Procedure No.	WQPA-SWS-3	Date Issue	9-30-89
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Subsection 4. Fish

Part A) Training

1) *Sampling Methods*

All new full-time field personnel in the Fish Evaluation Group receive in-house training in the following procedures prior to the start of the field season. A senior staff member also accompanies the new field crew leader for at least the first two weeks of the field sampling season (and thereafter if necessary) instructing in all aspects of the field sampling. Individuals are then permitted to proceed on their own with periodic conferences with the Fish Evaluation Group supervisor to assure the sampling effort is being conducted in accordance with the procedures described herein.

New part-time summer field personnel receive copies of the fish section of the Quality Assurance Manual (Subsection 4) and are given pre-field season training on the procedures involved in the fish sampling program for a one week period prior to the field season.

2) Species Identification

All new field personnel, summer or full-time, are given a test consisting of a collection of different Ohio fish species to identify and count to determine their familiarity with Ohio fish taxonomy and their ability to accurately count large numbers of fish. Full-time field crew leaders perform or supervise *all* of the actual field identifications and counts with the summer personnel assisting.

Part B) Field Methods

1) *Sampling Site Selection*

The selection of fish sampling sites is based upon several factors including, but not limited to, the following:

1) location of point source dischargers;
2) stream use designation evaluation issues;

3) location of physical habitat features (e.g. dams, changes in geology, changes in stream order, presence of a stream confluence, etc.);
4) location of nonpoint sources of pollution; and,
5) variations in macrohabitat.
6) proximity to ecoregion boundaries.

Each study area has a set number of biological sampling sites allocated based on the number and complexity of the priority issues requiring field evaluation. Optimum placement of sampling sites is determined recognizing practical access and resource constraints. The principal objectives of each survey determine where sampling sites will be located. Generally, sites are located upstream from all pollution sources to determine the background condition for the study area. Should the upstream portion of the stream be impacted, an alternate site may be chosen on an adjacent stream with similar watershed characteristics. Reference sites within the same ecoregion may also be used in this role (these are listed in Ohio EPA 1987). The role of upstream sites is not necessarily to provide a biological performance level against which downstream sites are compared since the ecoregion biocriteria fill this niche for the respective aquatic life use designations. Upstream sites are, however, important in defining any site or watershed specific background conditions that might temporarily or permanently influence eventual aquatic life use attainment in the downstream reaches. Selection of sampling sites within a segment is accomplished by selecting the most *typical* habitat available in an effort to represent the current potential of that segment. An attempt should be made to sample typically similar macrohabitats at all sampling sites established within the study area.

To address point source discharge concerns, at least one site is situated upstream from the primary process wastewater outfall(s), one within the mixing zone, and sites located at intervals downstream from the mixing zone (i.e. dependent on stream size and mixing characteristics) to determine the near and far field impacts, the longitudinal extent and severity of any impact, and to determine if and where recovery occurs. Spacing of the downstream sampling sites is based on physical macrohabitat characteristics, access to the segment, other adjacent point and nonpoint sources, stream size, and other factors. An attempt is made to place sampling sites between point sources where sufficient distance between each exists. Sampling sites may also be situated in the mouths of major tributaries to determine any potential effects on the mainstem. Localized areas of macrohabitat modification such as instream impoundments or channelized sections alter macrohabitat available for fish and can affect community structure and function. Generally, these areas are not *typical* of the macrohabitat in a free-flowing river or stream. However, these areas are often times impacted by the principal sources targeted for evaluation in certain study areas (particularly in urban areas), therefore, sampling sites are located within these modified areas as needed. These areas should be sampled in order to understand the underlying influence that they exert on biological performance and eventual aquatic life use attainment.

