American Currents

Publication of the North American Native Fishes Association

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The North American Native Fishes Association

Est. 1972 — John Bondhus, founder

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

BOARD OF DIRECTORS

Josh Blaylock
Richmond, KY
606-273-0718
jblaylock@hotmail.com

Scott Schlueter
(See under Member Services)

Derek Wheaton
Knoxville, TN
540-907-3754
wheatonderek@gmail.com

Fritz Rohde, President
***American Currents* Co-editor**
Wilmington, NC
910-431-3891
fritz.rohde@gmail.com

Tom Watson, Treasurer/
Membership Coordinator
Federal Way, WA
253-838-6745
nanfatreas@gmail.com

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Statham, GA
706-296-7731
michael.wolfe@nanfa.org

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Gambier, OH
330-417-9476
smbass444@yahoo.com

MEMBER SERVICES

Sajjad Lateef,
Web Technologies Host and
E-mail List Administrator
Santa Clara, CA
sajjadlateef@yahoo.com

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Breeder's Award Program
Royal Oak, MI
248-398-0195
rdmuller625@gmail.com

Scott Schlueter
Corcoran Education Grant Chair
Fabius, NY
716-864-8184
Scott_Schlueter@hotmail.com

Konrad Schmidt
***American Currents* Co-Editor**
St. Paul, MN
651-776-3468
ssminnow@usfamily.net

Bruce Lilyea,
Conservation Grant Chair
Lakeland, FL
863-513-7611
bruce.lilyea@gmail.com

Nick Zarlinga, Website Contact
njz@clevelandmetroparks.com

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NANFA FELLOWS

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REGIONAL REPRESENTATIVES

Michael Wolfe, Coordinator

AL: Bruce Stallsmith
Huntsville, AL
256-882-2231
fundulus@hotmail.com

AR: Isaac Szabo
Marble Falls, AR
497-890-1222
isaac@isaacszabo.com

CA: Phil Farrell
Placerville, CA
(954) 839-5303
philter622@gmail.com

CT: Barrett Christie
Norwalk, CT
203-852-0700, ext. 2356
bchristie@maritimeaquarium.org

FL (central):
Charles A. Nunziata
Largo, FL
727-393-3757
epiplaty@tampabay.rr.com

GA: Michael Wolfe
(see under Board of Directors)

IA: Ken Glackin
Cedar Rapids, IA
219-374-5951
naa@imonmail.com

IL: Dylan Bane
Rockford, IL
319-290-7934
Dbanefishstuff333@yahoo.com

IN: Mike Berg
Cedar Lake, IN
219-689-5951
bergmichael@att.net

KY: Josh Blaylock
(see under Board of Directors)

LA: Joshua Porter
Saint Gabriel, LA
760-412-1957
jdporter@ymail.com

MD: Robert Bock
Silver Spring, MD
bockhouse1@verizon.net

MI: Leo S. Long
Troy, MI
248-689-8375
lscalong@wideopenwest.com

MN: Jenny Kruckenberg
Inver Grove Hts., MN
651-457-2302
jennyk@usfamily.net

MS: Jan Jeffrey Hoover
Vicksburg, MS
601-634-3996
hooverj@bellsouth.net

MO: Bob Hrabik
Oak Ridge, MO
573-788-2028
roberthrabik@gmail.com

NC: Gerald Pottern
Wake Forest, NC
919-556-8845
gbpottern@yahoo.com

NH: Josh Jarvis
Richmond, NH
603-239-4413
FirstChAoS_2000@yahoo.com

NY (central and west): Scott Schlueter
(see under Member Services)

NY (eastern): Michael Lucas
Schenectady, NY
Psalm19.111@gmail.com

OH (southern): Matt DeLaVega
Pleasant Plain, OH
513-877-2063
delavega31973@msn.com

OH (northern): Matthew Smith
Ashtabula, OH
440-992-5845
matthew.smith@dnr.state.oh.us

OK: Brandon Brown
Madill, OK
580-320-2959
madtom@itlnet.net

SC: Dustin W. Smith
Lexington, SC
803-808-0258
dsmith73@hotmail.com

Coastal SC: Jake Wade
Charleston, SC
615-806-9806
jakewade97@gmail.com

TN: Derek Wheaton
(see under Board of Directors)

TX: Jeremy V. Jordan
Roanoke, TX
817-789-1279
jvjordan17@gmail.com

VA (northern): Michael Thennet
Fairfax, VA
703-425-5046
michael.thennet@cox.net

VT: Dennis Bruso
Addison, VT
802-373-1947
dennis@eastcoastprinters.com

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American Currents

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FRONT COVER: A male Redstripe Longear Sunfish *Lepomis* sp. "Ozark" guarding its nest in an Ozark stream in Oklahoma. (Photo by Brandon Brown)

BACK COVER: A male Redfin Darter *Etheostoma whipplei* from the Arkansas draingae in Oklahoma. (Photo by Brandon Brown)

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NANFA News

MEMBERS, EVENTS, ACCOMPLISHMENTS, AND ADMINISTRIVIA

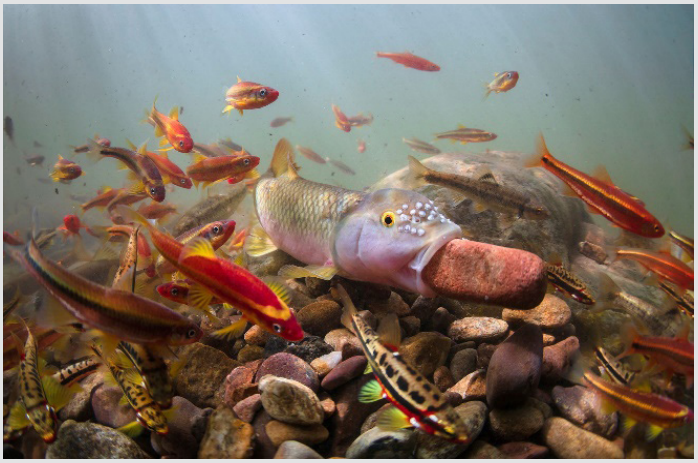
A REQUEST FROM THE EDITORS: DON'T BE MODEST! SEND YOUR NEWS!

We would very much like to receive news items from more members. The well is in danger of running dry! Please, don't be shy. Blow your own horn about fishy things going on in your life, big or small, or tip us off to things you heard about other members. Native fish topics could include, but are by no means limited to:

- Summaries and species highlights of collecting, microfishing, or snorkeling trips
- Invitations to upcoming local or regional events and gatherings
- Captive breeding reports
- Discoveries, DIY tips, and other aquarium-related topics
- Articles published in local papers, scientific journals, magazines, etc.
- Presentations to aquarium or professional organizations
- Involvement in local environmental events or issues
- Brief stories of the crazy things that happened while out doing something fishy

Please forward items or offer suggestions to Konrad Schmidt: ssminnow@usfamily.net

ISAAC SZABO RECOGNIZED IN PHOTO CONTEST FOR HIS RIVER CHUB NEST



Several fishes gathered near a River Chub's *Nocomis micropogon* nest in a freshwater stream in Virginia's Whitetop Laurel Creek. During springtime spawning, male River Chubs sometimes carry rocks and pebbles up to 10 meters to form a mound where eggs can be sheltered from currents and predators. Other minnow species also use their nests to keep their eggs safe.

Isaac Szabo (Marble Falls, Arkansas) is very well known within NANFA for his stunning photos, many of which have appeared on *American Currents* covers. The Natural History Museum in London recently recognized his River Chub nest as Highly Commended (i.e., runner up) in the Underwater category of their Wildlife Photographer of the Year competition. The contest is the most prestigious nature/wildlife photography competition in the world. Nearly 50,000 photos were entered and only 100 awarded. His image is currently displayed in the museum's gallery and on their website: https://www.nhm.ac.uk/wpy/gallery/2023-rock-idol. It was also reported in a National Geographic article: https://www.nationalgeographic.com/animals/article/wildlife-photographer-of-the-year-59 (subscribers only). Congratulations, Isaac!

A selfie of Isaac in his element.

NANFA AUCTION ITEMS WISHLIST

Whether or not you are planning to attend the 2024 NANFA Convention in Broken Bow, Oklahoma, it is never too early to think about donating items to the NANFA auction. All proceeds fund our education and research grants. Great auction items include just about anything fishy, including collecting gear, snorkeling accessories, microfishing gear and tackle, photo tanks and other photography devices, aquariums and accessories, books, magazines, clothing, or gift certificates from Cabelas, Bass Pro Shops, Memphis Net and Twine, or anywhere else that might be useful to your fellow NANFAns. There have been many beautiful works of art in past auctions. If you have a vacation property on a river or lake, consider donating a week's stay. If attending the convention is just not in the cards, items can be mailed in advance to ATTN: Brandon, 9097 N 34th St W., Porter, OK 74454.

Please forward news items about NANFA and NANFA members to Konrad Schmidt: ssminnow@usfamily.net

NANFA BOARD OF DIRECTORS ELECTION

In September, Michael Wolfe requested nominations for four expiring positions on the NANFA Forum, but none were received. In October, he nominated the four serving members (i.e., Fritz Rohde, Brian Zimmerman, Michael Wolfe, and Derek Wheaton) to continue in their positions and there was no further discussion on the forum. In December, the Board passed a resolution suspending the elections and the four nominated members will continue to serve in 2024–2025. These are volunteer positions that receive little recognition, but are integral to NANFA functions. Thank you for stepping forward to support NANFA with your time and effort!

A FOND FAREWELL TO AN ICHTHYOLOGICAL ICON

On October 14, 2023, family, former students, and friends of David "Ets" Etnier gathered at an idyllic setting by the Holston River near Strawberry Plains, Tennessee, for a celebration of his life. Konrad Schmidt left Minnesota early on October 13, picked up Bob Hrabik at Old Appleton, Missouri, late the same day, and finally arrived the next day just minutes before the service began. Casper Cox (Chattanooga, Tennessee) hailed them as they rushed to the tent from the endless row of parked cars. Inside, they found Wayne Starnes (Raleigh, North Carolina) and Ben Keck and Ed Scott (Knoxville, Tennessee). Ets' children Jenny, Michael, and Shelley shared wonderful, charming memories about growing up with parents as exceptional, nurturing, and inspirational as Ets and Liz. All of them went on to receive PhDs in science professions. Even more touching was the grandchildren recalling annual summer trips to Saganaga Lake in Ontario, Canada, where Ets not only took them fishing often, but also left them spellbound with his "teaching" about the countless wonders of nature in the Ontario wilderness. All agreed that these experiences were the most memorable of their lives. Students nostalgically spoke of him as a mentor second to none and told several hilarious stories about the good professor that caused the crowd to erupt in laughter. Afterward, everyone spread out into smaller groups to chat. A lucky few heard Liz's marvelous story of how she met Ets. In 1960, they were both enrolled at the University of Minnesota in Fish and Wildlife Management (Liz would become the first woman to receive a degree from the program). She and David were in a few classes together, but had barely spoken to each other, but when Liz went home for Thanksgiving, she told her boyfriend she had met the man she was going to marry. He asked if they were dating, and she said, "No, but we will be." Ets was a character, and was loved and admired by all!

To read more about this amazing person, please read remembrances of Ets in the summer 2023 issue of *American Currents*.

The photo above is a final cherished memory of Konrad's. Ets, the master fishing guide, proudly looking on at the "unofficial" Minnesota state record Nipigon Cisco *Coregonus nipigon* Ray Katula (Onalaska, Wisconsin) caught in Saganaga Lake on September 13, 2003. This fish, weighing a whopping 1 pound, 2 ounces, was hooked on an Etnier Spoon that Ets made from a soup can.

NANFA SUBMITS COMMENTS ON PROPOSED CHANGES TO OKLAKOMA'S ROUGHFISH HARVEST LIMITS

Fritz Rohde, NANFA's president, sent a letter to the Oklahoma Department of Wildlife Conservation in November 2023 on behalf of NANFA voicing support for efforts in Oklahoma to enact new limits that would protect native fishes from over-harvest and to make it illegal to release fish shot with arrows. Excerpts follow.

The letter begins by introducing NANFA and its mission, highlighting that our members are "a diverse group including fisheries professionals, academics, and amateur native fish hobbyists" and notes that "the organization is the oldest and most respected of its kind and strives to serve as a voice for native fishes (and their habitat), especially nongame species, which are often little known, little studied, and offered little protection."

"North America hosts the largest temperate freshwater fish assemblage in the world, with over 1,100 species currently described," the letter says, but points out that almost 40 percent of them are in peril, that this number is increasing, and that the number of threatened fishes is particularly high in the Southeast and Central US. "Virtually all of these imperiled fishes are nongame species with little management or regulation."

Of course, NANFA is no stranger to Oklahoma's fishes. The letter notes that the 2015 convention was held in Tahlequah and 2024's convention will be in Beavers Bend State Park, then gets to the main point.

"NANFA has learned of ODWC's recent proposal to implement harvest regulations for bow fishermen and nongame species. Although native species targeted by bow fishermen (primarily gars, buffalo fish, and suckers) have traditionally been viewed

by many as "trash fish," NANFA considers these species to have great intrinsic and ecological value. In addition, as evidenced by the growth and passion of the bow fishing community, these species hold great recreational value as well. Furthermore, recent research done in Oklahoma and other states has shown that some of these species have life histories more complex than previously thought, with unusually long-life spans (>100 years) and episodic recruitment.

"ODWC's efforts to establish limits and prohibit catch and release of native nongame fish for bow fishermen are directly aligned with NANFA's mission of increasing appreciation and conservation of native nongame fishes and we commend Oklahoma's efforts to manage and delegate value to these important native species. Please consider this letter as an official comment of support for the proposed rule changes and Oklahoma's efforts to increase appreciation, awareness, and management of its nongame native fishes."

THE WRECK OF THE SS *SCULPIN*

With apologies to the memory of Gordon Lightfoot and his hit folk song *The Wreck of the Edmund Fitzgerald*, we offer this tale as a cautionary reminder of how things can go seriously wrong in an instant—especially when collecting, microfishing, or snorkeling alone.

Towering clouds of smoke from the Pagami Creek Fire, September 12, 2011, from US Hwy 169 facing east toward Ely, Minnesota.

In September 2011, Konrad Schmidt (St. Paul, MN) was on his last survey of the year heading for Shagawa Lake near Ely, Minnesota. Still several miles west of town he could not overlook a massive thunderhead filling the eastern sky, but this was no thunderstorm. A lightning strike had smoldered for weeks and was now a crowning fire fanned by 35 mph winds. In a very short time, the Pagani Creek Fire engulfed 93,000 acres in the Boundary Waters Canoe Area Wilderness. The fire was heading away from Ely so he decided to set his nets. However, hindsight being 20/20, he realized too late to always respect the potential danger of high winds on small watercraft like his canoe christened the SS *Sculpin*. At the boat launch, Shagawa was froth-whipped from two-foot whitecaps. Undaunted, he launched his canoe. One net was set without incident, but the second was set way too shallow. While trying to reset it, a rogue wave hit him from behind instantly swamping the canoe and spilling gill nets and gear into the water. His Golden Retriever, Saber, was rudely awakened from a sound sleep and paddled around the overturned canoe trying to get back in again. Then something caught Saber's eye and he steamed full speed away. Konrad looked where he was heading. Only 100 feet away an angler was casting a 12-inch Muskie lure from his boat. The retriever was on a mission to rescue that lure. Thankfully, Saber's rescue of the Muskie lure failed. Treading water, Konrad shouted at the angler, "Can I have a little help here!" and realized by the man's startled look that he was totally unaware of the situation. He grabbed the floating gear and towed the canoe back to shore, but two gill nets (still stowed in mesh bags) went to bottom of the lake. Another post-trauma loss was Konrad's decades-old, dependable outboard. After its dunking, it seized up from rust in its cylinders. The next day, Konrad, on calmer seas, recovered the two nets that had been set, but Shagawa dealt one more unexpected and frustrating blow. Each net had hundreds of non-native Rusty Crayfish entangled in it. He bagged up the writhing mass and had his son, Bryan, clean the nets after arriving home later that day. Waste not, want not: Chef Bryan cooked them up and feasted for three days.

