WATER QUALITY PROGRAMS DIVISION

Standard Operating Procedure for the Collection of Fish in Streams

Adopted April 2004

Draft Copy

OKLAHOMA WATER RESOURCES BOARD
WATER QUALITY PROGRAMS DIVISION
3800 NORTH CLASSEN
OKLAHOMA CITY, OK 73118

STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF FISH IN STREAMS [1]
ADOPTED APRIL 2004

1.0 General Information

Fish assemblage monitoring is an integral component of the Oklahoma Water Resources Board (OWRB) Water Quality programs. Assessment of the fish assemblage measures the structure and function of the ichthyofaunal community to evaluate the integrity of a stream. Following is a detailed description of sampling procedures. Efficiency is the key, and finding a comfortable sequence of sampling is essential. This will vary from person to person and from sampling team to sampling team. Yet, employing consistent sampling patterns at every site will maximize the number of sites sampled per day and decrease the chance for introduction of sampling error.

2.0 Definitions/Terms

- Team Leader—crew member of fish collection team who provides support, expertise, and opinions; gives instruction and has final say on how work will be done; must score a 95% on critical fish identification
- Team Member—crew member of fish collection team who provides support, expertise, and opinions; follows the instructions of the team leader
- Formalin—fixative used in fish collections; is a carcinogen and can also cause permanent damage to mucous membranes and eyes.
- Electrofishing—use of an electrical field in the water to stun fish for collection; selective for areas of instream cover as well as larger fish with more surface area
- Seining—wide and deep net dragged through water to collect fish; selective for runs and pools as well as smaller fish with less surface area

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. Please refer to the OWRB safety manual for instructions. During most fish collections a backpack electrofisher or 2.5 GPP pram/boat electrofisher will be used. Because electrofishers send an electrical current through the water, not following safety procedures may result in serious injury or death. General safety guidelines include:

- Primary responsibility for safety while electroshocking rests with the team leader.
- **DO NOT CHASE FISH!!**

[1] Much of this SOP is adopted from two documents: Oklahoma Water Resources Board (1999) Technical Report 99-3: Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development, Oklahoma City, OK.; Oklahoma Conservation Commission (2001), Standard Operating Procedure for Fish Collection in Streams. Oklahoma City, OK.

- All crewmembers should receive training in First Aid and CPR. Electro-fishing units have a high voltage output and may deliver dangerous electrical shock. Electric shock can cause heart fibrillations and/or death.
- While electrofishing, avoid contact with water unless sufficiently insulated against electric shock. Use chest waders with non-slip soles and watertight rubber gloves that cover to the elbow. If they become wet inside, stop fishing until thoroughly dry.
- Avoid contact with anode at all times. At no time while electrofishing should a crewmember reach into the water for any reason.
- The backpack electrofishing equipment provided is equipped with a 45-degree tilt switch, which interrupts the current. Do not make any modifications to the electrofishing unit, which would make it impossible to turn off the electricity.
- The pram/boat electrofishing equipment provided is equipped with an emergency shutoff switch. Do not make any modifications to the electrofishing unit, which would make it impossible to turn off the electricity.
- General safety guidelines should be observed. If waders or gloves develop leaks, leave the water immediately. Avoid operating electrofishing equipment near people, pets or livestock. Discontinue any activity in streams during thunderstorms or heavy rain. Rest if crew becomes fatigued.
- Gasoline is extremely volatile and flammable. Its vapors readily ignite on contact with heat, spark or flame. Never attempt to refill the generator while it is running. Always allow the generator to cool before refilling. Keep gasoline out of direct sunlight to reduce volatilization and vapor release. Always wear gloves and safety glasses when handling gasoline. Keep gasoline only in approved containers.
- Decision to use electrofishing equipment will depend on size of site, flow, conductivity and turbidity. If the specific conductivity is below 10 uS or > 1000μs; if the flow is too high; if the site is too deep; if the water is too turbid to assure safe footing or locate stunned fish, the crew may consider using the seine only or determine that site cannot be sampled. This is a safety decision.
- Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. Proper precautions should be taken when handling formalin.
    - Protective gloves and eyewear should be worn
    - Avoid inhalation of vapors
- FAILURE TO OBSERVE SAFETY PROCEDURES WILL RESULT IN DISCIPLINARY ACTIONS INCLUDING PROBATION AND DISMISSAL.

4.0 Quality of the Measurement

4.1 Training

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and

measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs. Prior to collecting fish, all staff should familiarize themselves with Fisheries Techniques (edited by L.A. Nielsen and D.L. Johnson and published by the American Fisheries Society 1983), this SOP, and OWRB Technical Report 99-3 Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development.