2) Fish Sampling Procedures

a) Introduction

The principal method used by Ohio EPA to obtain fish relative abundance and distribution data is pulsed direct current electrofishing. As with any single method there exists inherent sampling selectivity and sampling bias. Pulsed D.C. electrofishing is, however, widely viewed as the single most effective method for sampling fish communities in lotic habitats. Twelve different fish sampling techniques have been assigned sampler type codes. Six codes are currently recognized as valid for generating fish relative abundance data for the purpose of calculating Index of Biotic Integrity (IBI) and Modified Index of Well-

Being (Iwb) scores from which aquatic life use attainment is partially judged (Table V-4-1). The remaining codes are assigned to seldom used or currently experimental methods. This system of letter codes superceded a system of numerical codes used prior to 1984. The use of any one of these sampling methods is dependent on the type of information required and the type of aquatic habitat being sampled. Since 1979 certain methods have been modified or abandoned (e.g. seining). The boat mounted and wading electrofishing methods are the most commonly used fish sampling techniques by Ohio EPA in lotic habitats. The boat electrofishing methods (sampler type A) are used to sample the largest streams and rivers (Table V-4-1). Wading methods (sampler types D, E, and F) are used in wadable streams. These are the most frequently used sampler types and are regarded as suitable for calculating IBI and modified Iwb scores (Ohio EPA 1987). Sampler type B (18' boat, circular electrode array) is used in the deeper rivers (e.g. Ohio River) and embayments (e.g. Lake Erie tributary river mouths). This is also considered to be an acceptable method. Sampler type C is used in free-flowing rivers to sample riffle habitats. This method is used only to supplement the boat methods and the data is not used to calculate the IBI or modified Iwb. Sampler types G and H are seining methods and are no longer in routine use. The fyke net and hoop net methods (types I and J) may be necessary in lentic, wetland, or large river habitats. The experimental gill net method (type K) may be necessary to sample for mid-channel and pelagic species. These *passive* methods (types I through K) are seldom used and only in special situations to supplement routine electrofishing sampling.

Fish sampling is preferably conducted between mid-June and early October, when stream and river flows are generally low, pollution stresses are potentially the greatest, and the fish community is most stable and sedentary. Sampling may be conducted outside of this time period, but the results may not be applicable for Ohio EPA biocriteria purposes. The use and applicability of this data will be evaluated on a case-by-case basis. Special studies are conducted by the Fish Evaluation Group on a periodic basis to determine the effectiveness of each sampling method, comparability of methods, necessary sampling frequency, evaluate new and emerging techniques, and to better understand gear selectivity and effectiveness.

Table V-4-1. Designation of sampler types and description of fish sampling methods used by Ohio EPA (revised June 1, 1984).

Sampling Method Description	Sampler Type	Relative Abundance Based On	Data Collected #	Data Collected Wt[a]
Boat-mounted electro-fishing - *straight electrode array*	A	Per 1.0 km	X	X
Boat-mounted electro-fishing - *circular electrode array*	B	Per 1.0 km	X	X
Boat longline - riffle method)[b]	C	Per 0.3 km	X	X
Sportyak-generator unit	D	Per 0.3 km	X	X
Longline generator unit	E	Per 0.3 km	X	X
Back-pack electro-fishing - battery unit	F	Per 0.3 km	X	X
Backpack electrofishing-seine combination[c]	G	Per 0.3 km	X	
Seines[d]	H	Per 0.3 km	X	
Fyke net[d]	I	Per 24 hours	X	X
Hoop net[d]	J	Per 24 hours	X	X
Gill net[d]	K	Per 24 hours	X	X
Boat-mounted electro-fishing - *straight electrode array* NIGHT	N	Per 1.0 km	X	X
Boat mounted electro-fishing - *circular electrode array* NIGHT	M	Per 1.0 km	X	X
Reserved	L-Z[e]			

[a]Weight data is taken if modified Iwb is needed.

[b]Experimental method in conjunction with sampler type A.

[c]Discontinued method .

[d]Method is not suitable for calculating IBI or modified Iwb scores.

[e]These codes are available for methods developed in the future.

b) Pulsed D.C. Electrofishing Methods and Equipment:

Selection of the Appropriate Sampler Type

Selection of the appropriate sampler type is dependent upon the type of data needed, the type of macrohabitat being sampled, and the size and *depth* of the water body being sampled. This is a critical part of the sampling process since data quality essentially determines data applicability for the purposes of evaluating attainment of aquatic life uses. Thus it is important that the appropriate sampler type be used.