The next week, the Minnesota Department of Natural Resources (MDNR) Fisheries office from Tower sent out a team that trolled with a body hook for my lost gill nets in their mesh bags, but the team came up empty. Fast forward to 2023 when a MDNR biologist found the nets. He was "too grossed out" to assess their condition for future use and left them on the dock for the local warden to dispose of properly.

Lost gill nets found during MDNR fish survey August 21, 2023, after 12 years at the bottom of Shagawa Lake.

Oklahoma is home to about 175 species of fish, including **Golden Topminnows, Bluehead Shiners, Creole Darters, Red River Pupfish, Cardinal Shiners, Banded Pygmy Sunfish, Paddlefish,** and **Alligator Gar.** This high species number is due largely to Oklahoma's varied climate, geology and topography, all of which contribute to its high habitat diversity. Although few people realize it, Oklahoma is **one of only four states with more than 10 ecoregions** (or broad habitat types) and, **per square mile, is the most habitat-diverse state in the contiguous United States**.

NANFA's 2024 Convention will be held in far southeast OK where the Ouachita Mountains meet the Gulf Coastal Plain. This area holds **one of the state's most diverse fish assemblages,** and **both upland and lowland species** can be collected within a short drive of each other. **Species likely to be encountered include Orangethroat, Orangebelly, Slough, Cypress, Dusky, Channel, Harlequin and Creole darters, Western Starhead and Golden topminnows, Banded Pygmy, Longear and Bantam sunfish, Flier, Ouachita Mountain Shiners, and Grass Pickerel**.

The park is holding **30 cabins** for NANFA members until **March 1, 2024.** They cost approximately $115 – $170/night and can hold multiple guests. The Beavers Bend Lodge is holding **27 rooms** for NANFA members until **April 6, 2024.** They cost approximately $132 (2 queens) – $185 (suites). **Any cabins or rooms not reserved with deposits by the deadlines will be released.** Cheaper rooms are available in Broken Bow and Idabel. A new Choctaw Nation Lodge, scheduled to open in April, might be a good option. We're also working on a few low-cost (maybe even free) rooms for students approximately half an hour away. Beavers Bend State Park has seen a dramatic increase in visitation the past few years and is the most-visited state park in Oklahoma. **Rooms and cabins will fill quickly, so please make reservations as early as possible.**

Beavers Bend State Park Cabins (where the meeting room is): **580-494-6300.**

Beavers Bend Lakeview Lodge (a few miles away): **580-494-6179.**

Or reserve at **https://www.travelok.com/state-parks/beavers-bend-state-park**

ONE FISH, TWO FISH, THREE FISHES MORE: LONGEAR SUNFISH—OKLAHOMA'S PRETTIEST (AND NEWEST) NATIVE FISHES

Brandon Brown

Tahlequah, Oklahoma

Driven by environmental and chemical triggers we can't see or completely understand, each spring and summer a whole host of Oklahoma's fish species invest a tremendous amount of work and metabolic energy into reproduction. Some follow rising flood waters and broadcast huge numbers of eggs over newly flooded vegetation. Others, like Flathead Catfish, leave their deep-water haunts for shallower waters and excavate nest cavities under rocks and logs. Still others, like White Bass and Paddlefish, swim great distances upstream to lay their eggs. But perhaps no other Oklahoma fish invests more time, work, and energy into reproduction than the Longear Sunfish. Each year they devote weeks—even months—of round-the-clock effort into nesting and caring for their young. It's hard to even describe the myriad of fatherly duties constantly performed by the males, but to put it simply, they are the energizer bunnies of the fish world and are busy, busy, busy. Nonstop, twenty-four hours a day, seven days a week, a group of nesting Longears is a dizzying display of color, motion, and energy all following a precise set of rules innately known by the Longears but seemingly hidden from our eyes. They are arguably Oklahoma's most beautiful and hardworking fish.

A male Redstripe Longear in an Ozark stream.

A version of this article appeared in the March/April 2023 issue of *Outdoor Oklahoma*. It is reprinted here, in a slightly edited form, with permission. Photos by the author unless otherwise indicated.

Brandon Brown is a southeast region fish biologist for the Oklahoma Department of Wildlife Conservation.

Editor's note: Visit YouTube to watch the many outstanding underwater videos Brandon has made about Longear Sunfish and other Oklahoma native fishes: https://www.youtube.com/watch?v=8n8mCOM0X0U

Longear Sunfish are one of the most common and widespread, yet unique and interesting of Oklahoma's 175 (or so) species of fish. Their species name *megalotis* is derived from their prominent gill flaps, but what people usually notice and remember about them most is their striking coloration. This is especially true for breeding males, which can be absolutely stunning during the summer months.

Longears belong to the sunfish family, a fairly large and popular group that includes well-known species like Largemouth, Smallmouth, and Spotted basses, as well as Black and White crappies and an additional 11 species that most Oklahomans collectively (but incorrectly) just refer to as perch. Although they can be found in our large lakes and rivers, Longears are first and foremost creek fish. No matter where you live in Oklahoma (except the Panhandle), there's probably one swimming within a few minutes of your house. Even in urban areas, Longears are abundant in almost any small creek or ditch with clean, permanent water.

Mature Longears are sexually dimorphic, meaning that males and females look different. This contrasts with many kinds of fish, and even some of their cousins such as Largemouth Bass. For example, if you hold a two-pound male and female Largemouth side by side, it is difficult to tell which is which. However, with Longears, it's easy to see some obvious differences between the sexes. The length of the opercular flap (gill flap) is one example, with males developing longer and more pronounced flaps than females. Perhaps not too surprisingly, there is also good evidence suggesting females prefer males with longer gill flaps.

Another good example is size. For many fish species, females are larger than males. However, with Longears, the opposite is true. Although males rarely exceed six inches, they are noticeably larger than females. The development of a nuchal hump—an enlarged area of fat, soft tissue, and fluid best described as a swollen forehead—is another example and is most prominent in the oldest and largest males.

Perhaps the best example of sexual dimorphism in Longears is the development of the male's striking breeding colors. These

consist of varying shades of intense electric blues and turquoise greens, contrasting with deep reds and vivid glossy oranges. The exact patterns, markings, and combinations of these colors is quite complex and covers the entire face, body, and fins. These colors are most intense during summer and seem to glow and produce vibrant flashes of color in the right lighting conditions. By comparison, females are plain and ordinary looking, with dull and muted colors.

Longears are colorful throughout Oklahoma, but what's interesting is that they look different depending on where they are found. While a Largemouth Bass caught in Mississippi looks just like one caught in Wisconsin, Longears don't all look the same.

These differences in appearance are significant enough to make one wonder whether they are all fish of a single species and this has been discussed by a handful of ichthyologists over the years.

One of these is Bruce Bauer of Tennessee,[1] who has studied our state's Longear variation and who is trying to finish his life's work unravelling North America's Longear Sunfish speciation.

Bauer's tremendous undertaking spans 50 years of collecting, identifying, and documenting differences in Longear Sunfish from across the country. He's an encyclopedia of all things Longear and has been cited in a wide range of fisheries books and publications during the last four decades.

Bauer began working with Longears in 1973 at Eastern Kentucky University on an undergrad work study counting scales on Longears from all over North America. "When we looked at the ones from the Little River drainage in southeast Oklahoma, they really stood out. And the longer we looked, the more they stood out."

After finishing his undergraduate degree in Kentucky, Bauer moved to Tennessee Tech for his master's degree and then on to the University of Tennessee to work on his doctorate project with Longear and Dollar sunfish. "We were looking at everything and measuring anything that could be different—things like how many pectoral rays, which ray is the longest, how much longer is it, how many scales in the lateral line, how many scales above the lateral line, how many around the caudal peduncle, etcetera." These assessments were performed on literally thousands of fish.

Over the years, Bauer would set the project down and pick it up again, but he never gave up on finishing it. A few years ago, he had an opportunity to look at Longear variation using genomic-scale DNA sequencing. "It was really expensive, and some of the new DNA science stuff is over my head. But I was able to partner with some topnotch geneticists from Yale (Daemin Kim and Thomas Near) and finally take a closer look at some of these different forms of Longears. My morphometric work said they were different, but I really needed to be able to confirm it with DNA, too."

The results confirmed much of what Bauer had believed for years. In 2021, he co-authored a paper (Kim et al. 2022) on the findings: *Lepomis megalotis* wasn't one species with several different forms but a complicated group of fish with enough genetic and morphological (size and shape) variation to warrant the recognition of six stand-alone species. Three of these Longears occur in Oklahoma, with two of them being newly recognized and still yet to be formally named. Bauer said that work is in progress now and should be announced this year.

A male Longear with a prominent nuchal hump.

While Oklahoma's two new Longear species were "unknown to science" and are just now being recognized, it doesn't mean they are newly discovered, as in "never seen before." All three of Oklahoma's Longear species are common where they occur and are well-known to anglers and biologists alike. But the research by Bauer and others did answer the longstanding question: "Are all these different-looking Longears really the same kind of fish?"

Bauer's research continues and he plans to receive several more specimens from Oklahoma. Altogether, he has examined 5,406 individual Longears and 39 morphometric traits on each fish—that's a remarkable 210,834 data points.

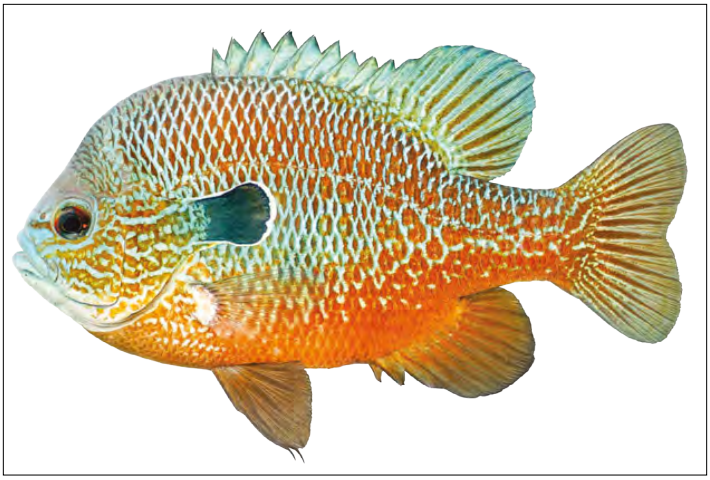
The most widespread Longear in Oklahoma is currently known as the "Plains Longear" or *Lepomis aquilensis* (although that common name may change). It's found throughout central and western Oklahoma and in the lowlands of the Arkansas and Red rivers as far east as the Arkansas line. They are typically powder-blue or turquoise green on the front half of the fish, transitioning to brick red on the back half. They are also stockier bodied with stout "bulldog jaws" and are probably the largest of our state's three species.

The tentatively named "Redstripe Longear" is one of Oklahoma's newly recognized Longear species and is currently designated *Lepomis* sp. "Ozark". Its range is basically the Western Ozark region of Oklahoma, Arkansas, Missouri, and Kansas, but can be found in a few streams as far west as Ponca City and as far south as tributaries of the Poteau River. These Longears are best known for their distinctive red stripe extending along

[1]Bruce Bauer passed away on March 23, 2023, at the age of 72. See memorials of Bruce and his work in the Summer 2023 issue of *American Currents*.

the nape from the dorsal fin to the top of the forehead. Their coloration is brilliant blue intermixed with vivid orange-reds throughout the body, stomach, forehead, and fins.

The third Oklahoma Longear species is also new and is currently referred to as the "Caddoan Longear" or *Lepomis* sp. "Ouachita."



Plains Longear *Lepomis aquilinsis*

Redstripe Longear *Lepomis* sp. "Ozark"

Caddoan Longear *Lepomis* sp. "Ouachita"

These are perhaps Oklahoma's most genetically and morphometrically distinct Longear, and one of the original forms that first got Bauers's attention 50 years ago. They are found throughout the Little and Kiamichi river drainages of the Ouachita Mountains and extend to near the Gulf coastal plain to the south. Their primary colors are shiny deep red or orange with iridescent blue markings on the face, with blue dots well-distributed across the body.

Longears are undoubtedly among Oklahoma's most unusual and interesting fish species. Often caught on hook and line, they are decidedly too small for table fare, too pretty to use as bait, and too special and unique not to be appreciated for what they are. Perhaps their best purpose is to just be admired and appreciated for their unparalleled beauty, tireless energy, and the role they play as one of the true gems among Oklahoma's native fishes.

ACKNOWLEDGING THE LATE BRUCE BAUER'S LONGEAR SUNFISH RESEARCH IN OKLAHOMA

I had known Bruce as the "Longear guy" and through emails for several years but didn't get to actually meet him until 2021. That June, I got to tag along with him and his old friend (and expert fish photographer) Richard T. Bryant to sample Longears from southeast Oklahoma. We spent two or three days hopping from creek to creek collecting fin clips and vouchers for Bruce's project and live specimens for Richard to photograph.

Bruce Bauer in southeastern Oklahoma holding a "Caddoan" Longear. (Photo by Richard T. Bryant)

Bruce and Richard were a hoot to be around, and as a nice bonus Henry Robison stopped by one morning and I was able to have all three of them sign my old *Fishes of Arkansas* (Bruce and Richard took many of the photos in the first edition).

That trip stands out as one of my all-time favorite fish trips and Bruce was one of the most passionate and knowledgeable fish people I've ever known. He was also one of those rare people you feel like you've known longer than you really have and seem to be able to fit perfectly into any conversation regardless of whether it's while standing behind a podium or standing knee deep in a sandy creek catching "perch" and talking to a landowner down in southeast Oklahoma. I sure miss talking fish with him.

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NANFA 2023 FINANCIAL SUMMARY
Submitted by Tom Watson, Treasurer

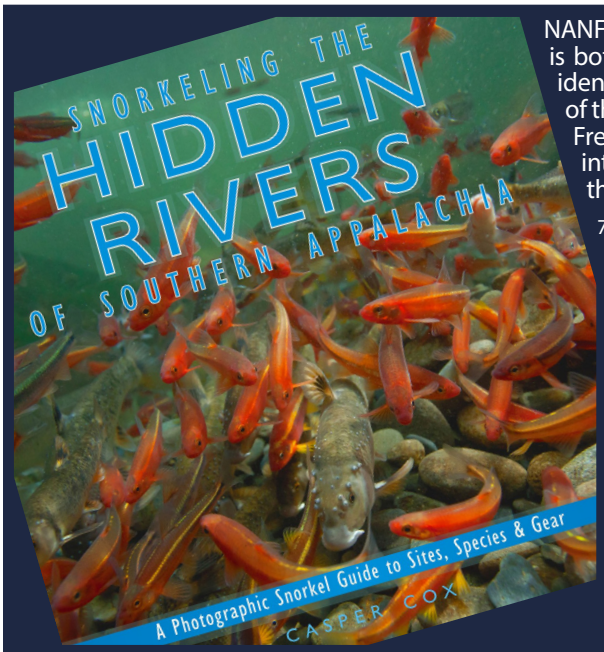
BEGINNING BALANCE: $58,338.91 (AS REPORTED IN JAN. 2023 *AC*)

INCOME		EXPENSES	
Membership Dues	11,678.28	Convention[2]	-3,107.31
Convention	14,790.67	*AC*	-14,130.41
T-shirt sales	699.25	Grants	-1,000.00
Donations	1,419.98	USPS	-720.94
Misc.*	1,229.19	Web Site	-1,069.40
		Misc.*	-279.77
TOTAL INCOME	**29,817.37**	**TOTAL EXPENSES**	**-20,307.83**
		YEAR END BALANCE (12/31/2023)	**$ 67,848.54**

* Includes hats, cards, decals, *AC* CD, etc.

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

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



NANFA's very own Snorkelmeister, Casper Cox, has written a snorkeling guide that is both useful (with maps and information about locations, access, biodiversity, identification, safety and more) and beautiul (with dozens of color photos by some of the best underwater photographers in the world). Written to complement the Freshwaters Illustrated film "Hidden Rivers," the book is a distillation of Casper's interests, experiences and skills, as well as a love letter to his favorite waters and their inhabitants.

