PURPOSE
Collectors must have proper licenses/permissions for using particular collection method. Fishes can be collected using a variety of gears (see example, Murphy and Willis 1996, Zale et al. 2012). Many of these methods, including electrofishing, seining, gill netting, trap netting, trawling, push nets, light trapping, and capture by hook and line, are accepted practices by the American Fisheries Society (AFS), American Society of Ichthyologists and Herpetologists, and the American Institute of Fishery Research Biologists (AFS 2004). Among these gears, the most commonly used are electrofishing, gill netting and seining. The method used in any particular study will depend on the type of habitat sampled (stream versus ponds or lakes) and the species being sampled because each species is differentially susceptible to various sampling gears. Methods proposed for use herein follow the recommendation of The American Fishery Society (AFS, 1988) to select and deploy sampling gears in a manner that reduces injury and stress to sampled fishes, as well as to minimize any potential environmental impacts of sampling.

ELECTROFISHING
A. Background Information
1. Electrofishing is the collection of fishes that are momentarily stunned by introduction of an electric current into the water. A typical electrofishing unit consists of a generator that produces an electric current, a power control device that allows modification of the electric current to maximize efficiency and reduce potential injuries to the fish, and one or more electrodes that are submerged beneath the water surface.
2. Electrofishing can be conducted using direct current (DC), pulsed DC, and alternating current (AC). Research has shown that the greatest risk of injury to fish occurs with use of AC. The lowest incidence of injury and death is associated with use of DC; however, maintaining a constant DC field requires a larger power source (e.g. generator) than is commonly available. There is little overall difference between DC and pulsed DC in the rates of injury and death to fishes; therefore, pulsed DC is the most commonly used and recommended waveform.
3. Fishes responses to DC and pulsed DC fields are fairly predictable. If the field is detected from a distance, fish will evade (flee from) the field. Within the field, fish often face and then approach the anode (positively charged electrode). There is a progressive inhibition of swimming as the fish nears the anode, which includes taxis (induced movement toward the anode), narcosis (a state of electrically induce immobility in which the muscles are relaxed), and loss of equilibrium.
B. Protocol for Field Collection of Fishes Using Electrofishing

1. It is highly recommended that persons conducting electrofishing review the USFWS, National Conservation Training Center, “Principles and Techniques of Electrofishing,” which is a free comprehensive online training program that covers all aspects of electrofishing. (https://training.fws.gov/courses/CSP/CSP2C01/resources/)

2. Fishes will be collected with either a boat-mounted electrofishing unit or a small, backpack-mounted unit.

3. The boat-mounted electrofishing unit has a generator that produces a maximum current of 100 amps. The generator is specifically built for electrofishing and is the smallest model capable of producing sufficient electric current for local, highly conductive waters. The power control device generally is set to deliver a pulsed DC current of 10-12 amps (40% of maximum) into the water via paired electrodes mounted at the front of the boat. The waveform and amperage are determined by properties (salinity and temperature) of the waters sampled and the species being collected. Ideally, we create a relatively small electrical field in the water and, under local conditions, settings are used that have been found to create the minimum current necessary to induce taxis and narcosis in fishes. Once stunned, fishes are immobilized briefly (5-10 seconds) before they recover and swim off. Stunned fishes are captured by use of a dip net, placed in a livewell and are then handled as described in appropriate study protocols.

4. The back-pack-mounted electrofishing unit is powered by a DC battery that produces a pulsed DC current. The current is delivered into the water by two hand-held electrodes. Pulse frequency and current are set as above. Stunned fishes are captured by use of a dip net, placed in holding tanks, and are then handled as described in appropriate study protocols.

5. In ponds and smaller lakes, electrofishing will be used to capture centrarchid fishes (largemouth bass, bluegill, and various other sunfish), minnows, and gizzard, and threadfin shad. In larger lakes and rivers, electrofishing will be used to capture the above fishes, as well as other freshwater fish. Most of these species are course-scaled fishes, which typically experience low rates of injury and death due to electrofishing. Our use of low- to mid-range currents of pulsed DC is intended to minimize the potential for injury of fishes collected by electrofishing. Pulse rate and duration are set to minimum effective values, determined through experience in local waters, to minimize the length of time fish are subject to current, further reducing the potential for injury.