Investigators are tested for identification abilities with a statewide assemblage of fish fauna before fish collections begin. These fish are comprised of species that are typically found in Oklahoma stream systems. The majority of the test specimens include fish with larger body sizes that are typically field identified and/or found in large numbers. Species of special concern such as the Arkansas River Shiner are also utilized during the testing procedure to insure endangered or threatened species may be correctly identified and released. A test score on critical species of 95% or better must be achieved before the investigator will be a field crew leader. Investigators that score under 95% will not collect without direct supervision of the crew leader.

4.2 Kinds of Quality Assurance Samples

4.2.1 Replicate Collections

Replicate samples will be collected during each biological season. The scope and number of replicates will be determined by the project Quality Assurance Project Plan. They may include replicates for various habitat or stream order.

4.2.2 Vouchers and Photodocumentation

The OWRB has adopted a list of critical species (developed by the Oklahoma Conservation Commission) that will be released in the field. This list includes large fish (>100 gms or 0.25 lbs), fish easily identified (e.g., Longnose Gar), and fishes of special concern (e.g., Leopard Darter). However, proper procedures must be taken before fish may be released. Please follow these guidelines:

1. If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely. **The crew leader does have the final say on releases**.
2. All released fish must be documented on the Fish Collection sheet. Included with this documentation should be the common name (species if known) and

characteristics noted to make a positive identification. Fish not recorded, must be brought to the laboratory for identification.

3. All large fish (e.g., smallmouth buffalo) or fish easily mistaken for another (e.g., river carpsucker) must be photographed. Background data in the photo should include the common name of the fish, the date and time (24h), station name or number, and county. Characteristics used to make the identification should be prominently displayed in the photo (e.g., lateral line scales of a redhorse). Photos should be managed digitally in the OWRB network and printed as needed.
4. When feasible, a voucher specimen should be kept of all released species. This may not be possible with large fish such as suckers or gar. Vouchers should also be kept when a juvenile member of the species is released (e.g., largemouth or spotted bass).

5.0 Personnel and Equipment

5.1 Personnel

Fish collection crews will consist of two to three people. In some instances, a fourth crewmember may be added on larger streams where a pram or boat shocker is used. The team will consist of a team leader and one to three team members. The team leader is someone with one or more seasons of collection experience who has scored above a 98% on critical species identification. Collection experience in other programs may be substituted for that with the OWRB. In certain instances, a team leader may have test scores below 98%. In this case, tests will be reviewed and species that were commonly missed in the scoring will be excluded from releasing. The team leader will have the final say on all crew activities. A team member is someone trained on fish sampling protocols. Team members will be expected to participate in the decision-making and follow the team leaders direction.

5.2 Equipment and Supplies

5.2.1 Backpack Electrofisher

A Smith-Root Backpack Electrofisher model 15 with a Honda model EX-350 generator will be used for collecting fish. Always use this equipment in accordance with manufacturer instructions. The team leader will provide a detailed explanation of how the shocker works as well as safety precautions. Each team member before operating and/or assisting with the shocker should read and understand the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer. The shocking team must consist of at least two people—an operator and a netter. **This unit may be extremely dangerous if used inappropriately and without the proper safety equipment. Please refer to Section 2.0 for further details.**

The unit works to develop an electrical field, and everything within that field is subject to electric shock. The shocker consists of a trailing stainless steel cable electrode (cathode) and a ring electrode (anode) mounted on the end of a PVC pole. By

pressing the anode button, the electrical field is created. The backpack electrofisher works effectively in specific conductance ranges from 40-1000 microsiemens (uS) with and optimal range of 150-650 uS.

The shocker selects for habitat and fish differently than does the seine. The electrofisher selects for fish with more surface area (i.e., larger or deep-bodied) such as bass or suckers. Also, the electrofisher is more effective in habitat where seining may be more difficult such as brush piles, root wads, undercut banks, bedrock ledges, cobble substrates, and shallow riffles. To effectively shock, the anode should be gradually passed back and forth over and in these areas as the team works upstream. As fish are stunned, they will usually roll over and become more visible, allowing the netters to see and capture them. Shocking may also be done in deep or shallow pools.

The unit should be maintained according to manufacturer specifications.