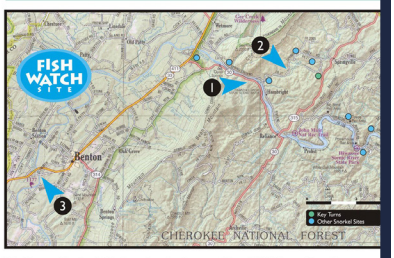
75+ pages, lay-flat spiral binding, 3rd printing. $30 each

NANFA receives a donation for each copy sold through
http://www.nanfa.org/cart.shtml#guide

Hellbenders, aka **Devil Dogs** or **Snot Otters**, are also found in the Hiwassee River. The clean water, large flat stones and an abundance of crayfish provides an excellent watery world for them to live in. If you were to spend a day here you may well see one, especially in the early dawn or dusk hours as they are generally nocturnal hunters. They breathe through the folds of skin running down their sides and remain in the water year round. Some people are afraid of them but you have nothing to fear. They are not venomous as some unknowing people claim. Consider yourself very fortunate to see a Hellbender in one of the few remaining rivers they still thrive in. They are North America's largest salamander reaching lengths of 24 inches or more.

David Herasimtschuk was honored with an international first place award in London for this stunning photo. By the way, the Northern Water Snake got away, a bit too much for this Devil Dog.

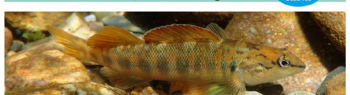
Hiwassee River • Map & Directions



The Hiwassee River is only 30 minutes from the Conasauga River, via US Highway 411 north. A convenient location is the Hiwassee Picnic Site and it's just a few miles from 411, along TN 30 east toward Reliance. The picnic site offers tables, an access ramp, a restroom and a shallow gravel bar to wade out from. Be careful here as the water can dramatically and dangerously rise during power generations upriver. While in Reliance, visit the historic Webb Brothers general store and post office. On the other side of the river, at the bridge, is a fly fishing store and deli as well. Free camping is availab along Spring Creek and paid camping with facilities at Gee Creek Campground. A visitor center is nearb

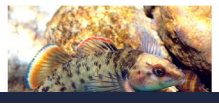
1 The Hiwassee River Picnic Site.

Site 1 Fishes *of the* Conasauga River



Bronze Darters are the most common darter in the Snorkel Hole. I consider them handsome with their many pronouncements of bronze. From shiny brass to muted patinas, they wear their metallic scales proudly. The Latin name for the Bronze Darter is *Percina palmaris*, which means "The Prize." They seem to enjoy feeding in the carpet-like moss covering the rocks. Rubbing your hand gently over this river weed gently dislodges micro edibles that these handsome darters will promptly feed upon.

Greenbreast Darters are at their most beautiful in the early spring. During the spawning season the males are out and about parading themselves to entice the more bland colored, gravid females, (being those filled with eggs), into their selected nesting sites. Usually this species tends to live and hide beneath the stones located in or

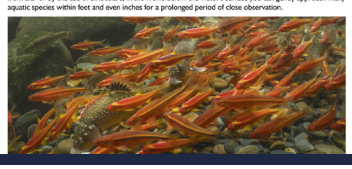


Speckled Darters, during the spring spawning season, only the males get the vertical bars of iridescen blue. During most of the year their bodies are a light tan color blending into the sandy substrate they to favor, generally found in the calmer flowing areas.

There are many, many other species of fish found in the Conasauga River. Typically on any given day yo will see 20 to 30 different fish species at the snorkel hole, and even more as you learn when and where look. Snorkel the pools and bouldered rapids further downstream and return during other seasons to out new sights. Explore! Below is one of the beautiful crayfish, marked with vermilion over soft t

Looking Below the Surface

Snorkeling is a wonderful way to experience another aspect of our world. Not only will you see things that most never will, it is a full sensory experience. Your body and senses are fully immersed, you are soon one with the watery world, floating freely in its space. Your vision is magnified by an optical enhancement making everything appear larger. Aquatic creatures will come near you, as curious of you as you of them, soon accepting your presence. Unlike on the surface world, where one generally has to view creatures from afar or by the use of binoculars, in the world below the water's surface you can gently approach many aquatic species within feet and even inches for a prolonged period of close observation.



Aquatic Diversity

Fishes come in all types of shapes and sizes with their bodies adorned by marked patterns, gold reds, blues, greens and colorful flowing fins. Fishes vary from long, toothy gar patrolling the sh backwaters to little snubnosed fish darting along the gravelled bottom. Schools of silvery shine by you, shimmering in the sunlight's rays while a Redeye Bass watches, lurking in the shadows log jam. A new world of aquatic life awaits, beckoning your visit from the Earth's surface. Ease the flow and listen for the sounds of redhorse suction popping microscopic meals from the life slabs of broken bedrock. In the cracks and crevasses tiny translucent eggs, filled with new life, another generation of foraging fishes taking their place in the aquatic food web. Schools of sm stonerollers graze on slippery stones covered with algae, shaving off patches with their lower l sharp as our fingernails. They are feeding, moving as a herd of aquatic cattle, grazing on the al Return in the spring and some of these sleek stone grazers will have morphed into armor-spike rolling stones and pushing deep trenches into the clean gravel for the egg-filled females. After her eggs, dominant males will fertilize and protect the eggs with a cover of newly rolled stones

This is a world mostly unseen, yet eager to be witnessed by you. With a mask of tempered gl float free, released from gravity's pull, drifting through their watery world with a quiet ease. Y astronaut, floating in the void of space, but no, you are here in a medium of living water, and to aquanaut, exploring new mysteries.

Shiners and Sunfish. Trout and Redhorses. Darters and Dace. Buffalos and Hog Suckers. Dru Predatory Bass and their prey. Lampreys and Minnows. Whiskered Catfish, along with their t Madtoms. Topminnows cruise the surface, perhaps a Sunfish in the shallows nearby, the large

SEARCH FOR THE HOLY GRAIL: AKA "LAKE WACCAMAW BROADTAIL" MADTOM

Fritz Rohde

Wilmington, North Carolina

"What on earth are you doing?" I get asked this question a lot by visitors at the Lake Waccamaw dam and walking/fishing bridge (Figure 1) as this old guy leaves his car donned usually in hip boots and armed with a dip net and bucket or collecting jar. My standard response is "Going after the big ones!" If they still show interest or ask more questions, I'm sure that I bore them to death as I go on and on about miniature catfishes called madtoms. I tell them there is one species that is widespread throughout eastern North Carolina and there is one species that is only found here in Lake Waccamaw and nowhere else in the world. But sadly, I have none to show them for I haven't caught one since 2002. But first, let me provide you with some background information.

Lake Waccamaw is the largest of the Carolina Bay lakes and is located in southeastern North Carolina (Figures 2 and 3). Unlike most of the other Carolina Bay lakes, Lake Waccamaw gets the majority of its water from the surrounding swamp instead of direct rainwater. A limestone bluff along the north shore filters the water and reduces the acidity levels, making the lake ideal for a wide range of aquatic life, including many endemic fish and mussel species. My long-time friends, JR and Peggy Shute (along with Pat Rakes, founders of Conservation Fisheries Inc.) and the late Dr. David Lindquist from the University of North Carolina-Wilmington (UNCW), reported 62 fish species from Lake Waccamaw and the Waccamaw River basin, including three endemics: the Waccamaw Silverside *Menidia extensa*; Waccamaw Killifish *Fundulus waccamensis*; and Waccamaw Darter *Etheostoma perlongum* (Shute et al. 1981). Since their intensive study in the late 1970s, three additional fishes have found their way into the lake: two benign fishes via natural immigration from nearby South Carolina, the Green Silverside *Labidesthes vanhyningi* and Golden Topminnow *F. chrysotus*, and one introduced by anglers, the devastatingly predatory Flathead Catfish *Pylodictis olivaris* (Tracy et al. 2020).

I first visited the lake in 1976 on a pilgrimage that all young (and old) ichthyologists should make to follow in the footsteps of legendary Dr. Edward C. Raney and Dr. Ernest A. Lachner. They, along with R.A. Pfieffer, had driven from Cornell University on Spring Break and visited the lake on the night of March 30, 1941. During that one brief effort they collected many fishes, including the three endemic fishes (thousands of killifish and silverside were encountered) that were later described by Dr. Carl Hubbs and Dr. Raney (Hubbs and Raney 1946).

Figure 1. Dam with lake and foot bridge to the left and start of Waccamaw River to the right. Midway down the dam is a primitive fish ladder.

Photos by the author unless otherwise indicated.

Figure 2. Lake Waccamaw when viewed from the foot bridge.

Figure 3. Lake Waccamaw. 1=Dam; 2=Secluded Site; 3=Open Site; 4=Transect; 5=Coastal Carolina University Site.

Since 1976, my visits have become increasingly laser-focused on a madtom, commonly known as the "Waccamaw Broadtail" Madtom *Noturus* sp., which was initially reported in the lake by Shute et al. (1981). They stated:

> The Lake Waccamaw form (found throughout the lake and directly below the dam) was often found in cans and bottles as well as under tiles placed as experimental spawning sites for the Waccamaw Darter. Broadtail Madtoms appear to be relatively common in the lake and may outnumber [Tadpole Madtom] *N. gyrinus*.

Shute et al. (1981) said that the form in the lake clearly differed from "river" specimens found downstream in the Waccamaw River and the adjacent Cape Fear drainage. The difference was clearly shown by Bennetts et al. (1999) who also reported that the Broadtail Madtom forms (Edisto, Pee Dee, Cape Fear, and Lake Waccamaw) were most closely related to the Margined Madtom *N. insignis*. Recently, more advanced genetic analyses by Dr. Joe Quattro, University of South Carolina (personal communication) and morphometric analyses by myself (personal observation) have confirmed the uniqueness of the Lake Waccamaw population. Tracy et al. (2020) listed it as the "Lake Waccamaw Broadtail" Madtom *Noturus* sp., a species of State Special Concern.

So what is the current status of this lake-dwelling fish? My first encounter with it was on May 16, 1984, when Dr. Brooks Burr (Southern Illinois University-retired), Dick Biggins (US Fish & Wildlife Service-retired), and I were invited by Dave Lindquist to join him on a boat trip on the lake. Dave and Dick donned SCUBA gear to search for the Broadtail Madtom beneath the tiles that the UNCW crew had placed in deeper portions of the lake. They were successful and brought several back to the surface for us to view and photograph (Figure 4), along with a Tadpole Madtom (Figure 5). Since then, I have visited the lake an untold number of times to wade the lake and search for the fish in discarded bottles and cans in a roughly designed transect along the south side in knee-deep water with scattered patches of Maidencane *Panicum hemitomum* and Bald Cypress *Taxodium distichum* (Figures 3 and 6) where I could usually find one specimen each trip.

The last time I saw a "Lake Waccamaw Broadtail" Madtom was when I found one in a brown beer bottle on May 12, 2002 (Figure 7), almost 18 years after I saw my first one and now 21 years since I last saw one. After my last sighting in 2002, I had visited the lake 28 more times from 2007–2015. And in addition to searching bottles and cans along my transect (while getting strange looks by the locals), I even placed floor tiles on the bottom to attract them (unsuccessful), baited minnow traps (unsuccessful), and once a "trot line" of beer bottles connected by a string (also unsuccessful). It's possible that Lake Waccamaw State Park staff or concerned citizens may have picked up some of my "debris," believing they were clearing up trash in the lake.

In 2019 Brena Jones, nongame aquatic biologist with the North Carolina Wildlife Resources Commission (NCWRC), contacted me about jointly participating with them in a hunt for Broadtail Madtoms, with me focusing on Lake Waccamaw because it's only about an hour from my home in Wilmington and I was already going over there on a regular basis. Her idea was to use madtom "motels" similar to what North Carolina State University graduate students had used to catch Carolina Madtom *N. furiosus* (Midway 2010; Cope et al. 2019). The motel is an inverted clay flowerpot, glued onto a clay base and a weighted disc, with a notch chiseled out of the rim (Figure 8). I quickly agreed and she later supplied me with ten motels. I first put

Figure 4. My first "Lake Waccamaw Broadtail" Madtom in 1984.

Figure 5. Tadpole Madtom collected in 1984. Yes, I know it's out of focus. In the days of 35-mm film, shots were not unlimited.

Figure 6. Part of my original transect with Bald Cypress and Maidencane.

Figure 7. "Lake Waccamaw Broadtail" Madtom found in 2002.

Figure 8. Madtom motel.

Figure 9. Motel in the lake held in place with rebar.

seven of them into the lake on February 17, 2020, secured by rebar (Figure 9). My initial site was in one part of my transect (Figure 3), but after a couple of visits I added three more motels and divided the ten motels into two sites: one secluded and the other more open (Figure 3, 10, and 11).

The actual number of motels checked each visit has varied due to missing motels, high lake levels, or often turbid waters. After 14 visits in 2020 (when I was excited and enthusiastic), 7 in 2021, 3 in 2022 (lake levels and my enthusiasm were dropping substantially by late 2021 and remained low through 2022), and 9 visits in 2023 (last one on Christmas Day), I have tallied the contents of my 268 motel-efforts: motel visitors included Tadpole Madtom (55) (Figure 12), Red Swamp Crayfish *Procambarus clarkii* (30), Warmouth *Lepomis gulosus* (9), Redbreast Sunfish *L. auratus* (3), American Eel *Anguilla rostrata* (2), White Catfish *Ameiurus catus* (2), Bluegill *L. macrochirus* (1), Waccamaw Darter (1), Waccamaw Crayfish *P. braswelli* (1) (Figure 13); and

Figure 10. Secluded Site.

Figure 11. Open Site.

ZERO reservations by Broadtail Madtom. Almost all species caught had taken up residence at the secluded site.

Well, they do work great for Tadpole Madtom (Figure 14), and I often find a pair sharing a room. However, the results sadly contradict the observations made by the Shutes back in the late 1970s where the Broadtail Madtom was the dominant species. These findings have led me to ponder: is the "Lake Waccamaw Broadtail" Madtom extirpated from the lake, perhaps being gustatorily consumed by Flathead Catfish, has it been displaced/out-competed by Tadpole Madtom, or are the young madtoms being preyed upon by the invasive Red Swamp Crayfish?

Just as importantly as the madtom's demise, I have also thought long and hard about what keeps me faithfully returning to the lake. That's easy to answer: optimism! On October 12, 2019, I received an email from Dr. Derek Crane of Coastal Carolina University located in Conway, South Carolina. He and his class were at Lake Waccamaw, and he wanted to know if the attached images were in fact Broadtail Madtom (Figure 15 and 16). Heck, yes they were! I immediately called him to ask if he still had them because I needed to get a good photograph. Sadly, he was already back on campus, but he did tell me they were caught at the east end of the lake by the state park, one by using a seine and the other hand-caught by a student after it fell out of an empty mussel shell. Both fish were released unharmed. This one sighting is what keeps me going back and back and back! Maybe one day….

Figure 12. Tadpole Madtoms caught in secluded Site.

Figure 13. Waccamaw Crayfish. (Photo by Scott Smith)

Figure 14. Tadpole Madtoms right out of the motels.

Addendum: I initially wrote this narrative in summer 2023 and then periodically updated the numbers after each unsuccessful trip. Much to my surprise—almost shock—I got an email from NCWRC fisheries biologist April Boggs on November 7 telling Brena and I that the day before they had "popped up" a madtom while boat electrofishing for game fishes in Lake Waccamaw and thought it was a Broadtail. Bingo! Based on her photos it was indeed a "Lake Waccamaw" Broadtail Madtom (Figure 17). After measuring, photographing, and taking a fin clip, the madtom was released back into the lake near its capture site under a dock slightly to the northwest of the dam. Now more energized, my search continues.

Figure 15. "Lake Waccamaw Broadtail" Madtom caught by Coastal Carolina University crew. (Photo by Derek Crane)

Figure 16. Second "Lake Waccamaw Broadtail" Madtom caught by Coastal Carolina University crew. (Photo by Derek Crane)

Figure 17. "Lake Waccamaw Broadtail" Madtom caught by NCWRC on November 6, 2023. (Photo by April Boggs)

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UNDERSTANDING CUTTHROAT TROUT

John Lyons

University of Wisconsin Zoological Museum

I've been a big fan of Cutthroat Trout (historically, *Oncorhynchus clarkii*) for over 50 years, since that day in late June 1973 when I caught my first one from Yellowstone Lake in Yellowstone National Park (Figure 2). It was during a fishing trip to the Rocky Mountains with my dad, the highlight of my nearly 16 years of life up to that point, and still one of the best experiences I've ever had. In those days, I was obsessed with trout (still am), and I was thrilled by the chance to encounter new species. I had grown up fishing the streams of New York State and had caught many native Brook Trout *Salvelinus fontinalis* and non-native Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta*. But I had dreamed for years of fishing in the fabled trout waters of the West and seeing the different species found there. When I landed that first gorgeous Yellowstone Cutthroat Trout (historically, *Oncorhynchus clarkii bouvieri*), I whooped for joy and began a lifelong fascination with the species.

