

Collection and Preservation of Fishes

In order to conduct studies on the systematics and biologies of fishes it is often necessary to make collections. When making a general collection of fishes from a locality it is advisable to thoroughly sample all habitat types and, if possible, to preserve large series, representing all size classes, of each species collected. In this way, potentially new information on distribution and habitat of fishes can be discovered, and adequate sample sizes are assured for any studies that might ensue. Of course, in some cases, restraint should be used in the collecting of rare species with localized populations. When conducting more specialized collecting, as in targeting a particular species under study, it is advisable to also retain those fishes incidentally collected as they are always potentially informative to another study. For some research, such as population dynamics or ecological studies of various kinds, repetitive sampling at a given locality is necessary. In such cases, the sampling regimen and the kinds and numbers of fishes that will be retained in collections should be carefully considered previous to conducting fieldwork.

Collecting Permits

For most types of collecting, it is necessary to obtain a scientific collecting permit from the state agency governing fish resources (e.g., the Tennessee Wildlife Resources Agency). In some states, including Tennessee, it is permissible to collect non-endangered fishes and non-game fishes with a small seine (up to 10 ft) with an ordinary fishing license. However, for most of the other methods discussed below, a special collecting permit is necessary, and it is advisable to obtain a permit in any case if one is to be engaged in frequent fish-collecting activities.

Collecting Techniques

Ichthyologists collect fishes by a variety of techniques, including several kinds of nets and traps (see several chapters in Nielsen and Johnson, 1983), chemicals, and electroshocking. In some cases, even angling has provided valuable specimens for study.



Use of twelve-meter seine to beach seine small fishes in Mississippi River.

One of the most common techniques, particularly for smaller fishes, is with small-meshed nets called seines. These nets have mesh sizes ranging from a few millimeters to over a centimeter and may be from less than 1 to many meters in length and 1 to 3 or so meters in depth. Such seines are weighted with lead along the bottom edge so as to maintain contact with the substrate and have floats along the top edge to keep the net extended vertically. The float and lead lines are usually tied to poles (sometimes called brail poles) at each end to facilitate pulling the seine through the water. Practice and skill come into play in maneuvering the seine through the water in such a way as to trap fishes within it. The poles should be angled backward at all times so that the bottom of the seine is in the lead; fishes are usually trapped by landing the seine smoothly on shore or quickly lifting it horizontally. Maintaining contact with the bottom for as long as possible is essential; it may be necessary to “walk” the lead-line by hand over obstructions or vegetation, forcing it to the bottom as much as possible. Kicking the substrate or vegetation just ahead of the seine to scare up fishes is productive in areas of substantial current. Long seine-hauls relative to the length of the net are generally not more productive than shorter ones and increase the chances of snagging. When seining in moderate current, it is advisable to pull downstream a little faster than the current velocity to avoid current resistance and take advantage of fishes’ natural tendencies to escape upstream, although occasionally it is very productive to seine upstream to an ob-

struction and trap fishes against it. In riffle habitats, fishes that live on the substrate, such as darters, can be collected by stretching the seine across a portion of the riffle and vigorously disturbing the substrate upstream of it by kicking, followed by a quick lift. In slack waters, shoving a seine beneath cover, such as brush or tree roots, as far as possible without impeding retrieval—followed by kicking that cover and quickly lifting the seine—can be very productive.