Boat electrofishing methods (sampler type A) are used in moderate to large sized streams and rivers where the use of wading methods are both impractical and less efficient. These include streams and rivers that have pools deep enough to accommodate the 12', 14', or 16' boats and equipment. Sites sampled with the boat methods are referred to as *boat sites*. The usual drainage area range of boat sites is 150 to more than 6000 sq. mi. although the 12' boat method has been used for sites as small as 75 sq. mi. where pool depths exceed 1.5 - 2.0 m and greater. This situation is the most frequently encountered in the Western Allegheny Plateau ecoregion (southeastern Ohio). The 12' electrofishing boat is the smallest of the boat-mounted devices and is used in moderate sized streams that generally cannot be navigated by the larger boats, usually 150 - 400 sq. mi. drainage area. The 14' and 16' electrofishing boats are used in larger rivers where near continuous navigation is possible (usually greater than 400 - 500 sq. mi.). The 18' boat electrofishing method is designed for use in the largest and deepest rivers, impoundments, and embayments. This boat employs either a straight (sampler type A) or circular (sampler type B) electrode array. Night electrofishing may be appropriate for the largest rivers (e.g., Ohio River, impounded sections of the Muskingum R.) where the drainage area exceeds 6000 - 7000 sq. mi. Depending on the electrode array used this method is termed sampler type N (straight array) or sampler type M (circular array).

Wading methods are used in smaller, wadable streams that cannot accommodate the boat methods due to the physical limitations of the stream channel. These are referred to as *wading sites* and range from the smallest headwater areas (<20 sq. mi. drainage area) to sites of 400 - 500 sq. mi. The Sportyak-generator method (sampler type D) is used in streams that range in size from 5-20 m in width and 0.5 - 1.0m in depth (average). There is a great deal of overlap in terms of drainage area between the sites where either the wading or boat sampler types may be most appropriate. The key factors in making the choice between these two methods is pool width and depth *and* access for the sampling equipment. The longline-generator method (sampler type E) is used in areas where the pools are separated by shallow riffles which make the use of the Sportyak method impractical. Both methods will sample the same site with equal efficiency. The backpack electrofishing method (sampler type F) is used in very shallow, small headwaters streams where the longline method is not necessary to secure an adequate sample. Streams that are more than five times the width of the anode net ring and more than twice the depth of the same should not be sampled with the backpack method (sampler type F). The seining methods (sampler types G and H) were used in the past, but have been discontinued by Ohio EPA. These sampler types are retained only to accommodate data generated by non-Ohio EPA entities and to make possible the use of historical data. Results generated by these latter methods (sampler types G and H) may not be suitable for determining aquatic life use attainment using the IBI and modified Iwb.

Selection of any of the previously described methods is based on the best professional judgement of the field crew leader and information gathered in a pre-survey

reconnaissance of the stream. Reconnaissance should take place during low-flow conditions if at all possible. Drainage area, stream length, and stream order are good physical indicators which aid in the selection of the appropriate sampling gear. Information to be collected during the reconnaissance includes the general width and depth of the stream, presence of riffles, dams, log jams and other impediments to navigation, access sites, and location of pollution sources and tributaries. All of these factors are used in choosing the appropriate sampler type(s).

General Cautions Concerning Field Conditions

Electrofishing should be conducted *only* during "normal" water flow and clarity conditions. What constitutes "normal" can vary from stream to stream. Generally "normal" water conditions in Ohio occur during *below* annual average river discharge levels. Under these conditions the surface of the water generally will have a "placid" appearance. Abnormally turbid conditions are to be avoided as are elevated flow and current. All of these adversely affect sampling efficiency and may rule out data applicability for calculating the modified Iwb and IBI. Since the ability of the netter to see stunned fish is critical, sampling should take place only during periods of "normal" water clarity and flow. Most Ohio surface waters have some background turbidity due to planktonic algae and suspended sediment and very few, if any, are entirely clear. Rainfall and subsequent runoff can cause increased turbidity due to the increased presence of suspended sediment (clays and silt). In most areas this imparts a light to medium brown coloration in the water. Floating debris such as sticks and other trash are usually obvious on the surface. Visibility under such conditions is seldom more than a few inches. Such conditions should be avoided and sampling should be delayed until the water returns to its "normal" clarity. High flow should be avoided for the obvious safety reasons, but this also reduces sampling efficiency. The boat methods are particularly affected as it becomes more difficult for the driver to maneuver the boat into areas of cover and current heterogeneity. These cautions apply to all of the electrofishing methods.