6. Stress in fish captured by electrofishing has not been well studied. Stress associated with capture by electrofishing include acidosis and reduced respiratory efficiency. However, recent studies show that electroanesthesia is no more stressful to fish than exposure to sedatives and is recommended over chemical sedatives in some cases (Vandergroot et al. 2011; Trushenski and Bowker 2012). Recovery from electrofishing-related stress is believed to be relatively rapid in centrarchid fishes, catostomids, and minnows. Recovery rates in other fishes generally are unknown. Our use of the minimum necessary current should minimize any stress experienced by fishes collected with electrofishing.
GILL NETTING

A. Background Information

1. Gill nets are vertical panels of netting that are suspended in the water column. Gill nets generally are set in a straight line either near the surface or at the bottom of a body of water. Panels are composed of mesh that ranges between ¼- to 6-in across, depending on the size of fish targeted. Along the top and bottom of the gill net, there are, respectively, a series of floats and a weighted “lead” line that keep the net upright in the water. Fish may be caught in gill nets in three ways: by becoming wedged in the netting-held by the mesh around the body of the fish; gilled- held by mesh slipping over the head and opercula; or tangled- caught by teeth, spines, fins, or other protrusions. Most often the fish are gilled.

2. Many species of fish may be captured in gill nets, but gill nets are most selective for species that move substantial distances in their daily routines, such as striped bass and white bass, among others. Size and species of fish captured is influenced by size of mesh used, time of day, and season. Gill nets tend to be biased toward larger fish.

3. Gill nets are used by many fishery conservation agencies in routine population monitoring programs (Fisheries Techniques Standardization Committee [American Fisheries Society] 1992).

B. Protocol for Field Collection of Fishes Using Gill Netting

1. Gill nets will be deployed from a boat. The length (100-300 ft), depth (6-12 ft), and mesh size (1/2-to 6-in) of nets used varies depending on the species targeted. Specific dimensions will be given in appropriate study protocols. As gill nets are being set, weights, and buoys are used, as needed, to suspend the net at the appropriate depth in the water column (generally either at the surface or at the bottom).

2. Stress, injury, and mortality of captured fishes can be minimized by examining nets at frequent intervals. Nets should, at a minimum be examined at 1 to 4 hour intervals, depending on the water temperature (shorter intervals when the water is warm), to reduce the time that fish are held in nets. Larger individuals and larger species of fish generally exhibit lower rates of injury and mortality than small species and individuals. The largest possible mesh in gill nets should be used, consistent with capture of targeted species, to minimize the incidence of non-target collections.

3. Fish captured with gill nets are to be removed from the net, held in on-board holding tanks, and then handled as described in appropriate study protocols.

SEINING

A. Background Information

1. A seine is a woven-nylon mesh net, both ends of which are attached, top and bottom, to poles (brailles). Seines are pulled through the water to concentrate and capture fishes. A weighted line keeps the bottom of the net at the bottom of the water body and a series of floats keeps the top of the net above water.
2. Seines vary widely in length, depth, and mesh size depending on the species targeted and the body of water being sampled.

B. Protocol for Field Collection of Fishes Using Seining
   1. Adult and juvenile fishes may be sampled with minnow seines or bag seines, 8- to 10-ft in length, 6-ft in depth, with 1/8- to 1/4- in nylon mesh. Larval fishes and newly-settled juveniles may be sampled with larval seines, which are typically much shorter (3-6 ft) and possess much finer mesh (1-2 mm) than those used for adults and larger juveniles. Length of seine hauls varies depending on the species targeted and habitat characteristics. Most seine hauls are 5-m in length, as described in study protocols to minimize trauma to specimens that are to be captured, identified, and released. However, longer distances may be sampled when specimens are to be collected, euthanized, and preserved for laboratory examination.
   2. In ponds, lakes, and coastal waters, larger seines (50- to 100-ft in length and 6-to 10-ft in depth) may be used to sample fishes. The length of the seine hauls varies depending on the species targeted and habitat characteristics.
   3. Fishes collected with seines are identified, counted, and immediately released, or are held in water-filled ice chests for a period of several minutes before being treated as described in appropriate study protocols.
   4. Concentrating fish with a seine, along with subsequent handling for removal and identification, represents a source of stress to collected fish that has not yet been investigated, probably because seining is viewed as having a minimal impact on fishes (AFS, 1988). Researchers should attempt to minimize stress by keeping the length of the seine hauls to the shortest distance consistent with study objectives. This reduces stresses associated with herding and concentrating fish and minimizes the time fish are in the seine prior to removal and processing.