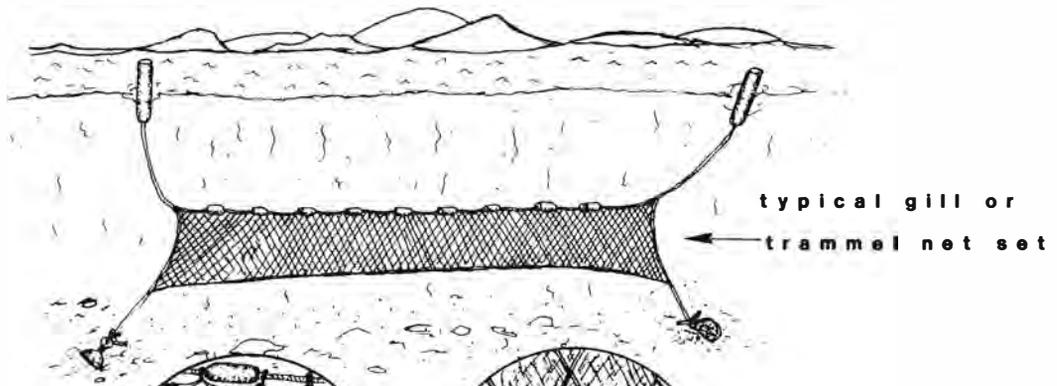
Some species of stream fishes, such as active darters or those living beneath boulders, can be very difficult to collect with seines. If water clarity permits, a very effective way of selectively collecting these fishes is by snorkeling with a face mask and carefully pursuing them with a dark-colored (green is best) dip net. The 8–10 inch varieties available from aquarium dealers work reasonably well, though a slightly larger mesh size (such as seine material) is more maneuverable in water. It is relatively easy to approach most benthic fishes with such a net and, with a little practice, maneuver them into it. It is usually better to wear sneakers rather than swim-fins when working in shallower areas.

Other types of nets sometimes used for collecting, particularly larger species, are gill nets, trammel nets, hoop or trap nets, and trawls. Gill nets are constructed of fine material, such as monofilament, with mesh sizes ranging from one to several centimeters, depending on what the targeted catch is. They are weighted along the bottom and have floats along the top, and lengths may range from a few to hundreds of meters; depths are usually about 1 to 3 or 4 m. Nets with alternating panels of varied sized mesh, called “experimental gill nets,” are sometimes used for sampling a habitat. Fishes that encounter a gill net usually pass partway through a mesh opening and become ensnared behind the gills and further entangled from the subsequent struggling. Gill nets are usually set out for a few hours, often overnight when reduced visibility improves their effectiveness. Trammel nets, which are somewhat similar, consist of one small-mesh net suspended closely parallel to two large mesh nets. Fishes encountering the net force the small-mesh net through one of the large mesh openings, becoming impocketed on the opposite side. Gill and trammel nets may be fished suspended from the surface by the float-line or heavily weighted at either end and fished at the bottom or in midwater. They are most often used in slack-water habitats but may be fished in rivers if anchored parallel to the current. An example of a good set of a net would be the downstream tip of an island at dawn or dusk. Cross-current sets will usually quickly fill with floating debris and be rendered ineffective.

Hoop or trap nets are somewhat similar to the familiar minnow trap consisting of netting stretched over a frame or hoops to form a box or cylinder with an inwardly tapering funnel entrance. Fishes entering the traps through the funnels have difficulty relocating the small apertures in order to escape. Sometimes wing nets are added to further funnel fishes toward the trap net, and the traps may be baited but most often are not. In streams, these nets are anchored with the funnel entrance facing downstream. They are most effective when fishes are “on the move,” such as during spawning migrations.

Trawls are bag-shaped nets that are towed behind boats. They range in size from 2 to 3 m (such as the “try” nets used by shrimpers) to 20 m or more in width (large vessels). The bottom lip of the bag is weighted and the top floated to keep it open in the vertical dimension. “Doors” or “otter boards” are attached to the tow bridles on each side of the net; these “flare out” when towed through the water to widen the mouth of the net and stabilize it. Trawls may be fished on the bottom or in midwater. Trawling is the only method for making large collections from deeper waters. Obviously, there are numerous hazards to these operations; they are successful only on relatively snag-free bottoms. Methods of rigging trawls for collection from small boats were elucidated by Lopez-Rojas et al. (1984).