Figure 1. Yellowstone Cutthroat from the Greybull River, WY, in Shoshone National Forest, showing the characteristic red slash under the jaw from which the Cutthroat Trout take their name, July 2023.

Photos by the author unless otherwise indicated.

John Lyons is the Curator of Fishes at the University of Wisconsin Zoological Museum and retired Wisconsin Department of Natural Resources fisheries research scientist (1985–2017). He is a complete fish nerd, interested in all aspects of all fish species in all places, including research, conservation, fisheries management, sport fishing, keeping and breeding fish in aquaria, underwater observation, and cooking and eating fish. He has been fishing for trout since 1966 and working with the freshwater fishes of Wisconsin and the Great Lakes region professionally since 1979 and the freshwater fishes of Mexico since 1986. He received his PhD and MS in Zoology from the University of Wisconsin Madison and his BS in Biology from Union College, Schenectady, NY.

My dad and I had great fishing in 1973, and we made plans for another trip the following year. But when we returned to our magic spot on Yellowstone Lake in June 1974, we couldn't get a bite. As we dejectedly followed a small stream back to our car, the reason for our lack of success became clear. It had been a relatively early summer, and the Cutthroats had already left the lake and begun spawning in the tributaries. Stream fishing was closed to prevent disturbance of spawning fish, and although in those days I was more interested in catching than observing, I was nonetheless enthralled by what I saw. Fat ripe females dug redds in the gravel where they would lay their eggs while colorful males jockeyed and fought for access to mate with them. There were dozens of large Cutthroats splashing about in a stream that I could jump across in many places and in water only inches deep. It was one of the greatest wildlife spectacles I'd ever seen, and it made a huge impression. I didn't realize it at the time, but it triggered a deeper interest in fish biology and conservation and ultimately helped steer me to a career in ichthyology and fisheries science.

After two straight years of wonderful experiences on Yellowstone Lake, I figured I would continue to make regular trips

Figure 2. The author with his first Cutthroat Trout from Yellowstone Lake in June 1973. (Photo by Vincent Lyons)

Figure 3. The author after fishing Yellowstone Lake unsuccessfully in September 2015. Cutthroat Trout had become scarce because of non-native Lake Trout predation. (Photo by Mary Kay Lyons)

there to fish for Cutthroats. But life intervened, and it wasn't until 2015—41 years later—that I returned with my wife Mary Kay. My dad passed away in 2003. Yellowstone Lake looked as beautiful as ever, but underneath the surface it was a very different place. Twenty-five years earlier, some misguided soul had illegally stocked non-native Lake Trout *Salvelinus namaycush*, and this large predator had thrived and devastated the Cutthroat Trout population. Only an intensive Lake Trout netting and removal program organized by the National Park Service kept the Cutthroat population from collapsing. The bountiful spawning run I had observed in 1974 was largely a thing of the past, and the bears, eagles, and other wildlife that had preyed on the spawners and their offspring had suffered as a result. The entire ecology of the park had changed. I cast into the lake for a couple of hours without seeing a fish or having a strike. I was saddened but not surprised (Figure 3).

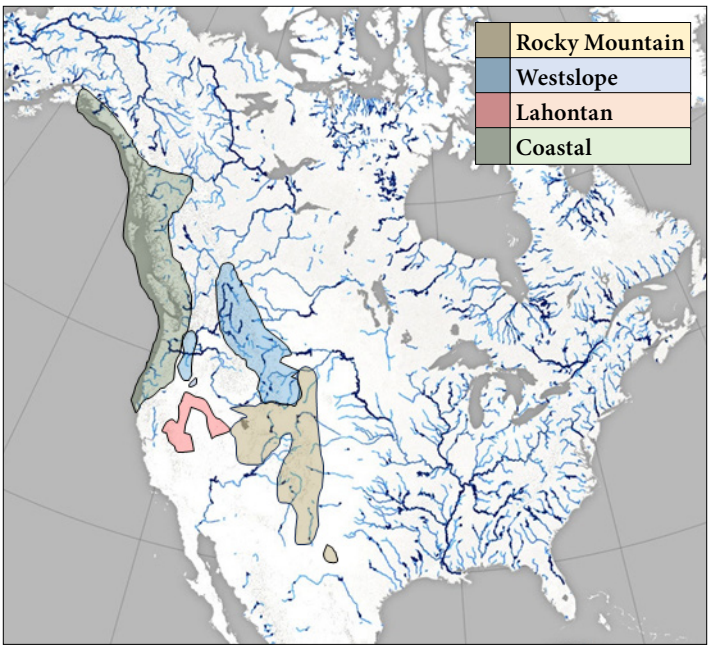

Figure 4. Map of the historical distribution of Cutthroat Trout.

A CUTTHROAT IS A CUTTHROAT, RIGHT?

Yellowstone National Park has long been a stronghold for Cutthroat Trout, but historically the species was abundant throughout much of the mountain and coastal west of North America. It occupied a vast range encompassing parts of Alaska, British Columbia, Alberta, Washington, Oregon, California, Nevada, Idaho, Montana, Utah, Wyoming, Colorado, New Mexico, and Texas (Figure 4). Across this huge area there was a tremendous variety of Cutthroat Trout forms that differed in appearance, behavior, feeding, habitat use, life history, and maximum size. In a small, icy, unproductive mountain brook, a Cutthroat might mature at 6 inches long and less than 4 ounces in weight and live for less than 3 years while feeding almost exclusively on invertebrates, whereas in a large, deep, productive lake, a Cutthroat might reach more than 30 inches, 20 pounds, and over 15 years of age and feed primarily on smaller fish. Early naturalists described multiple species and subspecies of Cutthroat Trout, often confusing them with each other and with the equally variable and closely related Rainbow Trout. It wasn't until the late 1900s, under the leadership of the late Dr. Robert Behnke of Colorado State University, that significant progress was made in sorting out the different types of Cutthroat Trout and understanding their relationships with each other and with Rainbow Trout (see Behnke 1992, 2002; Trotter 2008). But even today, as we'll see, there is still some uncertainty about the identity, taxonomy, and systematics of the various forms of the species.

What is not uncertain is that Cutthroat Trout have suffered huge losses in distribution and abundance throughout their range. Many populations and distinctive forms have been eliminated and others barely hang on, and the species now occupies just a small fraction of the waters where it was once found. The usual litany of human impacts have caused the declines: water removal and diversions that dried up streams or made them too warm; sewage, industrial, mining, and agricultural discharges that polluted the water; straightening and ditching of streams that eliminated habitat; erosion and siltation from poor land-use that filled pools and smothered spawning gravels; construction of dams that flooded essential habitats, blocked spawning migrations, and unfavorably altered downstream flows and temperatures; and harmful introductions of non-native species that led to substantial losses, including whirling disease caused by the parasite *Myxobolus cerebralis*, competition with Brook Trout, predation from Brown Trout and Lake Trout, and interbreeding with Rainbow Trout to produce a hybrid form, the "Cutbow." The devastating Lake Trout addition to Yellowstone Lake was only the latest in a long list of destructive introductions. In many areas, Cutthroats are now restricted to remote, high-altitude, wilderness headwater areas, but even there, climate change looms as an existential threat.

Cutthroat Trout have always been a popular sport and food fish, but for many years, the great variety within the species was often not recognized or was ignored in fisheries management. Consequently, some past efforts to improve fishing instead contributed to population deterioration and loss of biodiversity within the species. From the earliest days of Euro-American settlement of the West, the various Cutthroat Trout forms were moved about and introduced well outside their native ranges with little regard

Figure 5. Hidden Valley Creek, CO, in Rocky Mountain National Park, August 1984. What were thought to be Greenback Cutthroats had been reintroduced successfully here, but later genetic analyses revealed they were actually Colorado River Cutthroats.

Figure 6. A Colorado River Cutthroat (probably Green-Yampa UIEU) from Hidden Valley Creek, originally thought to be a Greenback Cutthroat, August 1984.

for the local adaptations each form had developed. Non-native forms of Cutthroat were stocked on top of native forms, resulting in hybridization and the loss of the characteristics that made each form unique. Mixing created populations of "mongrels" that often didn't do as well as either of the original forms. Co-introductions of other trout species to diversify fishing opportunities usually resulted in the Cutthroat Trout declining. But interestingly, stocking sometimes preserved forms that otherwise would have gone extinct. Take, for example, the Greenback Cutthroat Trout (historically, *Oncorhynchus clarkii stomias*).

Prior to Euro-American settlement, the Greenback Cutthroat was found in the mountain reaches of the South Platte River drainage in the Missouri-Mississippi River basin to the west and north of Denver in north-central Colorado and southeastern Wyoming. Once widespread and abundant, it was believed to be extinct by 1937, a casualty of habitat loss, pollution, dams, and stocking of non-native trout. Then in the 1950s, a few small populations that appeared to be Greenback Cutthroats were discovered in remote mountain streams high up in the Rockies in the South Platte and Arkansas river drainages. The Arkansas River drainage is just south of the South Platte and, like the South Platte, ultimately flows into the Mississippi River and from there the Gulf of Mexico. Fish from these populations were brought into hatcheries, propagated, and re-introduced in South Platte River drainage streams, primarily in Rocky Mountain National Park. The stocked fish did well and began to reproduce, and it appeared that the subspecies had been restored. The recovery of the Greenback Cutthroat was hailed as an important conservation success story. During a July 1984 visit to Rocky Mountain National Park, I fished one of the reintroduction streams, Hidden Valley Creek (Figure 5), and I was delighted to catch one of these re-established Cutthroats (Figure 6).

In the early 2000s, biologists began to employ newly developed genetic techniques to look at Cutthroat Trout relationships. When they examined the re-established populations from Rocky Mountain National Park and elsewhere, they found, to their dismay, that they were not Greenback Cutthroats but rather a different but very similar subspecies, the Colorado River Cutthroat Trout (historically, *Oncorhynchus clarkii pleuriticus*). This revelation was big news in the region and caused some embarrassment for the multi-agency restoration team that had worked so hard to bring back the Greenback Cutthroat. Colorado River Cutthroats are native to the upper Colorado River basin, which ultimately drains to the Gulf of California and the Pacific Ocean, in parts of Colorado, Wyoming, and Utah. It appears that the small high-mountain streams that had been believed to have native Greenback Cutthroats were really non-native populations established in the late 1800s from stockings of Colorado River Cutthroat Trout. Sadly, the Greenback Cutthroat, designated as the official state fish of Colorado in 1996, once more appeared to be extinct.

But then in 2012, ongoing genetic analyses provided some good news. Cutthroat Trout from Bear Creek, a somewhat degraded stream within the city limits of Colorado Springs and located in the Arkansas River drainage, were shown to be true Greenback Cutthroat Trout. This population was not native but had been established in the late 1800s by a transfer of Greenback Cutthroats from the South Platte drainage. The hatchery propagation program was restarted with fish from Bear Creek, and confirmed Greenback Cutthroats were stocked in the headwaters of Clear Creek, a tributary of the South Platte, beginning in 2014. In 2022, the first successful natural reproduction of these fish was confirmed, and the recovery team is hopeful that this time around they will be able to bring back the real Greenback Cutthroat Trout. In this case, the past stocking of the Greenback Cutthroat outside of its native range kept it from disappearing.

WHAT IS A CUTTHROAT TROUT?

The Greenback Cutthroat story makes it clear that the conservation of the biodiversity within Cutthroat Trout requires a better understanding of the status and characteristics of each unique form and a surefire way to identify them. This is especially true for formal legal protection measures such as listing a population or subspecies under the US Endangered Species Act. But to date, scientists have not been able to come to a consensus about how many different Cutthroat Trout forms there are, how they are defined, what they should be called, and exactly where they still occur in a "pure" condition. Although many forms look quite different, there is enough variation and overlap in morphology that genetic analysis appears to be the only way to resolve identities. But years of stocking have intermingled different forms and created mixed populations. Hybridization with Rainbow Trout further confuses the picture. Genetic analyses

are more time consuming and expensive than morphological analyses, limiting the extent and degree to which they can be applied. But ichthyologists, fisheries scientists, and conservation biologists continue to work on the species, and each year our knowledge and understanding grows.

In 2015, a workshop was convened at the annual meeting of the American Fisheries Society in Portland, Oregon, that brought together key fisheries scientists, conservationists, and geneticists working on the Cutthroat Trout. The two days of presentations and discussions of the latest data and ideas about Cutthroat Trout classification and status and subsequent follow-up analyses were summarized in a fascinating book (Trotter et al. 2018). Although the group did not agree on all points and many areas of uncertainty remain, the workshop was a huge step forward and clarified many formerly confusing aspects of Cutthroat taxonomy. Let's review how the workshop has advanced our understanding of Cutthroat Trout.

Prior to the workshop and based mainly on the work of Behnke, who died in 2013, the Cutthroat Trout was thought to be most closely related to the Rainbow Trout and to have 14 different subspecies in four major lineages. The Coastal Cutthroat Trout *O. clarkii clarkii* lineage was found in Pacific Coast drainages from northern California to southcentral Alaska. The Westslope Cutthroat Trout *O. clarkii lewisi* lineage occurred in the northern Rocky Mountains straddling both sides of the Continental Divide from extreme northwestern Wyoming through Idaho, Montana, British Columbia, and Alberta, with isolated populations east of the Cascade Mountains in Washington and Oregon. The Lahontan Cutthroat Trout *O. clarkii henshawi* lineage was known from several drainages in the western and northern endorheic (i.e., interior basin with no outlet to ocean) Great Basin in northeastern California, southeastern Oregon, and northern Nevada, and contained four additional subspecies: Paiute *O. clarkii seleniris,* Humboldt *O. clarkii humboldtensis*, Alvord *O. clarkii alvordensis* (pure forms extinct), and Willow-Whitehorse (not formally described and sometimes considered part of the Humboldt Cutthroat). The Yellowstone Cutthroat *O. clarkii bouvieri* lineage occupied the upper Yellowstone River drainage on the east side of the Continental Divide, the upper Snake River drainage on the west side, and eastern drainages of the Great Basin, and included six additional subspecies: Bonneville *O. clarkii utah*, Colorado River *O. clarkii pleuriticus*, Snake River Fine-Spotted *O. clarkii behnkei*, Greenback *O. clarkii stomias*, Rio Grande *O. clarkii virginalis*, and Yellowfin *O. clarkii macdonaldi* (extinct). Behnke proposed that Cutthroat Trout first arose in the Pacific Coast region, making the Coastal Cutthroat the most primitive (earliest) lineage, and that this ancestral form then gave rise to the Westslope Cutthroat, which ultimately evolved into the Yellowstone and Lahontan lineages.

The 2015 workshop confirmed much of Behnke's classification, including the close relationship between Cutthroat and Rainbow Trout and the validity of the four main lineages of Cutthroats, Coastal, Westslope, Lahontan, and Yellowstone. But the participants proposed different evolutionary relationships between the four lineages, which most argued were distinct enough genetically to be considered full species, and they recognized a total of 25 different possible subspecies, or as they preferred to term them, "Uniquely Identifiable Evolutionary Units" or UIEUs. In their updated classification, the earliest Cutthroat Trout arose in the Lahontan area of the Great Basin and then split into a form that became the Coastal Cutthroat lineage and a different form that eventually diversified into the Westslope, Rocky Mountain (which Benke had termed Yellowstone), and modern Lahontan lineages. The workshop agreed with Behnke that there was only one form of Coastal Cutthroat, but they proposed nine UIEUs within the Westslope lineage (vs one), nine (one of which was now extinct) within the Rocky Mountain lineage (vs seven), and six (one of which was now extinct) within the Lahontan (vs five). Most additional UIEUs represented further subdivisions of Behnke's subspecies, but some UIEUs were newly defined and combined populations previously believed to be part of different subspecies. Of particular interest to anglers, the Snake River Fine-Spotted Cutthroat of Behnke, a popular sport fish in Grand Teton National Park in Wyoming, was subsumed into the Yellowstone Cutthroat. Even though the two forms differ in spotting patterns, they overlap in all other morphological characteristics and have no consistent genetic differences. But the status of the Snake River Fine-Spotted Cutthroat remains under investigation.

