

# COLLECTING NATIVE FISHES 101

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### INTRODUCTION

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

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

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

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



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

Photos by the author unless otherwise indicated.

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

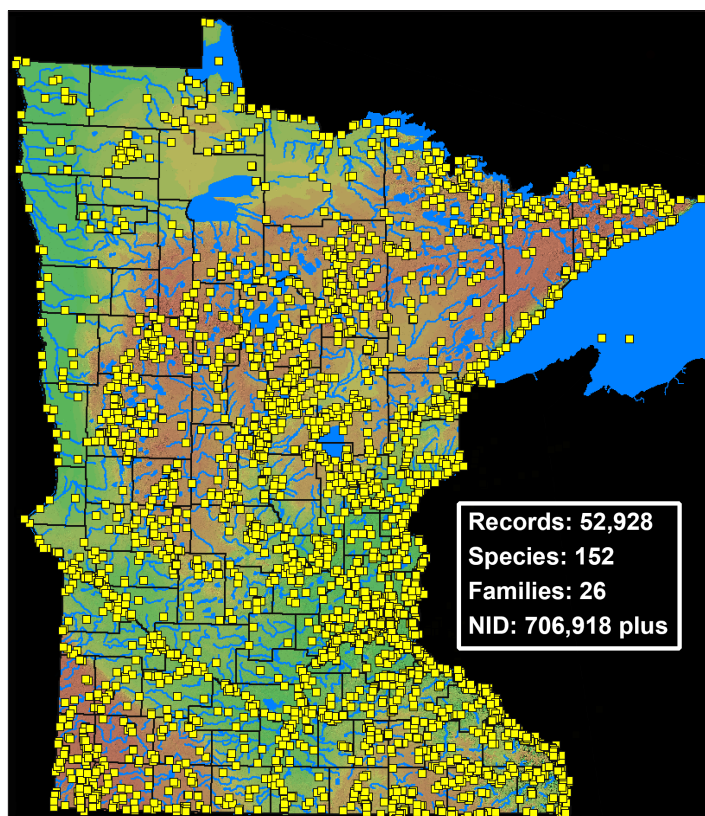


Figure 1. The author's fish collection records in Minnesota since 1974.





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



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



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

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

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

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

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





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



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

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

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

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

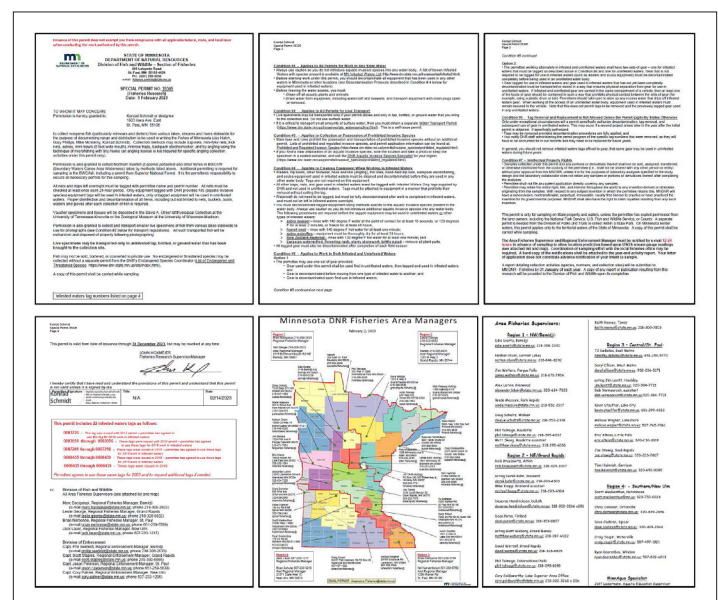


Figure 7. Example of one of the author's permits.