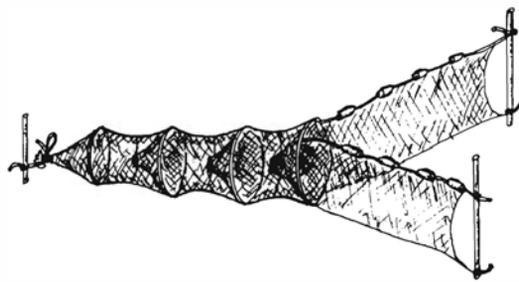
The most effective collecting techniques for thoroughly sampling shallower fish habitats involve the use of chemicals called “ichthyocides.” It is absolutely necessary to have a scientific collecting permit and additional special permission from authorities to utilize such techniques, and they should be performed only by experienced personnel. Ichthyocides affect and immobilize fishes that are virtually inaccessible to other collecting techniques and facilitate much more accurate quantitative sampling than other methods. These chemicals usually act by inhibiting oxygen uptake in the gills. One of the most widely used ichthyocides is “rotenone,” a derivative of certain leguminous plant roots, such as derris root. South American Indians discovered the powers of this chemical and have fished with it for centuries. Concentrated commercial preparations are very powerful, and a liter or two can effectively sample 50–100 m or more of stream or a portion of a lake; marine collectors have used it effectively in tidepools and on reefs. However, effectiveness is greatly reduced at lower water temperatures, and strength of rotenone preparations varies a great deal, particularly with age. It is possible to neutralize the effects of rotenone by the addition of other chemicals (e.g., potassium permanganate). In streams, in addition to dip-netting, it is usual practice to