In 2023, based on the results of the 2015 workshop, the Names of Fishes Committee of the American Fisheries Society and the American Society of Ichthyologists and Herpetologists, which every 10 years or so publishes a list of official common and scientific names for North American fishes, concluded that there were now four different species of Cutthroat Trout rather than just one. They were the Coastal Cutthroat *Oncorhynchus clarkii* (with 1 UIEU), the Lahontan Cutthroat *O. henshawi* (6 UIEUs), the Westslope Cutthroat *O. lewisi* (9 UIEUs), and the Rocky Mountain Cutthroat *O. virginalis* (9 UIEUs) (Page et al. 2023). The Coastal Cutthroat retained the original Cutthroat Trout scientific name because it was the first of the four species to be formally described, and the Rocky Mountain Cutthroat was given the species name of the Rio Grande form rather than the Yellowstone form because the Rio Grande form had been described earlier and therefore had nomenclatural priority even though the lineage had been known as "Yellowstone" for many years. It will take a while for native fish enthusiasts and anglers to learn of and adopt these new names, but keep in mind that if you're a life-lister, you now have three new species to chase!

A VISIT WITH SOME OF THE DIFFERENT FORMS OF CUTTHROAT TROUT

I still love to catch different kinds of trout, and one of my bucket list items is to see as many of the remaining 23 of the original 25 Cutthroat Trout UIEUs as I can before I die. Right now, I'm just at seven, eight if you count the Snake River Fine-Spotted. So, I've got a long way to go. Let's look at the forms I've encountered so far.

ROCKY MOUNTAIN CUTTHROAT TROUT: Yellowstone Cutthroat

Of course, this was the first form I ever saw. After 1973–74, the next time I caught them was on a fishing trip to the Boulder River, Montana, just northeast of Yellowstone National Park, in 1991, and then again, this past summer, in north-central Wyoming, east of Yellowstone National Park. In July 2023, I took a fishing trip to Wyoming with a good friend and fishing buddy, Greg Pils, and we tried to complete the Wyoming Game and Fish Department's "Cutt Slam." To complete this program, you

Figure 7. North Fork of the Tongue River, WY, in Big Horn National Forest, home of introgressed Yellowstone Cutthroat, July 2023.

Figure 8. Yellowstone Cutthroat from the North Fork of the Tongue River, WY, in Big Horn National Forest, July 2023. Fish here show evidence of introgression with Rainbow Trout. Note the more numerous and smaller spots, especially in the anterior part of the body, a Rainbow Trout characteristic. Compare with the Yellowstone Cutthroats in Figures 1 and 10.

must catch each of the four Cutthroat Trout subspecies/UEIUs currently found in Wyoming: Yellowstone, Snake River Fine-Spotted, Bear Lake (formerly part of Bonneville), and Colorado River. Greg's brother Andy is a wildlife biologist for the US Forest Service and a fine angler, and he guided us to great spots on the North Fork of the Tongue River in Big Horn National Forest and the Greybull, South Fork of the Wood, and Wood rivers in Shoshone National Forest, where he works, for Yellowstone Cutthroats. The fish we caught from the North Fork of the Tongue (Figure 7) were beautiful fish, but they didn't appear to be pure, having too many small spots (Figure 8). Apparently, they had a history of hybridization and introgression with Rainbow Trout. But the remaining three rivers yielded gorgeous unadulterated Yellowstone Cutthroats (Figure 9, 10). Even then, there was noticeable variation in cutthroat appearance within each river, with most fish having a tan or reddish cast but a few being distinctly yellowish. (Figure 11).

Snake River Fine-Spotted Cutthroat

Although the latest data suggest that these are merely Yellowstone Cutthroats with more spots, most anglers and fisheries management agencies still recognize and treat them separately because they look so dissimilar. They are also an iconic part of

Figure 9. South Fork of the Wood River, WY, in Shoshone National Forest, home of pure Yellowstone Cutthroat, July 2023.

Figure 10. Pure Yellowstone Cutthroat from South Fork of the Wood River with typical coloration, July 2023.

Figure 11. Pure Yellowstone Cutthroat from the Wood River, WY, in Shoshone National Forest, showing the yellow coloration of some fish, July 2023. Photo by Andy Pils.

Figure 12. Greg Pils fishing in the Gros Ventre River, WY, in Bridger-Teton National Forest, home of the Snake River Finespotted Cutthroat, July 2023.

Figure 13. Snake River Cutthroat from the Gros Ventre River, July 2023. Note the more numerous and smaller spots compared to the Yellowstone Cutthroats in Figure 1 and 10 even though there are minimal genetic differences between the two forms.

the Grand Teton National Park ecosystem. I had fished for them briefly during my 2015 western trip in the Gros Ventre River, a major Snake River tributary. The water had been low and clear and the fishing tough, and although I had briefly hooked a couple, I couldn't bring either to the net for a photo. In some ways losing a fish is worse than never having a strike at all, so I was determined to come back and have another go. During our July 2023 trip, Greg and I again fished the Gros Ventre (Figure 12) higher up than before and outside the National Park in the Bridger-Teton National Forest, but now the flows were greater and the fish more cooperative. Together we caught 10 fine specimens, and we marveled at how different they looked from the Yellowstone Cutthroats we'd caught in the days before (Figure 13). One of the best things about Cutthroat Trout fishing is that they live in beautiful places, and it's hard to image a more spectacular setting than the Grand Tetons (Figure 14).

Figure 14. The Grand Teton Mountains in Grand Teton National Park, center of the range of the Snake River Finespotted Cutthroat, July 2023.

Colorado River Cutthroat (Green-Yampa UIEU)

My first encounter with this subspecies was my 1984 non-native fish from Rocky Mountain National Park, but during my July 2023 trip I had a chance to see this form within its native range. All the online sources as well as my colleague and fishing friend Bryan Maitland, who had gotten his Ph.D. at the University of Wyoming and completed the Wyoming Cutt Slam, recommended that the most easily accessible place to catch them was Labarge Creek in southwestern Wyoming, a tributary of the Green River. This creek held Colorado River Cutthroat historically, but they had nearly disappeared by the late 1900s because of interactions with non-native trout. In the early 2000s the entire upper creek system was poisoned to kill all fish present, a dam was built to prevent recolonization from downstream, and pure Colorado River Cutthroats were stocked. Soon these Cutthroats were reproducing, and the stream was re-opened to sport fishing with strict regulations to preserve the population.

Labarge Creek flows through a beautiful valley, and it was a delight driving up a lightly traveled dirt road from the sagebrush cattle ranches of the lower elevations to the pines and spruces of higher elevations in Bridger-Teton National Forest. We passed the barrier dam and several pull-offs with signage describing the Colorado River Cutthroat restoration. A few miles farther upstream we found a good spot and prepared to fish. As we were rigging up, a Wyoming Game and Fish Department Conservation Warden stopped to chat. He was friendlier and more laid-back than the conservation wardens I worked with from Wisconsin, and we got into a discussion about fishing. When I asked him for advice about fishing Labarge Creek, he said "Go somewhere else." Apparently, the fishing in the creek had been terrible, and he had yet to talk to any anglers in 2023 who had actually caught anything. This was not good news, but it was too far to go to another Colorado River Cutthroat stream, so we resigned ourselves to give Labarge Creek a try. Maybe we were better anglers than all those others?

After an hour of fishing, it was clear that we were not. We covered some beautiful water with a variety of flies but had no strikes. We even walked through several good holes trying to get a glimpse of any trout present scurrying away. But the water appeared fish-

Figure 15. Labarge Creek, WY, beaver ponds in Labarge Meadows in Bridger-Teton National Forest, home of the Colorado River Cutthroat, July 2023.

Figure 16. Colorado River Cutthroat (Green-Yampa UIEU) from Labarge Creek, July 2023.

Figure 17. The lower reaches of Smiths Fork, WY, downstream of Bridger-Teton National Forest, home of the Bear Lake Cutthroat, July 2023.

Figure 18. Bear Lake Cutthroat from Smiths Fork, July 2023. Photo by Greg Pils.

less. Dismayed, we continued up the valley and speculated about what might have happened to all the fish.

Near the top of the valley, we reached Labarge Meadows, an important resting area on the Oregon Trail used by westward migrants during the 1800s. It was a beautiful spot, and we stopped to admire the view. The creek at this point was quite small and had been impounded into a series of marshy beaver ponds (Figure 15). This was where Bryan had caught his Colorado River Cut. In one of the ponds, I saw a fish rise to the surface to take an insect. We investigated further and noticed a few small trout. This was all the encouragement we needed, and we grabbed out gear and began to fish. Right away Greg caught a small Colorado River Cutthroat. I took pictures (Figure 16) and expected that we would soon catch more. But the fish proved to be scarce and not very cooperative. We worked hard for the next three hours, and we each had a couple of strikes, but that was it. We had to move on to stay on schedule. Greg was still in the running for the Cutthroat Slam, but I was out. Fortunately, I had some good pictures. But why the Colorado River Cutthroats in Labarge Creek had declined so much remains a mystery.

Bear Lake Cutthroat

At the top end of the valley of Labarge Creek, we crossed a basin divide and entered the range of the Bear Lake Cutthroat, formerly considered part of the Bonneville Cutthroat. We drove down the valley of the Smiths Fork, which flows into the Bear River and ultimately the Great Salt Lake. The Smiths Fork was just as beautiful as Labarge Creek, flowing through a steep and heavily wooded mountain valley. Once we got to a point where the stream had sufficient water, we stopped to try our luck. But it was déjà vu all over again, and as in Labarge Creek, the great-looking habitat apparently had no fish. What was going on?

After two fruitless hours, we continued downstream into the lowlands to spend the night in Cokeville. There we talked to our motel clerk who had had good Cutthroat fishing in the lower Smiths Fork just the week before. Buoyed by that knowledge, the next morning we fished where he recommended, which was much lower down in elevation and in sagebrush rangeland instead of

mountain forest (Figure 17), and between us we landed nine Bear Lake Cutthroats. I thought that one of the fish that Greg caught was the prettiest cutthroat of our trip (Figure 18), and that's saying something. Our difference in success between upstream and downstream was curious, and we hypothesized that the Cutthroats in Smiths Fork must move downstream to bigger water during the winter and spring and only occupy the cold headwaters during the hottest part of the year in late summer. But regardless of the explanation, Greg had successfully completed the Wyoming Cutthroat Slam!

Bonneville Cutthroat

As if the Wyoming Cutt Slam wasn't enough, in fall 2023 I continued my quest to find different Cutthroat UIEUs. On vacation in late September with my wife, Mary Kay, we traveled to Great Basin National Park in eastern Nevada to look for, among other things, Bonneville Cutthroat Trout. This is the most remote and least visited national park in the Lower 48, a mountainous "sky island" of relatively moist high-elevation habitats surrounded by desert, and it is well known for its clear air, dark night skies, and brilliant stars. Because of its isolation and lack of visitors, accommodations are quite limited, and we ended up staying in a cabin at Hidden Canyon Ranch Resort, about 15 miles outside the park and down a long dirt road that would be dicey in any sort of rain. But the cabin was fine, if basic. The canyon was beautiful, and the night skies were amazing. Best of all, it had a stream, Big Wash, purported to hold Bonneville Cutthroat. Bonneville Cuts were also known from a few streams in the park, but having them where I was staying was a big appeal.

We arrived at the resort in the late afternoon after a long but enjoyable drive from Las Vegas through many miles of empty, open, high desert. As we checked into our cabin, I asked the clerk how the fishing was in Big Wash. She gave me a strange look and said that no one fished in the stream because it didn't have any fish. I replied that their website had said that trout were present. On no, she said, there might be some trout farther downstream, but at the resort the stream was "too fast" for trout.

I was dismayed by this and a bit down as we went to our cabin, though the "too fast" comment didn't make sense to me. I could hear the stream rushing through the thick brush nearby as we unloaded our luggage, so I decided to take a look. It took some effort to get to the stream, but once I pushed my way through the thick vegetation, I was excited by what I saw. There was a small check dam, designed to prevent headward erosion and to allow water diversion for irrigation, and below it was a particularly trouty-looking deep plunge pool (Figure 19). I hustled back to the cabin and grabbed my gear. On my first cast with a small sinking fly, a nice trout flashed out from underneath the bank and grabbed it, but it quickly shook free. I was pumped! There was at least one trout in the stream, and only 50 feet from where we were staying! I flipped my fly back in, and the trout grabbed it again, but once more shook off. The next cast, the same thing happened. By now, the trout had apparently learned its lesson, and subsequent casts elicited no response. I was worried. Maybe this was the only pool in the whole creek with trout, and maybe I had blown it. I took a few deep breaths and changed to a floating fly. On my first cast, I watched a trout, maybe the same one,

Figure 19. Plunge pool below a small check dam on Big Wash, NV, home of the Bonneville Cutthroat, September 2023.

Figure 20. Bonneville Cutthroat from Big Wash, NV, September 2023.

slowly rise up and sip in my fly. For once I didn't strike too soon or too hard and I hooked the fish. I played it carefully for about 20 seconds and was just getting ready to land it, but suddenly it came loose. I couldn't believe it. My heart was pounding, and my blood pressure was skyrocketing. This couldn't be happening! I really was going to blow it.

Figure 21. The pool on "Stream X," NM, where I was successful at catching a Rio Grande Cutthroat, October 2023.

Despondent, I sat for a while to calm down. Then, not expecting much, I put on a different floating fly and cast into the pool. To my amazement, a different trout emerged, slowly rose, and took the fly. I was so surprised I didn't have time to overreact, and the trout hooked itself. My luck changed and the fish remained on the line, and I was soon able to slide a beautiful 10" Bonneville Cutthroat into my net (Figure 20). I was ecstatic, and my pulse and blood pressure rose even further, but for a very different reason.

By then it was getting dark, so I quit for the day. But at first light I was back, fishing the entire half mile of stream within the resort. The stream was small, steep, and extremely brushy, and the going was tough. Most areas were too shallow and fast to hold trout, so the clerk hadn't been completely off base. But there were about a half dozen more check dams that had good pools. Not all held fish, but from them I managed to catch two more Bonneville Cutthroats and lose a couple more. And it turned out that it was good that I had succeeded in Big Wash. The streams in Great Basin National Park that I saw were even smaller, steeper, brushier, and had significantly less favorable holding water than Big Wash, and it would have taken a lot of effort to catch any trout from them. Quite happy with my fish from the resort, I didn't even try to fish in the park and instead just enjoyed the beauty of a really wonderful place.

Figure 22. Rio Grande Cutthroat Trout (Pecos Strain) from Stream X, October 2023.

Rio Grande Cutthroat

You may recall my expedition to find this subspecies in 2022 as recounted in "In Search of New Mexico's Native Trout" in the Spring 2023 (volume 48, number 2) issue of *American Currents*. There I told how I spent two days stumbling around the southwestern Sangre de Cristo Mountains on a bit of a wild goose chase searching for Rio Grande Cutthroats before finally catching one that had some Rainbow Trout in it as well and then promptly fumbling it and letting it escape back to the stream before I could take a picture. The article triggered a contact from fellow native trout enthusiast, Craig Springer, who generously revealed to me a different fishing spot near Santa Fe. His only condition was that I not divulge the name or precise location of the stream. So, in October 2023, on a visit to Albuquerque to meet some old high-school friends and on my third trip of the year to Cutthroat Country, I took a day to visit "Stream X" in the Pecos Wilderness of the Santa Fe National Forest in the southeastern Sangre de Cristo Mountains. Unlike my 2022 streams, which drained to the Rio Grande River, this stream ultimately drained to the Pecos River, and the Cutthroats it held looked somewhat different than my 2022 fish, although both populations were part of the same UIEU.