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

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

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



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



**Figure 10. Public watercraft access.**

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

### WHERE AND WHEN TO COLLECT

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





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



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

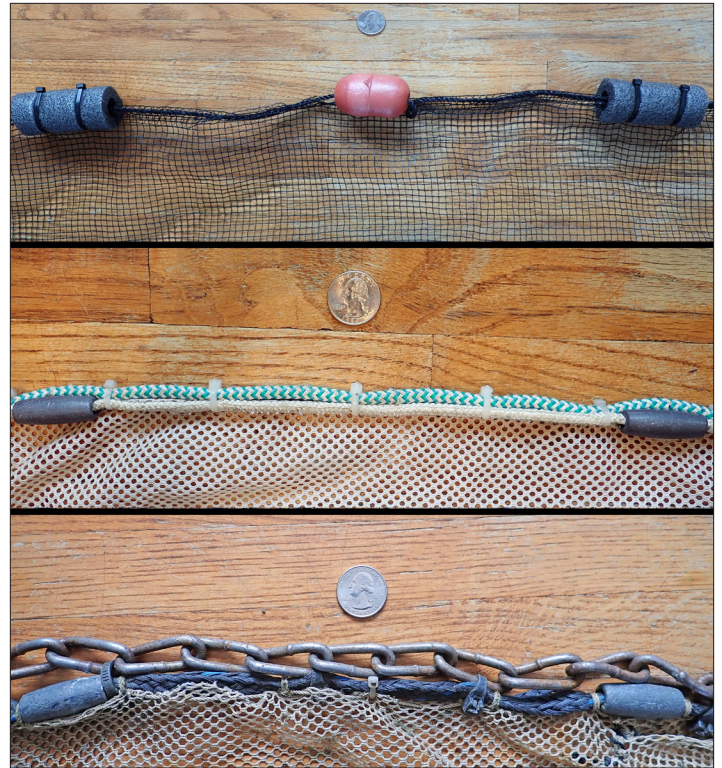


Figure 13. Seine modifications to improve capture effectiveness: From top: additional floats. Additional weight using lead-core rope for long seines. Large chain for short seines.

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

### HOW TO COLLECT

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





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

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

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

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

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

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



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

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

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

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

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

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

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

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

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





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



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

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

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





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

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

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

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

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

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



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



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

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

### TRANSPORTING FISH

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

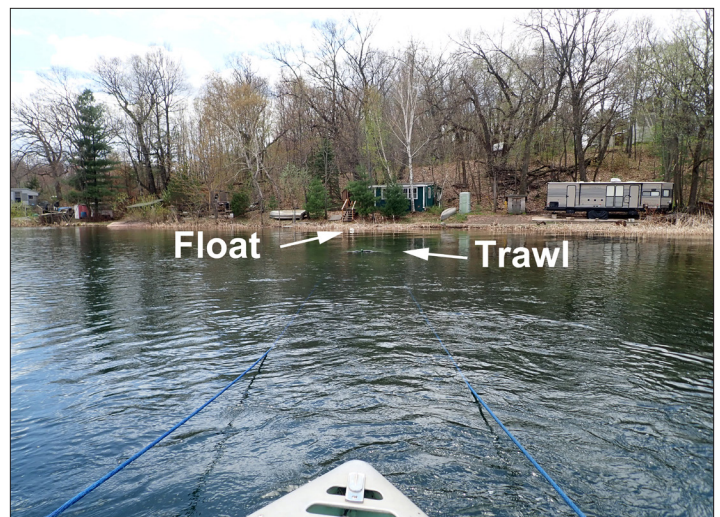
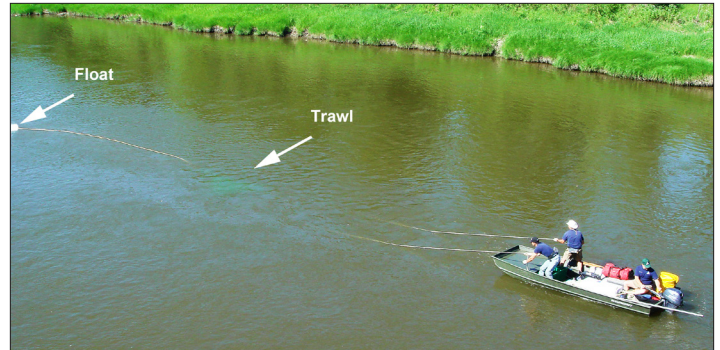


Figure 19. Benthic trawl examples. Top two photos: deployed in deep water from bow. Bottom photos: shallow water from stream bank or lakeshore (photo by Jenny Kruckenberg).