Boat Electrofishing Methods and Equipment

The boat methods (sampler types A and B) include the use of 12', 14', 16', and 18' john boats rigged for electrofishing. Equipment type, electrode design, and sampling methods follow the rationale and procedures outlined in Gammon (1973, 1976) and Novotny and Priegel (1974). Figure V-4-1 provides a diagrammatic description of the boat apparatus. A Smith-Root Type VI-A[1] or 3.5 GPP electrofishing unit[2] is used in the 12', 14', 16' and 18' boats. The Type VI-A unit rectifies 60HZ 240VAC (which is supplied by a 3500 or 4500 watt gasoline powered alternator) to pulsed DC. The pulse configuration consists of a triangular wave that can be adjusted to 60 or 120 pulses/second. Six voltage settings from 166 to 996 VDC in 166 volt increments are available. The voltage setting used in a particular situation is determined on a trial and error basis by increasing the voltage setting until a pulse width of 4-5 milliseconds produces an amperage reading of 8 amperes. In Ohio waters during June through October, relative conductivity values normally range from 300-600 umhos/cm. This generally results in a voltage selection of 336, 504, or 672 VDC. Conductivity values below this range may require higher voltage settings, whereas higher conductivity values may require lower voltage settings. The Smith-Root Model 3.5 GPP gas powered alternator and pulsator also delivers pulsed DC current. The pulse configuration consists of a fast rise, slow decay pulse which can be interrupted into 30, 60 or 120 pulses/second. The voltage range is continuously variable between 0-1000 volts and is adjusted by a percent-of-range rheostat to maintain the output amperage between 4 and 11 amps.

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[1] Use of product or company name does not signify endorsement.

[2] Smith-Root, Inc. 14014 N.E. Salmon Creek Ave., Vancouver, Washington 98665.