I arrived at the stream about noon on a cool mid-October day after a long drive. The stream was absolutely beautiful, as is the case for all areas where Cutthroats still thrive, but it was quite brushy, small, and steep and full of obstructions and the going was difficult (Figure 21). Following Craig's advice, I worked my way a few hundred yards upstream of my access point before I started. Things did not start well. I first managed to catch my fly rod in a tree branch and break the tip. This didn't make the rod unusable, but it made my casting more erratic. Then, more seriously, I stumbled while climbing over a large fallen tree and nearly impaled myself on a broken branch. For once, my big belly proved an asset, cushioning my fall and preventing the branch from penetrating my stomach. But it left a nice bruise. And it was sobering to think that if I'd fallen a little harder or if the branch had been a little sharper, I would have found myself with an abdominal punc-

Figure 23. Avalanche Lake, MT, in Glacier National Park, home of the Westslope Cutthroat Trout, September 2015.

Figure 24. Westslope Cutthroat Trout (Neoboreal UIEU) from Avalanche Lake, September 2015. Photo by Mary Kay Lyons.

ture wound a half-mile of difficult walking from my car in an area with no cell service.

Worst of all, the fishing was terrible. There were lots of good habitat, and I covered it thoroughly, but I had no response. In many pools I could see fish finning in the open. They weren't alarmed by my casting, but no matter what I tried, they showed no interest in my flies. Nothing worked. Finally, I got to a nice pool where I could see four to five fish. I was running out of time and that now all-too-familiar feeling of panic that I was blowing my one chance threatened to overwhelm me. I determined that I would fish this pool until I either spooked all the fish or caught something. I first tried some sinking flies that drifted right in front of the fish. They ignored them. Then I used some floating flies that Craig had recommended, but they passed overhead unnoticed. After several casts with no reaction, one of my floating flies sunk, and I began to pull it slowly through the pool in preparation for another cast. To my surprise and delight, a small fish turned and inhaled it as if it was the one food item it had been waiting for all day. I set the hook, quickly derricked the poor fish out on to the bank, and pounced on it before it could flop back into the stream. Woo Hoo! What a beautiful trout (Figure 22)! I held the fish carefully and snapped several pictures before gently releasing it back to the stream. I was elated.

OK, I had cracked the code and would now catch many more trout, right? You can guess the answer. No. I tried the sinking fly technique for the other fish in this pool and in several more pools but got no reaction whatsoever. The fish just weren't biting. The fickle fish gods had smiled briefly, and I had been able to seize my one and only chance. I was happy, and I quit for the day and began the long drive back to Albuquerque to meet up with my friends.

WESTSLOPE CUTTHROAT TROUT: Neoboreal Cutthroat UIEU

During my 2015 western trip, we visited Glacier National Park, a stronghold for Westslope Cutthroats. Although fishing was not the primary goal, I was determined to spend an hour or two trying for this species. A hike into Avalanche Lake provided me with an opportunity. There was a popular, well-worn, and relatively easy 2.5-mile trail into this spectacular high-mountain lake, and we walked with several other people. Normally I prefer solitude in wild areas, but here I was happy to have company. Grizzly bears are common in Glacier and represent a small but real risk, and I figured that the more people there were, the less of a target I would be. I knew I couldn't outrun a grizzly, but I was pretty sure I was faster than the elderly couple just ahead of us.

Avalanche Lake absolutely lived up to the hype and was incredibly beautiful (Figure 23). Its water looked transparent and evoked hackneyed descriptors used by past fishing writers such as "gin clear" or "pellucid." It was easy to see Westslope Cutthroats finning through the shallows and occasionally rising to the surface to inhale small insects. I was excited. As soon as I had caught my breath from the high-altitude hike and had taken a few photos, I quickly rigged up my fly rod. My first cast to a rising fish produced a strike, but the fish shook itself off. A few minutes later I hooked another fish, but it again escaped, and the process repeated itself a few minutes after that. I was in my usual panic. My fishing had spooked the remaining fish within casting range, and I feared I had missed my one chance at a Westslope Cutthroat. I kept casting despite not seeing any more feeding fish. But then my luck turned. As I checked my watch to see how few minutes I had before we needed to start

Figure 25. Coastal Cutthroat Trout. (Drawing by Joseph Tomelleri, used with permission)

our walk back, a Westslope Cutthroat rose from the bottom and took my fly. I played the fish as carefully as I could and finally beached it in the shallows. The fish was as beautiful as the lake and well worth the exertion of the hike and the tension of the fishing (Figure 24).

COASTAL CUTTHROAT TROUT

The Coastal Cutthroat Trout (Figure 25) is the only Cutthroat species I've caught while doing scientific sampling rather than sport angling. In June 1997, my late colleague and great friend Phil Cochran and I traveled to the annual meeting of the American Society of Ichthyologists and Herpetologists in Seattle, Washington. Phil and I were studying non-parasitic "brook" lampreys at the time, so we arranged to arrive a couple of days early and survey streams in the Seattle area for the Western Brook Lamprey *Lampetra richardsoni*. We visited a variety of sites and were ultimately successful, although the place where we found the lampreys was a bit unexpected. Juanita Creek was in a heavily suburbanized area east of Seattle and flowed through people's backyards. Usually streams in this sort of setting show evidence of degradation, but the habitat here had remained good and the fish community healthy, and, to my delight, we also caught numerous small Coastal Cutthroats and Coho Salmon *Oncorhynchus kisutch*. Coastal Cutthroats have many more spots than most other forms of Cutthroat Trout and we were struck by the similarity of them to Rainbow Trout, with which they often co-occur naturally but only rarely hybridize. Only the red slash under their jaws convinced us that we'd actually caught Cutthroats. We preserved some of the lampreys we caught, but foolishly took no pictures of the habitat or the Cutthroats or Cohos. In the era before cell phone cameras, I missed many great photo opportunities.

The Coastal Cutthroat is the only Cutthroat that goes to sea, although not all populations do, even if they have ready access. The ocean-going Coastal Cutthroats typically occur alongside anadromous Pacific Salmon species, as we found in Juanita Creek, but their life histories are a bit different. Salmon spend their early life in a freshwater stream or river and then migrate to the ocean at a small size and early age. They live there continuously for one to four years, often moving hundreds or even thousands of miles from the coast, and they grow large, from 5 to 50 pounds depending on the species. They then return to fresh water to mature, spawn, and die. In contrast, Coastal Cutthroats may move back and forth between the ocean multiple times during their life, occupying the ocean for the summer and fall each year for feeding before moving back into fresh water to overwinter and then spawn in the spring. While in the ocean, they rarely go far from the mouth of their home river, and they don't grow nearly as much as salmon. Most adult ocean-going Coastal Cutthroats are only 1-2 pounds, and anything over 5 pounds is a trophy. They do not automatically die after reproduction, and they may spawn multiple times during their lifespan. Coastal Cutthroats remain common in some areas, but, like their salmon cousins, they have declined because of dams, habitat loss, pollution, and introductions of non-native species.

Figure 26. Lahontan Cutthroat Trout from Pyramid Lake, NV. (Drawing by Joseph Tomelleri, used with permission)

LAHONTAN CUTTHROAT TROUT

I've yet to see any Lahontan Cutthroats (Figure 26), although catching one is at the top of my list. This species produced the largest Cutthroat Trout ever caught, a 42-pound fish from Pyramid Lake, Nevada, in 1925. Pyramid Lake, located about 30 miles north of Reno, is the largest and deepest lake remaining from vast glacial Lake Lahontan, which filled much of the northwestern Great Basin at the end of the last ice age. During the late 1800s and early 1900s, Pyramid Lake was well known for its numerous and large Cutthroats and supported a commercial fishery that provided fresh fish to San Francisco and a sport fishery that attracted anglers interested in catching trophies. But even as the lake was yielding massive fish, human activities were dooming the population. In 1905, Derby Dam was built on the Truckee River about 45 miles upstream of Pyramid Lake to provide irrigation water for regional agriculture. The Truckee River was the primary spawning area for Pyramid Lake Cutthroats. The dam blocked access to upstream spawning areas and diverted so much water that no spawning habitat remained downstream. Over the ensuing decades, the lack of water inflow caused the level of Pyramid Lake to drop by 80 feet, and a huge shallow delta developed at the mouth that further blocked access to the river from the lake even in those rare wet years when the lower Truckee River had sufficient water. Pyramid Lake Cutthroats are long-lived, and they persisted for many years after the dam became operational, but with no reproduction the population steadily declined, and by the late 1930s they were gone.

Pyramid Lake lies within the reservation of the Pyramid Lake Paiute Indian Tribe, and Cutthroat Trout have always been important to the tribe. In the 1970s, the Paiutes, along with the US Fish and Wildlife Service and the State of Nevada, began a stocking program to retore the Pyramid Lake population. The source of most of the stocked fish was Summit Lake, located about 100 miles north and not connected to Pyramid Lake and wholly within the reservation of the Summit Lake Paiute Indian Tribe. Owing to the habitat protections and management of the tribe, Cutthroat Trout still thrived in Summit Lake. The stocking program was successful, and a Cutthroat Trout population was re-established in Pyramid Lake. However, natural reproduction was negligible and regular additions of Summit Lake fish were required to maintain it. Anglers returned to the lake and began catching nice-sized Cutthroats, although not nearly as big as in the early 1900s.

The historically large size of Pyramid Lake Cutthroats seems to have a genetic basis. Summit Lake Cutthroats are not identi-

cal to the original Pyramid Lake Cutthroats even though they are similar enough genetically to be classified within the same Lahontan Cutthroat Trout UIEC. However, once again, the indiscriminate stocking of the last 100+ years proved to have a silver lining. An introduced population of Cutthroat in a small stream in the Pilot Peak region in western Utah, hundreds of miles away and in a different river basin from Pyramid Lake, proved to be a remnant of the original Pyramid Lake stock. Propagation and addition of progeny from the Pilot Peak population into Pyramid Lake began in the early 2000s, and since then Cutthroats of more than 20 pounds have become much more common. Nearly all these large fish have been from the Pilot Peak stockings. Both Pilot Peak and Summit Lake Cutthroats are still stocked in Pyramid Lake, with Summit Lake fish providing most of the fish caught by anglers but Pilot Peak fish most of the trophies.

The Pyramid Lake Paiute Tribe has long fought to re-establish Cutthroat Trout spawning in the lower Truckee River. The tribe battled in the courts for many years before finally being able to assert water rights to guarantee adequate river flows during the spawning period. They also worked with federal and state agencies to provide fish passage through the delta at the mouth of the Truckee and at other movement barriers for fish in the river. Their hard work paid off, and in 2014, successful natural reproduction of Pyramid Lake Cutthroat Trout occurred in the lower Truckee River for the first time since the 1930s. The tribe and cooperators are continuing to work on fish passage in the lower Truckee River with ground broken in 2023 on a new fish passage facility at the Numana Diversion Dam, about 11 miles upstream of the lake. Successful reproduction in the lower Truckee River has occurred every year since 2014, and the Pyramid Lake population is moving towards self-sufficiency. However, with ongoing climate change, the warmer and drier conditions projected for the future make these gains precarious. Only continued human management and conservation actions will preserve the Pyramid Lake Cutthroat and, more broadly, all Cutthroat Trout.

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WHAT EVER HAPPENED TO THE SILVERY MINNOW *HYBOGNATHUS NUCHALIS* IN THE TENNESSEE RIVER?

David A. Etnier, Wayne C. Starnes, Bruce H. Bauer

Department of Zoology, University of Tennessee Knoxville

During the winters of 1977 and 1978 we, accompanied by TVA biologists Charles Saylor, Gary Hickman, and Joe Feeman; and University of Tennessee graduate students Noel Burkhead, John Harris, and Dave Nieland, had the opportunity to spend two weeks in the University of Michigan Museum of Zoology for the purpose of sorting fish collections from the Tennessee River system. Samples had been collected by TVA field crews during 1937–43, and then sent to Michigan for identification and deposition in accordance with an agreement between TVA and Dr. Carl L. Hubbs. Although a large number of these samples had already been sorted and catalogued by UMMZ staff, an inventory of 256 unsorted samples comprising over 49,000 specimens remained. We thank TVA for defraying travel expenses, and Ms. Ellie Baker and Drs. R. M. Bailey and R. R. Miller for cooperating with us at UMMZ.

A large amount of our time was spent counting small purple stonerollers and Warpaint Shiners, and separating large mixed series of the very similar *Notropis volucellus*, *N. stramineus,* and Sawfin Shiner (*Notropis* sp.). We did uncover a number of unexpected and extremely interesting records, several of which are reported here. A limited number of xerox copies of the collection summaries are still available from the authors.

Hybopsis cahni, the Slender Chub, always considered as endemic to the Clinch and Powell rivers in Tennessee, is now represented by a single adult specimen from Holston River at "island above Three Springs," Hamblen Co., Tenn., 14 Sept. 1941. This locality, at Holston River Mile 87.2, is now under Cherokee Reservoir, which was impounded in December, 1941.

Hemitremia flammea, the Flame Chub, is currently restricted to four known localities in the upper Tennessee River system. The TVA collections indicated that it formerly occurred in nine additional sites in Blount, Loudon, Rhea, and Roane counties, Tenn.

Notropis ariommus, the Popeye Shiner, was previously represented from the Holson River system by a single specimen collected in 1888 in Watauga River, Carter Co., Tenn. (Gilbert, 1969). The TVA collections revealed its former presence in both Robinson and Poor Valley creeks, tributaries to the lower Holston River (Cherokee Reservoir) in Hawkins Co., Tenn.

Percina maculata, the Blackside Darter, an extremely rare species in the upper Tennessee River system, was represented by one specimen from Poplar Creek, tributary to the lower Clinch River, Roane Co., Tenn.

Percina macrocephala, the Longhead Darter, previously known from a single 1967 specimen from the Little Pigeon River (French Broad River System) was represented by an additional specimen from Walden Creek, tributary to West Fork Little Pigeon River at Pigeon Forge, Sevier Co., Tenn.

Percina copelandi, the Channel Darter, was previously represented in the main channel of the Tennessee River by a single 1893 collection of seven specimens (USNM 70686) from the Tennessee River five miles west of Knoxville, Knox Co., Tenn. (R. D. Suttkus, in Lit.). Other Tennessee River system records were restricted to the Clinch-Powell system of the upper Ten-

Editor's Note: This article originally appeared in the *Southeastern Fishes Council Proceedings* (January 1979). We are reprinting it here as another acknowledgement of the many significant contributions David and Bruce made to ichthyology during their careers (see remembrances for both in the Summer 2023 *AC*). It is also a valuable reminder of the importance of collections that may hold secrets of lost fauna that would otherwise go undetected. David's article in the Spring 2016 issue of *American Currents* ("Serendipity: the *Nothonotus wapiti* Story," available at http://www.nanfa.org/ac/serendipity-nothonotus-wapiti.pdf) also involved collections and another species almost slipping through the cracks into oblivion.

Mississippi Silvery Minnow (Menorkenut Slough, Butler County, MO). "Mississippi" was added to the accepted common name by Robbins et al. (1980) after this article's original publication. (Photo by Konrad Schmidt)

nessee. It was represented by a specimen from the lower Tennessee River at the upper end of Blood Island, Calloway Co., Ky., 22 Oct.1942. Kentucky Reservoir, impounded in 1944, now covers this area.

Hiodon alosoides, the Goldeye, not recently collected from the entire Tennessee River system but possibly persistent in the extreme lower portion of the river, was represented by specimens from Kentucky Dam site, and from the mouth of Pond Creek in the upper Tennessee River in Loudon Co., Tenn.

A trammel net sample from the main channel of the Tennessee River near Decatur, Alabama, contained only 58 specimens and 11 species, dominated by *Ictiobus bubalus*, the Smallmouth Buffalo (23) and *Ictalurus punctatus,* the Channel Catfish (12). Of the remaining 23 specimens, 5 were *Acipenser fulvescens,* the Lake Sturgeon, 3 were *Scaphirhynchus platorynchus,* the Shovelnose Sturgeon, and 1 was *Cycleptus elongatus*, the Blue Sucker. All of those are currently extremely rare or extirpated from the Tennessee River system.

Notropis stramineus, the Sand Shiner, is currently of spotty occurrence in the upper Tennessee River system only in the lower Little Pigeon and Little rivers. It was formerly much more widespread, occurring in 28 of the TVA samples from tributaries to the Tennessee and lower Clinch rivers in Roane County, and upstream through Tennessee, Holston, and French Broad River tributaries in Blount, Knox, Loudon, Hamblen, Hawkins, Grainger, Jefferson, and Cocke counties.