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

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

### PHOTOGRAPHY

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

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



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



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



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

#### VOUCHER SPECIMEN AND TISSUE PRESERVATION AND CURATION

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

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

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

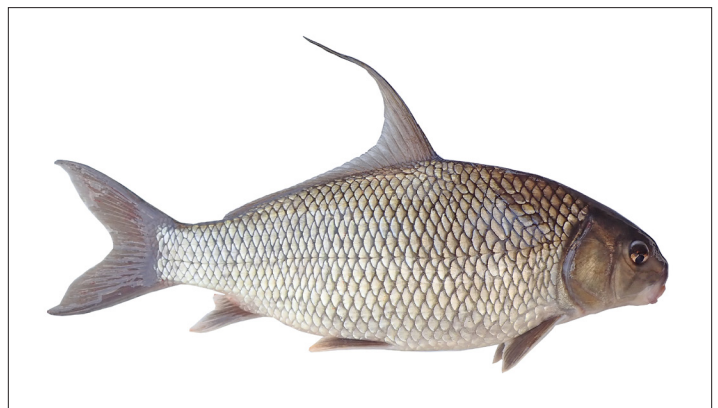


Figure 22. Top: Scott Smith demonstrating dry method for large species. Middle: author’s first try with technique, using a hooked rod to elevate dorsal fin. Bottom: edited image of Quillback *Carpiodes cyprinus*.



## CONCLUSIONS

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



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

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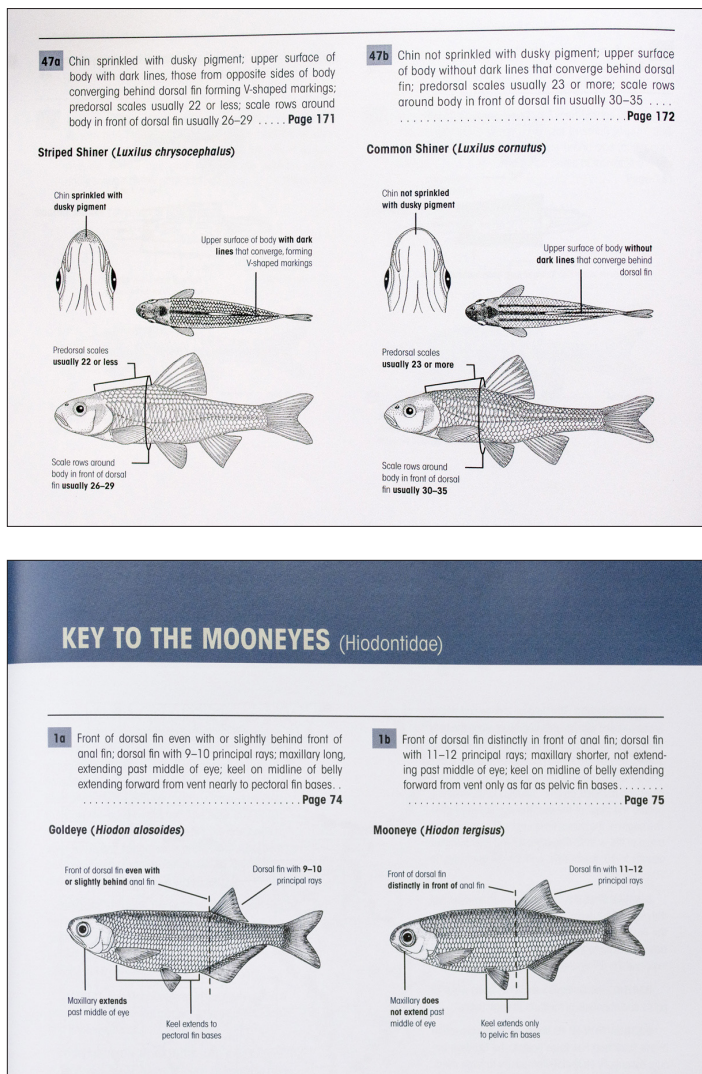


Figure 3. Examples of keys, showing some of the ways that relevant details are highlighted and explained.

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

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

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

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

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