5.2.2 Pram or Boat Electrofisher

A pram or boat electrofisher may be used in waters with extremely low conductivity, conductivity greater than the backpack can handle (up to 1700 uS), and in deeper waters. A Smith-Root 2.5 GPP electrofisher with a Honda model 2500 generator will be on the pram or boat. Always use this equipment in accordance with manufacturer instructions. The team leader will provide a detailed explanation of how the shocker works as well as safety precautions. Each team member before operating and/or assisting with the shocker should read and understand the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer. The boat shocking team must consist of at least two people—an operator and a netter. The pram shocking team must consist of at least three people—an operator, a netter, and a pram guide. Because the guide must turn off the unit in case of accident, it is particularly important that this team member stay fully aware. **This unit may be extremely dangerous if used inappropriately and without the proper safety equipment. Please refer to Section 2.0 for further details.**

The unit works much like the backpack electrofisher, but certain distinctions do exist. The anode for the boat shocker is a set of arrays that are lowered into the water, and the anode for the pram is a wand but can be operated up to 100 feet from the shocking unit. The cathode for the both the pram and boat shockers is the either the boat if using an aluminum hull or a series of cathode arrays if using a fiberglass hull. When cathode arrays are used, they are mounted at the midpoint of starboard and port gunnels and the starboard and port corners of the bow.

The unit should be maintained according to manufacturer specifications.

5.2.3 Seine

Various sized seines may be used to collect fish. Recommended sizes vary from 3 to 6 foot seines in 10, 20, and 30-foot lengths. Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. This will allow the center of the net to form a bag behind the operators where the fish are more likely to stay in the net. However, it is important to remember that the longer the seine is, the more difficult it will be to control in stream currents. Therefore, rule of thumb for length may be discarded. When this occurs, extra time should be spent seining the missed habitats. In general, the OWRB uses 10X6 and 20X60. A seine 20X8 may be used in very deep and/or long pools. Seines should be a ¼ inch mesh to reduce fishing pressure on some young of the year.

The seine selects for habitat and fish differently than does the shocker. The seine selects for fish with less surface area (i.e., terete or smaller body plan) such as minnows or darters. Also, the seine is more effective in habitat where electrofishing may be more difficult pools or runs. Seining may also be done along banks and around instream cover. Seining technique is explained in the later methods section.

Seines should be stored dry and free of debris and other snags.

5.2.4 General Supplies

Clothing

Rubber Gloves	as many pairs as the shocking crew consists of
Waders	as many pairs as the shocking crew consists of, although everyone is responsible for their own waders
Goggles	for use in mixing formalin

Documentation

Dry erase board or white paper and clipboard for photodocumentation
Camera with at least 2 rolls of film or adequate digital memory
Tape measure to record lengths of released fish if desired

Chemicals

Gasoline/oil mix for generator
Extra two stroke oil
10% buffered formalin—always premix in lab and keep jugs stored in separate ice chest

Shocker Parts

Spare plug, Plug wrench, and screwdriver
Spare Anode

Nets

Fishing line or dental floss to repair nets
Dip nets to collect shocked fish

Containers

Wide mouth 1-gallon jars, at least 4 per site
Whirlpacs for putting special fish in

6.0 Collection of Fish

The collection of fish follows a modified version of the EPA Rapid Bioassessment Protocol V (EPA, 1989) supplemented by other documents. Specific techniques for, and relative advantages of seining and electrofishing vary considerably according to stream type and conductivity. The specifics are discussed in detail in Fisheries Techniques (edited by L.A. Nielsen and D.L. Johnson and published by the American Fisheries Society 1983).

The collection of fish involves the use of two collection methods, seining and electrofishing. The combination of methods was selected in order to produce a representative fish collection. Variations of habitat, type of fish, and water chemistry dictate the use of different collection techniques. Electrofishing selects for denser habitat (e.g., undercut banks, root wads, etc.) and very shallow riffles while seining selects for more open habitat such as runs or pools. Electrofishing selects for more surface area (e.g., larger or deep-bodied fish) while seining selects for smaller fish such as minnows darters. Backpack electrofishers are not effective in waters with specific conductance <40uS and >1000uS. The 2.5 GPP electrofisher is not effective in waters with specific conductance over 1700 uS.

Sequence when using both methods is determined by site characteristics. In general, seining should conducted before shocking since fish that utilize cover in the stream will generally not leave the area when disturbed. These fish are most efficiently collected by shocking and should remain when electroshocking commences. However, in very silty waters or waters with low flow and many suspended solids, electrofishing is done first. Stirring up waters while seining may decrease catch efficiency during electrofishing. Also, on extremely hot days, electrofishing early in the day may alleviate some safety concerns.