It is obvious from these records that many changes have occurred in the Tennessee River fish fauna coincident with main channel impoundments (Wilson Reservoir, 1924; Wheeler, 1936; Pickwick, 1938; Guntersville, 1939; Chickamauga, 1940; Watts Bar, 1942; Loudon, 1943; Kentucky, 1944), and major tributary impoundments (Norris Reservoir, 1936, Clinch River; Cherokee, 1941, Holston River; Douglas, 1943, French Broad River; Fontana, 1944, Little Tennessee River). It is not surprising to note the disappearance of many of the above species in response to drastic alteration of the Tennessee River system. The decrease in range of the supposedly tolerant *Notropis stramineus* is difficult to explain, but it may be related to this shiner's finding suitable habitats only in and near mouths of small tributaries to the Tennessee River and its larger tributaries. Our lack of knowledge concerning the ecology of this species is apparent.

Even more surprising, and finally justifying the title of this paper, is the apparent complete disappearance of *Hybognathus nuchalis*, the Silvery Minnow from the entire Tennessee River system since the early 1940s. It was common in pre-impoundment small stream samples (Fig. 1), and was often the dominant species in both numbers and biomass. The explanation for this sudden demise is lacking, but we suspect that *H. nuchalis* depended on an unimpounded Tennessee River for certain aspects of its life history. The apparent isolation of the former upper Tennessee River population (Fig.1) is probably a collection artifact, since pre-impoundment samples between Rhea Co., Tenn., and Marshall Co., Ala., are lacking or virtually lacking. The same paucity of pre-impoundment collections prevails from areas near or in the Tennessee River between Pickwick Dam and the Kentucky border, and *H. nuchalis* was likely present in that area.

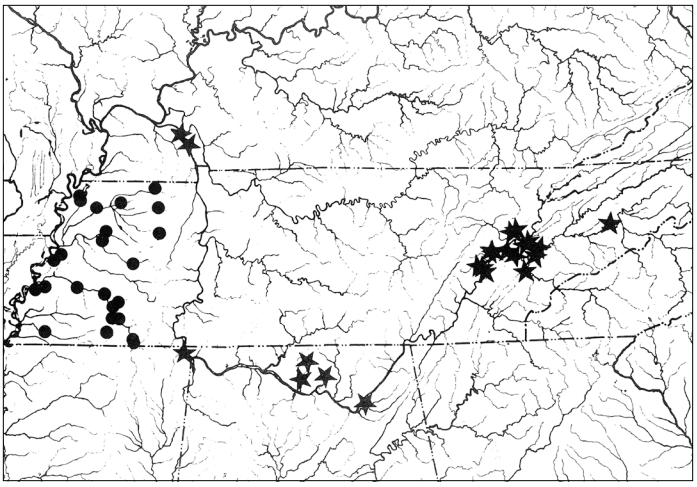

Figure 1. Distribution of *Hybognathus nuchalis*. Stars represent its distribution in the Tennessee River prior to impoundment. Dots represent the present-day distribution of *H. nuchalis* in Tennessee.

Species composition of the samples suggests that, even though rotenone was often used, little attempt was made to adequately sample riffle communities. Pool-inhabiting cyprinids, catostomids, and centrarchids dominate the samples, and unfortunately, only occasional specimens of *Phenacobius*, *Erimystax* chubs, and riffle darters were encountered. More to be regretted is the almost complete lack of collections of small fishes from the main channel of the Tennessee River. Apparently, there was little appreciation of the possibility that there may have been strictly riverine small fishes that never or only rarely ventured into tributary streams. It seems highly likely that the Tennessee River was inhabited by one or more such species that are now extinct and were never seen.

There is ample evidence provided by changing fish and mussel faunas to indicate that the Tennessee no longer exists as a river. The foremost aquatic biologists of the late 1930s could not have predicted the effects of impoundment on species such as *Hybognathus nuchalis, Notropis stramineus,* and *Hiodon alosoides.* The loss of the Tennessee River is an environmental tragedy of immense proportions, but equally tragic is our failure to be sufficiently impressed by the historical lessons to be learned. It is obvious that we are still unable to accurately assess the effects of habitat alteration on the faunas involved, and that any habitat alteration involving complex faunas is almost certain to adversely affect one more of the involved species. The overwhelming lesson is that habitat alteration will, often in ways we cannot guess, result in continued species decimation. Although our knowledge of the biota is incomplete, we are sufficiently informed to say unequivocally that the environmental effects of any major water project will never be "insignificant."

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THE MYSTERY OF THE BANDED KILLIFISH *FUNDULUS DIAPHANUS* IN THE MIDWEST, PART DEUX

Jeremy S. Tiemann, Jordan Hartman,

Illinois Natural History Survey University of Illinois

Eric R. Larson, Philip W. Willink

University of Illinois La Grange Park, IL

The recent inexplicable explosion of Banded Killifish *Fundulus diaphanus* populations across the Midwest was nicely summarized by Willink et al. (2019). To quickly recap these findings, the Banded Killifish was always considered imperiled in Illinois and found only in the kettle lake region of the five northeastern-most counties in the state, but it underwent a HUGE population expansion from 2000–2015 (Smith 1979; Rivera et al. 2013; Tiemann et al. 2015; Willink et al. 2018; 2019; Metzke et al. 2022). Its range in Illinois grew so quickly that the Illinois Endangered Species Protection Board (IESPB) considered de-listing the species. However, biologists from across the state sat down, looked at the data (and voucher specimens) and realized something was amiss (Willink et al. 2018, 2019). They recognized that this expansion was not a natural phenomenon of an imperiled species but was instead an invasion of a non-native taxon that was quickly colonizing new areas like so many invasive species do. The biologists then petitioned to the IESPB to recognize both subspecies and preserve the state-threatened status of the native Western Banded

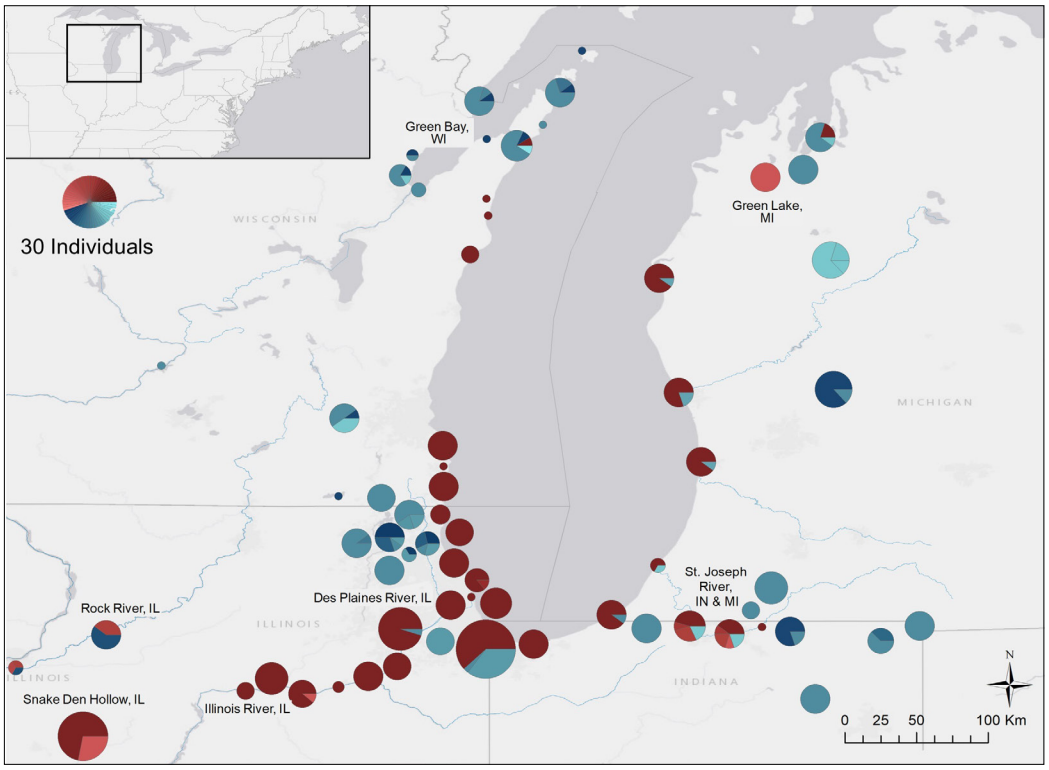

Figure 1. The distribution of mitochondrial DNA haplotypes for Western Banded Killifish (blue), Eastern Banded Killifish (red), and sites where individuals of both subspecies were found (both blue and red) across populations within our study (taken from Hartman et al. 2023).

Photos by the authors.

Jeremy Tiemann has been a Field Biologist/Aquatic Zoologist specializing in stream ecology with the Illinois Natural History Survey since 2002. He grew up on a farm in northeastern Kansas and developed a keen interest in aquatic biology while traipsing through streams as a kid. This passion led to a BS in Biology from the University of Kansas in 1998 and a MS in Biological Sciences from Emporia State University in 2002. Professional research interests include stream ecology and life history of non-game fishes and freshwater mollusks.

Jordan Hartman is a PhD Candidate at the University of Illinois, Urbana-Champaign studying aquatic invasive species with a particular interest in genomics and landscape ecology. She grew up dreaming of being a marine biologist. Being from the Midwest, her appreciation of freshwater systems grew during her BS in Fisheries and Wildlife (University of Missouri, Columbia) and MS in Biology (Tennessee Technological University). She loves using genomic techniques to study freshwater fishes and mussels and hopes to incorporate landscape genomic research.

Figure 2. Green Lake, near Grawn, MI, where Western Banded Killifish were collected in 2020.

Figure 4. A backwater bay of Lake Michigan near Traverse City, MI, where Eastern Banded Killifish were collected in 2020.

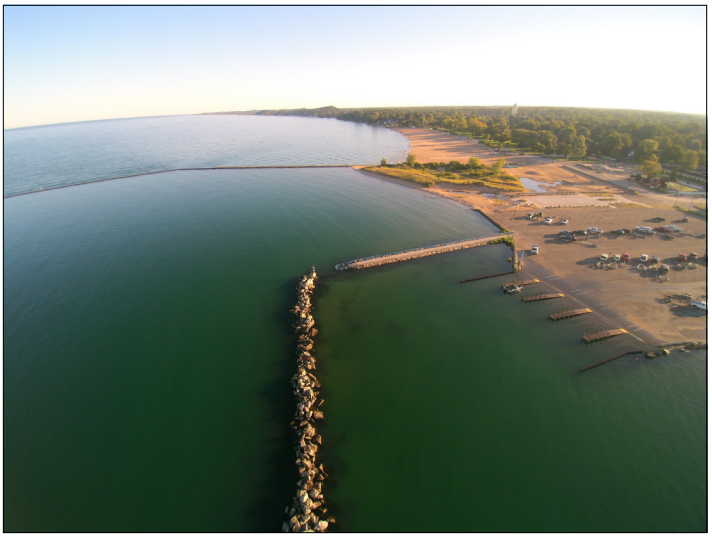

Figure 3. Lake Michigan, Ludington, MI, where Eastern Banded Killifish were collected in 2020.

Figure 5. A backwater bay of Lake Michigan near Racine, WI, where Eastern Banded Killifish were collected in 2020.

Killifish *F. d. menona* and recognize the non-native Eastern Banded Killifish *F. d. diaphanus*.

Phase 2 of our project was to determine which subspecies is where and how this invasion might have happened. We brought on new colleagues, including University of Illinois PhD student Jordan Hartman, and incorporated additional conservation techniques (e.g., genetics) to help us answer these questions. Like Phase 1, we reached out to several NANFA members to help us obtain specimens to build our dataset. We acquired 720 banded killifish from 104 sampling sites across nine states in the US and one province in Canada. These individuals were collected between 2004 and 2021 from our focal region in Illinois and the Lake Michigan drainage (Figure 1), localities elsewhere in the native range of both the Western and Eastern subspecies, and from populations of non-native Eastern Banded Killifish in the Ohio River watershed. The fish were collected using standard fisheries techniques, such as seining, electrofishing, trapping via mini-fyke nets, and

Eric Larson has been a professor at the University of Illinois' Natural Resources & Environmental Sciences since 2015. His main research interests are freshwater ecology and conservation science, with an emphasis in environmental DNA and invasive species. He received his BS in Fishery Resources at the University of Idaho in 2004, his MS in Biology at the University of Arkansas in 2007, and his PhD in Aquatic and Fishery Sciences at the University of Washington in 2011.

After Philip Willink received his PhD from the University of Michigan, he worked at the Field Museum and then the Shedd Aquarium (both in Chicago). He now serves on several state, municipal, and non-governmental organizational boards. He has conducted fieldwork in a dozen countries around the world, described several new species of fishes, and appeared in numerous documentaries and media articles. Phil is now searching the depths of Lake Michigan for meteorites with the Adler Planetarium in Chicago.

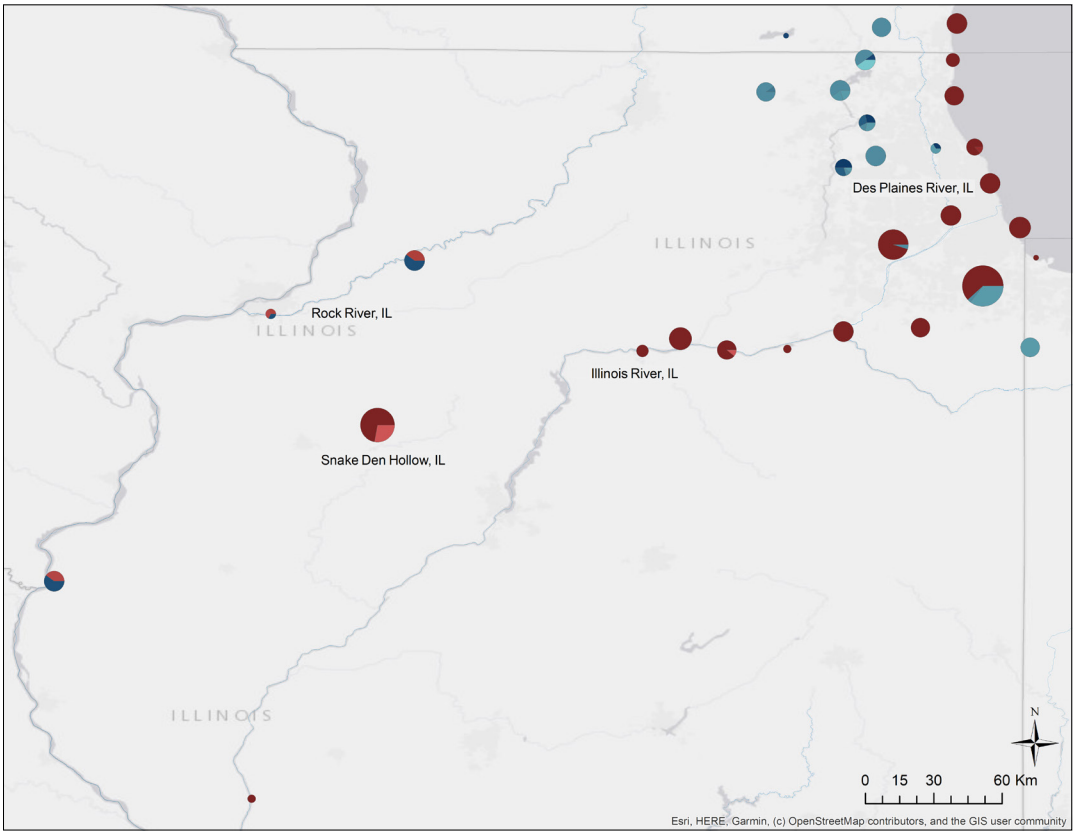

Figure 6. The distribution of mitochondrial DNA haplotypes for Western Banded Killifish (blue), Eastern Banded Killifish (red), and sites where individuals of both subspecies were found (both blue and red) across populations in Illinois.

dip-netting. Specimens were preserved in 95% ethanol and deposited in the Illinois Natural History Survey Fish Collection, Champaign.

