https://www.press.uillinois.edu/books/?id=c044144>. It is also available from Amazon and other booksellers.

### “Collecting 101,” continued

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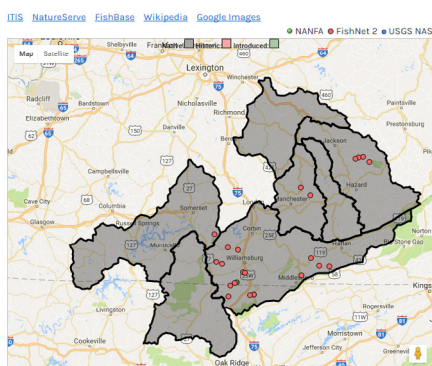
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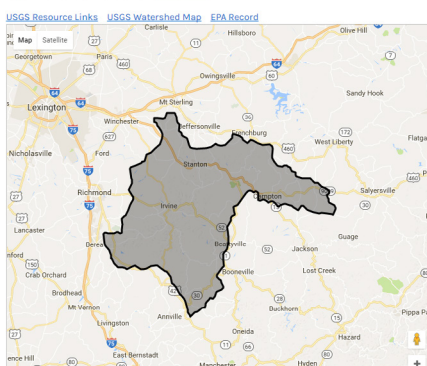
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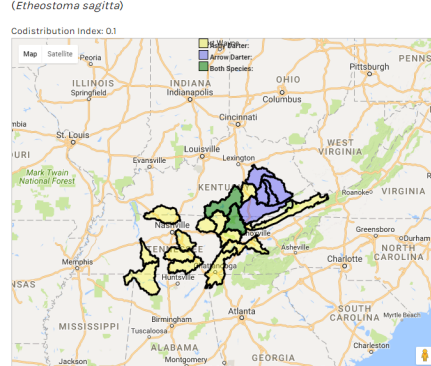
**FishMap.org** combines numerous data sources to provide a better view and more complete understanding of fish species distribution. It uses data from NatureServe, the National Atlas, the USGS water resources and Nonindigenous Aquatic Species programs, FishNet2, iNaturalist.org, GBIF, and iDigBio.

### Explore Watersheds



**FishMap.org** 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).

### Compare Ranges







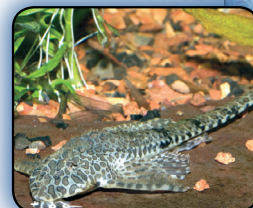
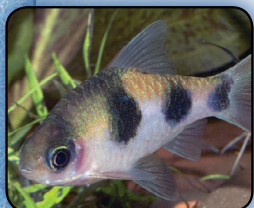
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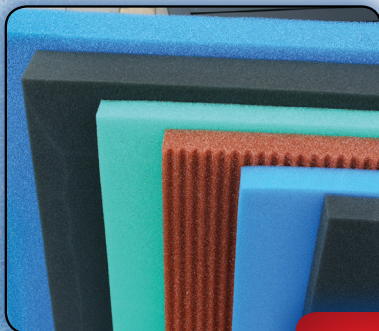
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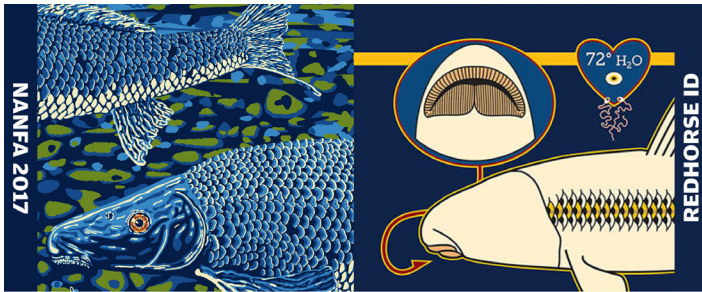
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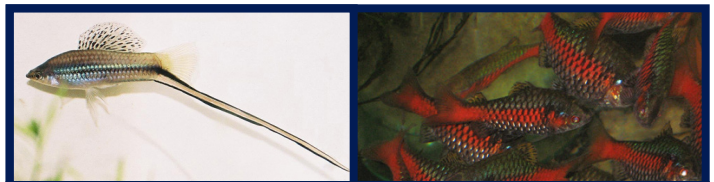
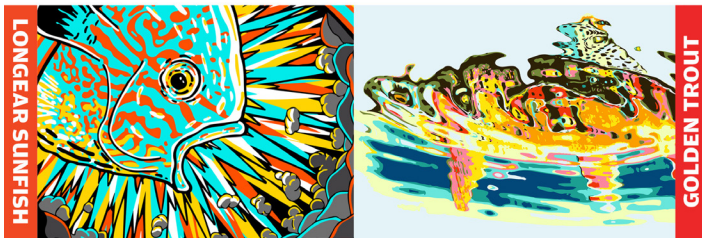


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### FISHES OF WISCONSIN POSTERS



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.





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