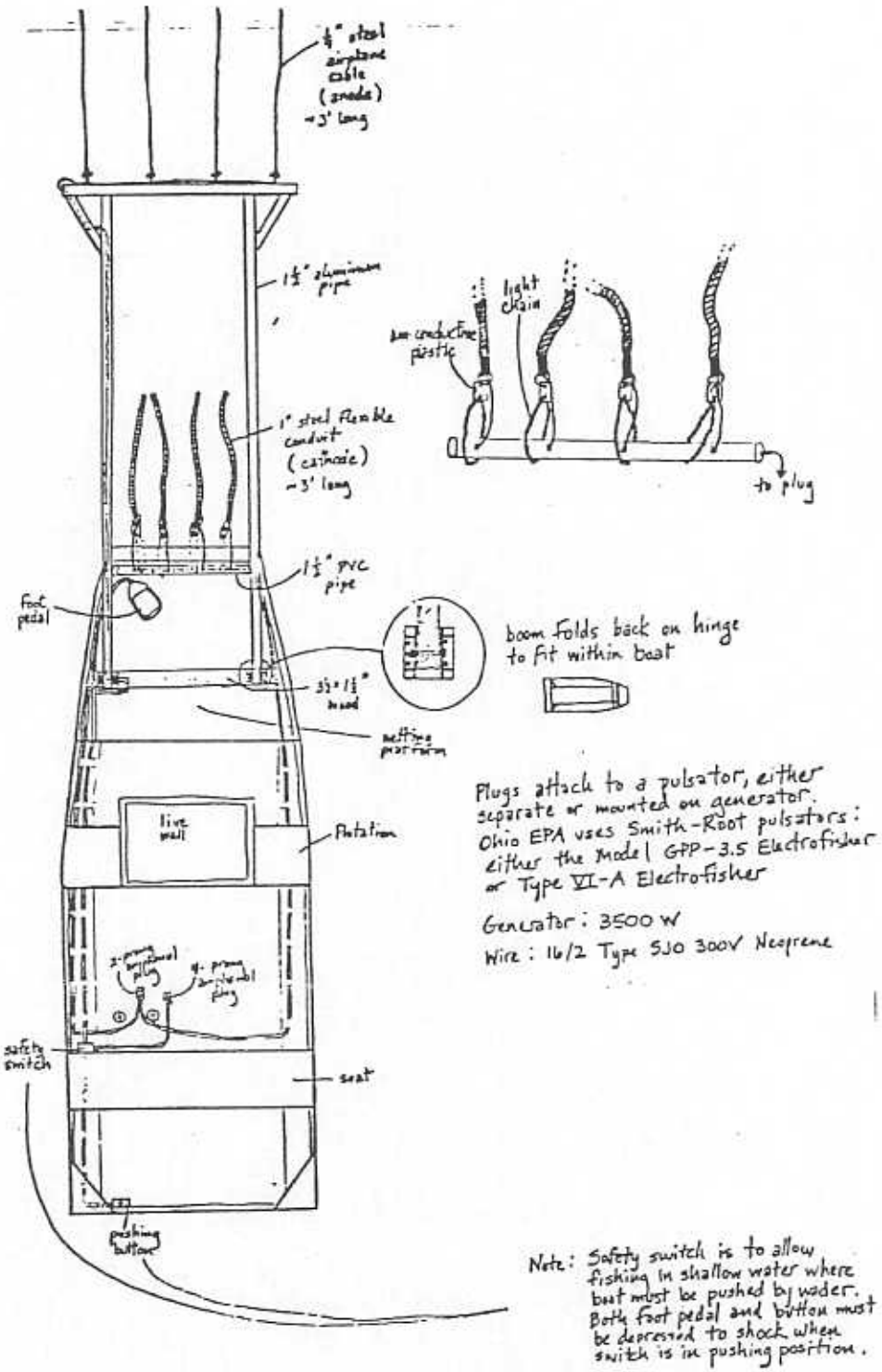


Figure V-4-1. Diagram of the boat electrofishing apparatus used by Ohio EPA to sample large river and stream fish communities.

The optimum range is selected on a trial and error basis by increasing the range until the indicator light flickers. Other comparable pulsed D.C. electrofishing units are acceptable for use as long as their performance is comparable to the aforementioned designs.

Pulsed DC current is transmitted through the water by an arrangement of anodes and cathodes suspended in the water from the boat. On the 12', 14' and 16' boats, four 32" long 1/4" diameter stainless steel aircraft cable anodes are hung from a retractable aluminum boom which extends in front of the boat. Boom length varies according to boat size and is approximately 3.05m on the 18' boat, 2.75m on the 16' boat, 2.15m on the 14' boat, and 2.0m on the 12' boat. Boom width varies from approximately 1.55 to 1.65m being wider on the larger boats. Four anodes are positioned on the front of the boom in a line perpendicular to the length of the boat. Four 64" lengths of 1" O.D. flexible galvanized steel conduit serve as cathodes, and are suspended directly from the bow in a line perpendicular to the length of the boat. The width of this array ranges from 0.75m on the 12' boat to 0.90m on the larger boats. Anodes and cathodes are replaced when damaged or worn. Safety equipment includes a positive pressure cut-off foot-pedal switch located on the bow deck and an emergency toggle cut-off switch adjacent to the stern seat. There is a magnetic-hydraulic circuit breaker on the Type VI-A electrofishing units.

For night electrofishing the equipment includes four 75 watt floodlamps attached to a guardrail which is mounted on the bow. These floodlamps are powered by 120 VAC produced by a separate gasoline powered generator.