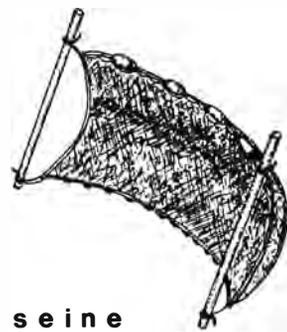
gill net



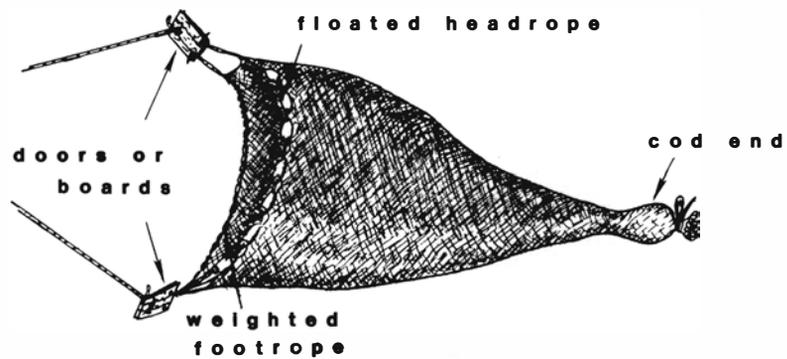
trammel net



hoop net with wings



seine



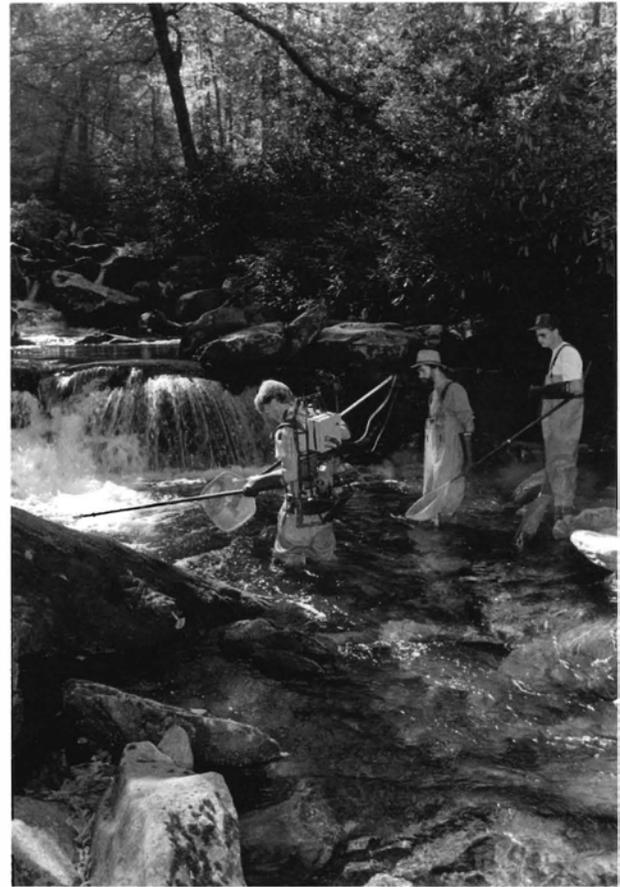
trawl

Basic types of fishing nets (trawl is shown from above).

place a block net, such as a long seine, across the stream at some distance below the chemical application site to collect immobilized fishes. In slack-water habitats, an area is usually enclosed by netting before sampling with chemicals. See Davies and Shelton (1983) for detailed information on the use of rotenone and other chemicals.

Another chemical which has been effectively used for general sampling, but to a lesser extent than rotenone, is sodium cyanide (Lewis and Tarrant, 1960; Tatum, 1969). Though far less toxic than potassium cyanide, it is still necessary in many states to have a special permit to handle this chemical in addition to the usual scientific collecting permits. The chemical comes in powder or briquette form, and a small amount applied to a stream can effectively sample a reach. Breakdown of the chemical occurs quickly after placing in water, and it is thus not necessary to neutralize it with additional chemicals as with rotenone applications; thus the effects on most fishes is temporary and the survival rate of those not collected appears to be quite high, though the benthic invertebrate community may be temporarily affected. Saltwater fishes collected with cyanide have low long-term survival, and the chemical has a deservedly bad reputation in the aquarium trade. Saltwater fishes drink sea water to compensate for loss of body water by diffusion, and cyanide apparently destroys digestive tissues and results in eventual starvation. An additional advantage of sodium cyanide over rotenone is uniform strength and thus more predictable results, though, like rotenone, effectiveness is positively correlated with water temperature. We have found this chemical a particularly useful tool in collecting difficult-to-sample habitats, and its use has made some important contributions to the knowledge of fishes in Tennessee. Again we emphasize that such chemicals are to be used only by experienced and properly permitted collectors with tasks at hand that justify their use.

Finally, another method sometimes used for fish collecting is electroshocking. Backpack units or small stream-side generators are used in smaller streams; larger boat-mounted units are used in rivers and lakes. In simplest terms, shockers consist of a generator unit or battery connected to electrodes which are placed in the water to produce an electric field. Both AC and DC current types have been devised, with DC being generally less harmful to fishes. Commercially available designs can be operated relatively safely. Fishes within the electric field of a shocker are generally temporarily immobilized by electrotetanus, though some mortality can result. In DC fields, fishes are literally drawn to the anode via *galvanotaxis* (forced orientation and swimming)



Electroshocking for brook trout in Smoky Mountains with gasoline-powered backpack unit.

as the electric current acts upon their sensory systems. Effectiveness of shocker units depends, of course, on the strength (voltage) of the unit and, especially, conductivity of the water. Like ichthyocides, electroshocking permits collecting in some habitats where seines are ineffective and has the advantages both of limiting coverage to a very specific area and of not being affected by water temperatures. On the other hand, shocker units are cumbersome, noisy, expensive, and less effective for thorough collecting of larger areas. See Reynolds (1983) for further information on electroshockers.