This is where Jordan and I (Jeremy) must stop and step aside from our co-authors. We took a collecting trip up and around the Lake Michigan drainage during the summer of 2020, during COVID. Simply put, the trip was *EPIC* (Figures 2–5). We collected along the shoreline of Lake Michigan and in various kettle lakes throughout the basin. In 25+ years of collecting fishes professionally, this is one of my (Jeremy) favorite trips because I collected with an aspiring PhD student in one of America's most beautiful areas. At one site we saw Mother Nature at her most cruel when a Bald Eagle plucked a loon chick off the surface of a kettle lake while the mother loon protected the rest of her brood, and yet at another site we were able to showcase our native freshwater fishes by having a small group of kids help us sort through our seine.

This trip was the first sampling trip of my (Jordan) career that I was in charge of organizing and planning where we would sample. Up until the summer of 2020 during my PhD, I had spent most of my time in the genetics laboratory extracting and sequencing Banded Killifish DNA. I based our sampling locations on lakes where Banded Killifish had previously been caught and areas on Lake Michigan that seemed to have easy access and looked like good killifish habitat. During the beginning of our trip, I remember feeling incredibly defeated after the first few kettle lakes did not have any Banded Killifish, but I also remember how great it felt when we eventually found Western Banded Killifish! Overall, the trip turned out to be amazing. We collected Banded Killifish from numerous sites and it was an incredible experience for me to get to work with such a seasoned and supportive biologist.

AND NOW, THE REST OF THE STORY…

After we had the specimens in hand, Jordan extracted tissue samples and conducted a genetic analysis. If you are a scientist/geneticist, all the methods are outlined in Hartman et al. (2023). For the rest of us, simply put, Jordan led the way using cutting edge genetic methods, and the results supported what we thought: the genetic data showed that the kettle lakes are comprised of the Western Band Killifish and this influx of new locations (e.g., Lake Michigan and the Illinois River) is due to the non-native Eastern Banded Killifish colonizing new areas (Figure 1). As natural resource scientists with precious limited resources, we know now where to focus our conservation efforts (that is the kettle lakes), and we know what is artificial/non-native (e.g., those populations in Lake Michigan) when attempting to conserve the Banded Killifish. Jordan's next two chapters of her PhD dissertation will 1) use yet additional analyses to dive deeper into the genetics and explore the origin of the Easterns that invaded Lake Michigan and whether the two subspecies are hybridizing, and 2) use stable isotopes and diet metabarcoding to determine what, if any, ecological overlap there might be in how these two distinct subspecies feed. For example, does one feed at the surface while the other is more opportunistic, or are they competing for food resources? An interesting caveat to all of this comes from the observation of Smith and Harris (2020) that Eastern Banded Killifish aren't always *top*minnows, as they can go undetected by swimming along the lakebed of the Laurentian Great Lakes. Regardless, there will more to the story in future years.

From the Illinois perspective, the Banded Killifish in Lake Michigan, through the Chicago Area Waterway System (CAWS), and down the Illinois River are the non-native subspecies (Figure 6). They look different as they are more vibrant (and bigger) than what we'd find in the kettle lakes (Figure 7). For our counterparts elsewhere in the basin, let's talk. If it doesn't seem right, it might not be right. We feel the Eastern Banded Killifish could be elsewhere in the Great Lakes basin. We are here to help identify what you might have as times are weird with climate change, budget cuts, and, let's be honest,

Figure 7. An Eastern Banded Killifish collected from the North Branch Chicago River, Chicago, IL, in 2018 (top), and a Western Banded Killifish collected from Green Lake near Grawn, MI, in 2020 (bottom).

"dinky fishes" aren't in the limelight of most natural resource agencies. Regardless, please recognize that citizen scientists—like NANFA and other hobbyists—can help natural resource agencies advance the conservation of our precious natural resource, especially when documenting under-sampled species (e.g., Tiemann et al 2014; Jones et al. 2022; Lyons and Schmidt 2022). They are an extra set of boots on the ground (or in the water) collecting data and making observations. Let's work together and help conserve our fishes for the next generation.

ACKNOWLEDGEMENTS

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COLLECTING THE YELLOW BULLHEAD *AMEIURUS NATALIS*

James E. Burgess

Glasgow, Kentucky

Bullheads (*Ameiurus* spp.) are usually not one of the targets for the average fisherman trying to catch a trophy catfish. Bullheads do not attain the size of the Channel Catfish *Ictalurus punctatus*, Blue Catfish *I. furcatus*, or Flathead Catfish *Pylodictis olivaris*. According to the International Game Fish Association, the world record for the Yellow Bullhead *Ameiurus natalis* (Figure 1) is a 6 lb, 6 oz fish caught in Drexel, Missouri, by John Irvin in 2006. Most anglers consider the Yellow Bullhead a nuisance when trying for the bigger species. In their defense, they are a lot of fun not only for the fight they put up when hooked, but also for the enjoyment of keeping and watching them.

The Yellow Bullhead is in the North American catfish family (Ictaluridae). All catfishes have four pairs of barbels, no scales, an adipose fin, and stout spines at the origins of the dorsal and pectoral fins. The caudal fin of the Yellow Bullhead is rounded or nearly straight. It is a medium-sized member of the catfish family. It is typically yellow-olive to slate-black on the back and sometimes mottled depending on habitat. The sides are lighter and more yellowish, while the underside of the head and body are bright yellow, yellow white, or bright white. Chin barbels are white, yellow, and rarely pale pink. Its native distribution is from southern Canada to Florida and westward to the Great Plains. It has been introduced into states farther west as well as overseas (Figure 2).

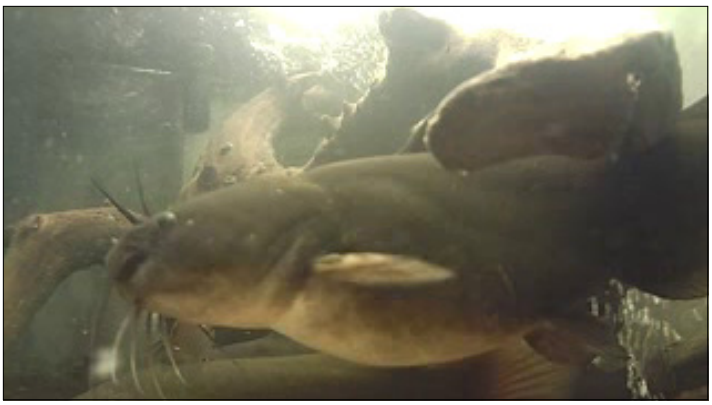

Figure 1. Yellow Bullhead in aquarium.

Photos by the author.

James Burgess has always loved fishing and keeping the fish he caught. He became extremely interested in the diversity of catfishes as a high school student. Even while serving in the Army, James continued his catfish studies. After he retired from the Army, he started writing articles and research papers and posting them on ResearchGate. He is a member of PlanetCatfish, Catfish Study Group, and the American Society of Ichthyologists and Herpetolologists. His grandchildren help him collect specimens in the local creeks. He continues to keep and be amazed by *Ameiurus natalis*.

To find Yellow Bullheads, one does not have to look very far. They are found just about everywhere within their native range, but they seem to thrive better in waterways without much current such as farm ponds or slow-moving creeks. They prefer to hang out around the weeds and areas littered with sunken debris. The most successful places to find them are usually at the base of dams or other hiding spaces during the daytime. My favorite place is the Drakes Creek boat ramp just on the outskirts of Franklin, Kentucky (36.718760, -86.547413). The area has abundant aquatic vegetation but is clear enough of obstacles to be effectively fished with lines or traps.

The tackle for catching bullheads can range from using a string tied to a stick to the most expensive rod and reel combo. The standard line that comes from the factory on a new reel is adequate. I usually use line with strengths of 10 to 15 pounds. This strength is ample for the Yellow Bullhead and is strong enough for most other fishes that you will encounter. The size of the Yellow Bullhead mouth makes the size of the hook a hard choice as these fish are known for swallowing the hook when taking bait. Everyone seems to have a different opinion. The hooks that I utilize are the #2 barbed hooks which have good bait retention. The weight is usually less than a quarter of an ounce for a double-hook configu-

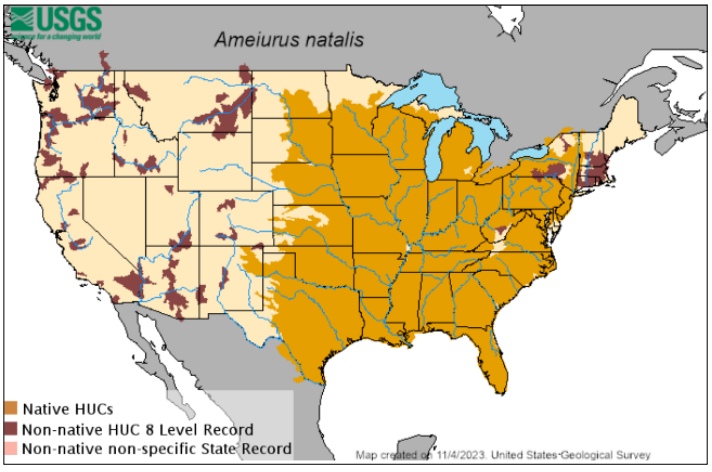

Figure 2. Yellow Bullhead distribution.

Figure 3. Rod and reel configuration.

ration. A trio of fishing poles is equipped as in Figure 3, but the poles are set out in a fan formation to cover a larger area.[1] The bait is cast out around thirty feet.

The last ingredient to this configuration is the selection of a tempting bait. Traditional baits work just as well as any specially designed attractants. The old adage for catfish bait of "the stinkier the better" is appropriate. Treats such as liver, chicken gizzards, rotten cheese have been used. What works in one area may not work in another area. An example of bait versus location from my experience was while living in San Angelo, Texas, and fishing in the Red Arroyo where pieces of shrimp was the best bait. However, here in Kentucky, shrimp is ignored, and nightcrawlers work best in Drakes Creek. My technique is very simple in the bait used. The old standard of pieces of nightcrawlers is what I normally use. By only using the pieces that can fit on the hook, the juices and the odors tantalize the taste buds of bullheads. No fishing method or bait can guarantee success, but a trial-and-error approach can be used to discover what works in your area.

The feeding behavior of Yellow Bullheads is best described as one-and-done. When they bite the baited hook, it is usually strong and hard, and the hook is very often swallowed. To cause as little damage as possible, I cut the leader and the hook stays in. Most of the time; the hook is expelled once I place the fish in the quarantine tank. A small percentage of fish continue swallowing, and the hook does irreparable damage.

How you handle a caught bullhead (or any catfish) is very

Figure 4. Handling catfish specimens.

important. It is one thing to catch this "aquatic warrior," but due to its evolutionary weaponry, it can be quite hazardous. The most prominent of these weapons are the spines in the pectoral and dorsal fins. These bones in these fins can be locked into a "triangle of pain." In addition, these fins are equipped with a mild venom. When the fisherman is "finned," the venom causes a pain something like a bee sting. In conjunction with the sharp serrated spine piercing the hand, the pain can become quite intense. There is a remedy, but not an immediate one. Try to immerse the affected area in warm water as soon as possible. The warmth neutralizes the venom, and the pain lessens rapidly. To avoid being finned while removing the specimen from the line, grasp the bullhead from underneath (Figure 4). By snugly holding this catfish with the locked fins between the fingers, one can

[1]**Editor's Note:** Please check local angling regulations regarding the number of poles and hooks allowed.

Figure 5. Some types of fish traps.

Figure 6. Livewell systems.

successfully remove the hook from the mouth or cut the leader if the hook was swallowed.

An alternative method for collecting is fish traps. Overall, this method is much better for the bullhead as they are baited into the trap without harming the fish from swallowing a hook. The baits used in these various traps usually include canned dog or cat food along with bread. The trap is set and left overnight (with high hopes the trap will still be there in the morning).

I have used three styles of traps (Figure 5). The first is shaped like an umbrella. There are six entry points around the perimeter. It has a single removal point that consists of a zippered opening. The next trap I tried was an improvement. The trap itself is hexagon shaped with an entry point on each side. The trap is collapsible by unzipping it from top to bottom; opening it up completely makes it easier to remove the fish. The newest collapsible trap I have used is round and resembles the old-style minnow trap. All of these traps operate in the same way, but it is the bait that makes the difference.

I have also used a cast net to catch bullheads. It is most effective in small areas. My preference is a net with a four-foot span. I used one at a fish farm when the water was being drained and the bullheads were concentrated in a small area. The drawbacks to employing this method is that it is labor intensive, and removal of the fish entangled in the net with fins locked in the mesh is very difficult.

Transportation of your collected fish is made easier since bullheads can survive in low oxygen levels. I use a homemade livewell system that is composed of two totes (Figure 6). The inside tote has multiple holes drilled into the sides and bottom. Pieces of pool noodles are zip-tied to the tote's inside rim along with a rock placed on the bottom middle. The lid is secured with zip ties through the handles and slits on the sides after the fish are put into the tote. A small length of rope is attached to the tote. The livewell is then ready for whatever fish are collected, and it can be floated in the waterway. This way the specimens stay in oxygenated surroundings. The second tote houses the floating tote.

Once the collecting is over, the bottom tote is filled with the same water. The floating tote is immersed into the bottom tote, and then an air stone is put into the floating tote. The air pump is run by a power inverter, thus keeping the fish alive on their way back to my lab.

Keeping your bullheads alive for further study was covered in an earlier article (Burgess 2019). The 250-gallon tanks that house most of my research specimens are made from field water tanks that have been converted. The filtration/aeration unit consists of a pool pump apparatus that pumps the water from the drain valve (the bottom) to the top going through activated charcoal and terry cloth filter media contained in plastic strainers. This configuration allows for quick filter changes and the ability to recycle the filter by washing. Multiple artificial plants are attached to a grate to provide cover for the fish. They feed on minnows from a nearby bait shop. It keeps their predatory instincts active and food is available when wanted.

Collecting catfish in general and Yellow Bullheads in particular is very rewarding. Whether it is being done for pleasure or investigative purposes, finding the fish and using the proper methodology for capture makes the trip more successful and rewarding. Being able to effectively transport, house, and feed your fish allows the researcher to continue investigations without having to postpone a project to collect more specimens.

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WELCOME, NEW MEMBERS!

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FishMap.org

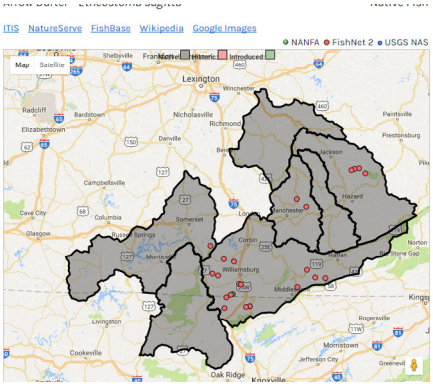
NORTH AMERICAN NATIVE FISHES ASSOCIATION (NANFA)

FishMap.org is for anglers, aquarium hobbyists, scientific researchers, or anyone else with a passion for fishes who wants to visually explore species' ranges or learn what species are in their local waters. The site is dedicated to spreading knowledge and respect for all fish species.

FishMap.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.

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).

Range and Collection Data



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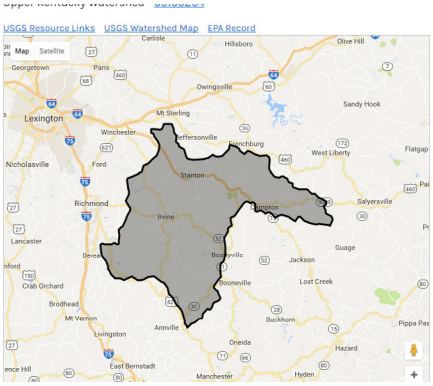
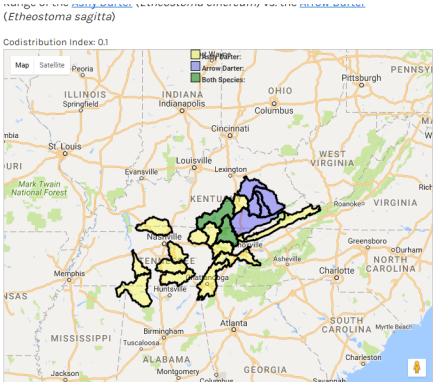


Compare Ranges



FISHES OF WISCONSIN POSTERS

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

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