In general, each stream is sampled for a distance of 400 meters. A representative stream reach is selected and measured such that primary physical features are included in the reach (riffles, runs, and pools). Very small streams may be sampled at 200 meters if all representative habitats are represented in that reach. Larger rivers with long pools or runs and braided rivers may be sampled for up to 800 meters. Again, ensure that all representative habitats are represented in that reach. The reach should be located away from the influences of major tributaries and bridge/road crossings. Record reach length on the Field Notes.

In general, all fish are placed in 10% formalin immediately after capture. However, if larger fish (> 100 g) can be positively identified in the field, they are returned to the water in a location where recapture is unlikely. All large fish released are photographed

on print film. A representative photograph or voucher specimen may be taken when large numbers of one fish species is collected and released. In all instances when fish are released, they should be recorded and the characteristics used to make the identification should be noted. Collected organisms are identified to species by an experienced taxonomist.

6.1 Seining

Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible, the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. The amount of obstructions in the stream will often preclude the use of longer seines however. When this situation occurs, the crew leader will decide on the most effective combination of seines. The OWRB uses 6 foot seines in 10 and 20 foot lengths on a regular basis. Deeper or wider seines are available to accommodate special cases.

To seine, two people drag the net through the water at a certain rate. This will allow the center of the net to form a bag behind the operators allowing the fish room to move within the net. Generally, the seine is hauled with the current because fish tend to orient towards the current. The leadline should be kept on the bottom, and in front of the float line. If there are many obstructions on the bottom, the leadline will become caught or bounce, and most fish will escape underneath the bottom of the net. If this happens use a smaller net that allows you to avoid obstructions, roll up the ends of the existing net to make it more manageable, use a trailer to move net over obstruction, or go to electroshocking. The brailles of the net should be used to disturb the area under any undercut banks, bedrock ledges, or beds of macrophytes near the edge in order to scare fish hiding in cover out towards the middle of the net.

Under ideal conditions the net should be pulled through the water in the manner described above for about 10 meters and dragged out of the water on a gradually sloping preselected beach. The person pulling the seine on the side of the stream opposite the beach should swing ahead of the other person so that the seine is pulled out on the beach stretched over the same distance it was stretched in the stream.

If the stream doesn't have gradually sloping banks, the dip method should be used. This method consists of sweeping around and through the area to be sampled, keeping a wide bag and moving the lead line as much under the undercut bank as possible. Use the brailles to probe repeatedly as far as possible into the undercut area working towards each other until the brailles overlap. The seine should then be swiftly stretched and lifted vertically from the water.

Other seining methods may be effective. All will not be discussed here, but may be demonstrated in the field. In certain instances moving with the current may not be possible. In these cases to keep from loosing fish, the bag should be deepened and the total reach seined should be shortened. Also, it is often not possible to reach a seine the width of a run while keeping an adequate bag. In these cases, seine perpendicular

to the flow of the water towards the opposite shore. The downstream person should operate slightly ahead of upstream person forming a “J”.

RECORD THE TIME SPENT SEINING AND SEINE MESH SIZE ON THE FIELD DATA SHEETS.

6.2 Electrofishing

Before operating or assisting with the shocker, READ AND UNDERSTAND THE MANUALS for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not spelled out in this text. The manuals can be obtained from the equipment file in the main office.

The shocker consists of a trailing stainless steel cable electrode and either a ring or diamond electrode mounted on the end of a fiberglass pole. Under most conditions, both the ring and diamond electrodes can be used at the same time. In waters of extremely low conductivity (<40 uS), the ring should be used. In waters of high conductivity (>500 uS), the diamond should be used. In very deep water where the ring seems to be ineffective the diamond electrode may offer better results.

The shocker is most useful where a seine cannot be used effectively in areas such as with dense instream cover, undercut banks, or riffles. In waters of high conductivity (>1000 µS/cm) backpack electroshocking is ineffective, due to the highly conductive nature of the water. Under these conditions, only seining is conducted.
In general, the following procedure should be followed:

- A minimum of two people is required for electrofishing. One carries and operates the shocker while the other(s) net stunned fish. With the pram shocker one person should act as the pram guide. This guide should stay fully aware so that the unit may be shut off in emergencies.
- Collection begins at a shallow riffle or other physical barrier at the downstream limit of the reach, and terminates at a similar barrier at the upstream end of the reach. In the absence of physical barriers, block nets may be set at the upstream and downstream ends of the reach prior to sampling.
- In general, fish collection procedures commence at the downstream barrier and proceeds in an upstream direction. Electrofishing is most effective when the team works upstream. Catch efficiency will decrease in turbid waters or waters with changing conductivity due to upturned mud, silt or sand. However, this is up to the discretion of the Crew Leader.
- The forward electrode should be gradually passed back and forth over the stream width, including brush piles and root wads. As fish are stunned, they will usually roll over and become more visible, allowing the netter(s) to see and capture them.
- In very dense brush or root cover, fish often sense the presence of the team before they are close enough to be stunned and then retreat so deeply into cover that it is impossible to net them when they are stunned. It is often

better in situations such as these to insert the electrode into the brush before it is turned on, give the fish a minute or so to get used to the new situation and then turn the current on. Many fish will be much closer to the edge of brush pile when they are stunned in this manner.

RECORD THE TIME SPENT ELECTROFISHING ON THE FIELD DATA SHEETS.

6.3 Sample Handling & Preservation

CAUTION: Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. The fish should be put into the jar with the lid tilted open away from the operator so that the lid shields the face and body of the operator. Flood any skin exposed to formalin with plenty of water as soon as possible. If it gets in your eyes, flood the eyes with water immediately and go to the doctor immediately after that.

The following steps should be taken to handle and preserve fish:

- Fish collected by seining and electroshocking should be kept in separate jars and labeled with capture method. This will make the methods independent if desired for analysis.
- Label each jar. Using a pencil, write the date, WBID #, collection time, stream name, number of jars composing one sample, county, legal location, and crew leader's name on a piece of ~2 x 3 inch waterproof paper and place one label into every jar of fish from each site. Write the same information on the front of each jar using a wax pencil or an indelible marking pen.
- In general all fish should be placed in 10% formalin immediately after capture. There are a few exceptions made for larger fish (>100 gms or 0.25 lbs), which can be positively identified in the field.
- If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely.
- All released fish must be documented on the Fish Collection sheet. Included with this documentation should be the common name (species if known) and characteristics noted to make a positive identification. Fish not recorded, must be brought to the laboratory for identification.
- All large fish (e.g., smallmouth buffalo) or fish easily mistaken for another (e.g., river carpsucker) must be photographed. Background data in the photo should include the common name of the fish, the date and time (24h), station name or number, and county. Characteristics used to make the identification should be prominently displayed in the photo (e.g., later line scales of a redhorse). Photos should be managed digitally in the OWRB network and printed as needed.

- When feasible, a voucher specimen should be kept of all released species. This may not be possible with large fish such as suckers or gar. Vouchers should also be kept when a juvenile member of the species is released (e.g., largemouth or spotted bass).
- When preserving fish much larger than 0.3 to 5 kg (0.5 to 10 lbs), the fish should be sliced open along the lower rib in order to allow the formalin to penetrate the body cavity fast enough to prevent decay. A slit through the ribs is preferred to a belly slit to facilitate counting belly scales in the lab.
- Fill out a Chain of Custody Form.
- The Crew Leader is responsible for transferring the samples to the Fish Sample Taxonomist (currently the OU Museum of Natural History).

7.0 Forms

7.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\.

7.2 Laboratory Log-in Sheets

Log-in sheets are documents turned into the analytical laboratory for each sample collected. These forms are used to denote the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time of sample collection and be legible and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper procedure to complete the log-in sheets, refer to your supervisor and or FTE. Log-in sheets can be found at S:\Monitoring\STREAMS\forms\.

7.3 Chains of Custody

Chains of custody are documents turned into the analytical laboratory for each group of samples collected. These forms are used for several purposes. They act as a legal document to show proper delivery of samples occurred and they make a general list of the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time for each sample collected and be legible and complete. They should also be signed and dated by field and laboratory receiving personnel at the time of delivery. To avoid confusion and loss of data, a new chain of custody should be used for each group of samples. For guidance on proper procedure to complete the chains of custody, refer to your supervisor and or FTE. Chains of custody can be found at S:\Monitoring\STREAMS\forms\.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets

should be either entered into or uploaded to the Water Quality Biological Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

EPA, (1999) Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd Edition, EPA 841-B-99-002, Office of Water, Washington, D.C.

Oklahoma Water Resources Board (1999) Technical Report 99-3: Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development, Oklahoma City, OK.

Oklahoma Conservation Commission, Water Quality Division, (2000) Standard Operating Procedures for Fish Collection in Streams, Oklahoma City, OK.

Nielsen, L.A. and D.L. Johnson, (1983) Fisheries Techniques, American Fisheries Society.