Treatment of Collections

When collecting fishes, it is important to quickly preserve them to insure their usefulness for scientific studies. The usual way of preserving fishes for systematics research, and many kinds of biological studies requiring subsequent dissection, is to fix them in a formalin solution. Formalin is a commercially available

liquid prepared from formaldehyde gas which stabilizes tissues by cross-linkage of proteins, thus preventing decomposition. Formalin is very irritating to the eyes, nasal membranes, and open cuts of the skin, and some persons develop extreme sensitivity after repeated use. Caution must be exercised by using it in well-ventilated areas and washing off after contact. If accidentally splashed in the eyes, repeated bathing with water will usually relieve the irritation in a few minutes. Some forms of formaldehyde are known carcinogens, and any unnecessary contact should be avoided.

The usual concentration of formalin for preservation is a 10% solution (5% buffered for larval fishes). Since fishes will dilute the liquid with their own fluids, it is advisable to begin with a 15–20% solution to achieve the desired strength if many fishes are to be preserved. Filling the collecting container (jar or sealable bucket) to 10–20% capacity with pure formalin before collecting, and then adding sufficient water at the collecting site to bring to 50–60% capacity before adding fishes, usually results in adequate preservation. Fishes should be placed directly in the preserving fluid, preferably while alive, to insure maximum preservation. If preferred, it is possible to anesthetize fishes before preservation with a solution of tricaine methanesulfonate (often commercially sold as “MS-222”). Specimens should not be so overcrowded as to distort body shape, crimp fins, or overtax the preservative. Larger specimens should be injected with fluid or slit along the right side of the abdominal cavity soon after initial preservation to assure penetration of the preservative. It is possible to preserve in formalin fishes that have been dead a few hours or frozen, but all but the smallest of these should be injected. Some ichthyologists prefer to use buffered formalin to offset its acidic properties, which may cause some skeletal and melanophore deterioration. If desired, buffering can be achieved with calcium carbonate in the form of marble chips.

It is of paramount importance to place a waterproof label in the collection container before leaving the field site to insure that locality information remains with it. Various waterproof papers are available and can be written on with india ink or pencil. Full locality information—including, for instance, state, county, stream name, road crossing, distance from town or suitable landmark, date, collectors, and field number—should be included on the label; or simply a field number referable to separate field notes with this information can be placed in the container. It is a good idea to

keep field notes with complete locality information, plus habitat characteristics such as stream size, water depth, temperature, color, substrate, shore type and others, and to make notations about the fishes collected, such as particular habitat, life colors (which will soon fade in preservation), and so on, and any fishes that may have been released.

Upon returning from the field, after the fishes have been fixed in formalin for 2–4 days, depending on size of specimens, for most uses it is desirable to transfer fishes to alcohol for permanent storage to avoid working with irritating formalin solutions and minimize possible long-term effects of formalin on specimens (decalcification). In silvery fishes, such as minnows and suckers, it may be desirable to leave the specimens in formalin for a couple of weeks until most of the guanine has cleared from the scales such that underlying pigment patterns are no longer obscured. The storage medium of choice for many years has been a solution of 70–75% ethyl alcohol. Specimens have remained well preserved in such solutions for well over a hundred years. More recently, a 40–50% solution of isopropyl alcohol has been used for fish storage. Isopropyl has the advantage of being less expensive and much easier to obtain than ethyl alcohol (which is tightly regulated by law). However, it has been questioned as a long-term storage solution because it is harder to keep up to adequate concentration to prevent specimen softening in the face of evaporation without overconcentrating at times, which causes brittleness and clearing of specimens. Specimens being transferred from formalin to alcohol should be thoroughly rinsed to remove excess formalin and allowed to soak in water or weaker alcohol solutions a few days during transferal.

After collections are processed in the above manner, they may become part of permanent museum collections (usually as sorted lots of individual species) for future systematics research, or they become part of a teaching or short-term research collection of a less permanent nature.

Interested amateurs who want to collect and preserve fishes in order to consult experts about them should follow the basic procedures outlined above only to the extent of formalin preservation and labeling with field data. This will suffice until such time as an ichthyologist can be consulted. If formalin is not available, specimens can be frozen or at least kept on ice until consultation. Amateurs can potentially make valuable contributions to our knowledge of fishes.