TRAWLING
A. Background information
   1. A trawl is a funnel-shaped net that can be towed along the bottom or through the water column. There are a large variety of different sizes and types of trawls suited for use in different habitats or targeting specific taxa.
   2. Generally, larger nets are pulled by boats and can require extensive hydraulics and winches for safe and effective deployment. These nets typically are operated by the crew of the vessel chartered as part of the research, and the researcher has virtually nothing to do with their deployment or retrieval beyond site selection and tow duration.
   3. Smaller trawls can be used with jon boats (<20 ft) and are deployed and retrieved manually. Researchers employing this gear should receive watercraft training/safety instruction as well as instruction on the proper use of the trawl.
   4. Smaller trawls can be mounted on sleds or other devices and pulled manually. These trawls are typically used for sampling newly-settled larval and juvenile fishes from coastal habitats.
   5. Fishes captured in a trawl net are gradually forced into the back of the net, known as the cod end, during a tow. The incidence of injury and stress to individual fishes
tends to be positively correlated to the duration of the tow due to contact with the net and with other individuals in it. Trawl distances will be minimized, consistent with study objectives, to minimize injury and stress.

B. Protocol for field collection of fishes using trawls

1. Fishes may be sampled with trawls of a size appropriate for the habitat being sampled and the capabilities of the boat being used. Local regulations requiring the use of turtle excluder devices (TEDs) or other bycatch-reduction devices should be followed.

2. Tow duration should be the minimum necessary to achieve study objectives. Sensitive habitats, such as reef structures, should be avoided.

LARVAL FISH COLLECTING METHODS

A. Background information

1. Due to their small size and incomplete development, larval fishes must be collected with specialized equipment and must be handled delicately to keep specimens intact for identification.

2. A common method for passively collecting larval fishes is the use of larval light traps. Because early stages of many species are positively phototactic, the light in the trap functions as an attractant when traps are set during night hours. Most light traps have a quatrefoil shape with a light source (either chemical light stick or L.E.D. bulb) in the center and a collecting cup at the bottom. The traps float near the surface and are secured to the substrate or the bank. They are most efficiently used in shallow, low-velocity habitats.

3. A common method for actively collecting larval fishes is the use of ichthyoplankton nets which are either pushed or towed horizontally through the water column. These nets typically range from 0.5 to 1 m in diameter and 1 to 2 m in length with mesh from 500 to 1000 μm.

B. Protocol for field collection using larval push nets and light traps

1. Larval light traps may be deployed in available low-velocity habitat types. Light traps are deployed at night for greatest efficiency.

2. A paired set of push nets may be deployed from a boat along transects near the shoreline in areas clear of obstructions. A tow net may be used by hand along the shoreline in habitats too shallow for boat access. Larval push or tow nets may be deployed in day or night hours. Most efficient timing of sampling will depend upon the drifting behavior of species of interest.

3. Upon completion of larval net transects and upon retrieval of light traps, any adult fishes inadvertently captured will be identified and immediately released. Because larvae must be examined under a microscope for identification, all larval fishes captured will be euthanized and preserved.

4. Stress, injury and mortality are expected to be minimal in light traps as their design allows for water circulation and movement of fishes within the trap. Traps should be examined within 8-12 hours of deployment, and shorter intervals may be necessary if high densities of larvae are encountered.
5. Some injury may be associated with larval nets. To minimize stress, larval net transects or tows should cover the shortest distance possible while remaining consistent with study objectives.

REFERENCES

- Fisheries Techniques Standardization Committee. 1992. Fish sampling and data analysis techniques used by conservation agencies in the U.S. and Canada. American Fisheries Society, Fisheries Management Section, Fisheries Techniques Standardization Committee, Bethesda, Maryland.