A boat sampling crew consists of a *netter* and a *driver*. It is the netter's primary responsibility to capture all fish sighted; the driver's responsibility is to maneuver the boat as effectively as possible giving the netter the *best* opportunity to capture stunned fish (the driver may assist in netting stunned fish that appear at the rear or behind the boat). Both tasks are skill dependent with the boat maneuvering task requiring the most experience to gain adequate proficiency. Each sampling zone is fished in a downstream direction by slowly and steadily maneuvering the electrofishing boat as close to shore and submerged objects as possible by rowing or motoring. This may require *frequent* turning, backing, shifting (forward, reverse), changing speed, etc. in areas of moderate to extensive cover. The electrofishing boat is pushed on the transom by the driver when the water is too shallow to motor or row. A hand actuated positive pressure cut-off switch located on the inside of the transom is used during this procedure in addition to the bow foot-pedal switch. Both the netter and driver are clad in chest waders and rubber gloves. The netter also wears a jacket type personal flotation device. Safety equipment includes a positive pressure cut-off switch located on the bow deck and inside the transom.

Boat Sampling Site Selection

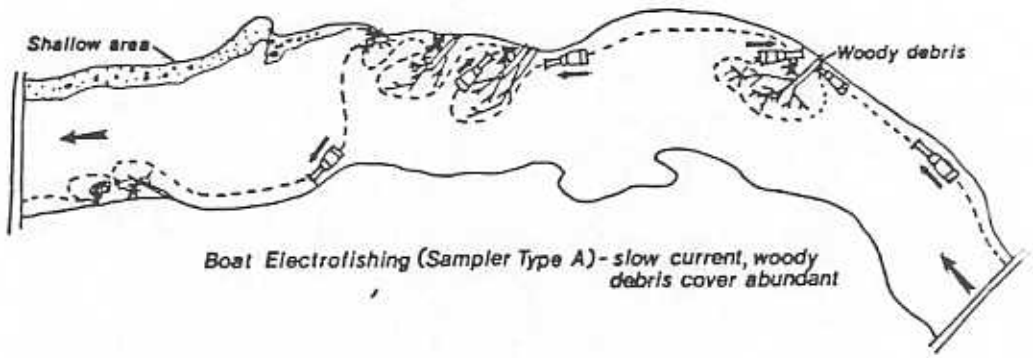
Sampling sites are selected along the shoreline with the most diverse macrohabitat features. This is generally along the gradual outside bends of the larger rivers but is not invariable. In free-flowing habitats part of each zone should include a run-type of habitat *if at all practical*. This of course is determined by the availability of such areas. Boat electrofishing zones generally measure 0.5 kilometers (km) in length, although shorter distances may be necessary in given instances. Distance is measured with a Topometric Products Limited (R) Hip Chain (preferred method) or a Ranging 620 optical rangefinder. Sampling sites are measured by securing the hip chain thread to a stationary object and then wading or motoring the length of the sampling zone. The length of the zone is then measured by the hip-chain counter. When using the optical rangefinder each zone is measured in increments approximating 50 m and accumulated to a distance of 0.5

km. This method is used only with boat methods where the use of the hip chain is impractical. Sampling site locations are verified on 7 1/2 minute USGS topographical maps. Hip chains and rangefinders are calibrated prior to being used in the field on a marked course and adjusted as necessary. The calibration results are recorded in a log book. Water depth in centimeters (cm) is determined to the nearest 10 cm at a minimum of ten locations in each zone with a marked dip net. The average depth is then recorded on the fish data sheet. The boundaries of each electrofishing zone are clearly marked on stationary objects (e.g. trees, bridge piers, etc.) with fluorescent orange paint. The starting point is marked with an arrow pointing in a downstream direction and the ending point is marked with a visible capital "E". This enables accurate relocation of the site on subsequent sampling dates. If the sampling zone is disjunct additional marks are necessary. If the zone stops and then resumes on the same bank then X marks where sampling stops and an arrow indicates where sampling resumes. If the zone switches banks then an arrow pointing skyward indicates the point to switch banks and an arrow pointing down on the opposite shore indicates where the zone resumes. The location of each sampling zone is indexed by river mile (using the river mile index contained in the Ohio EPA PEMSO RMI system) and marked on 7 1/2 minute USGS topographical maps for permanent reference.

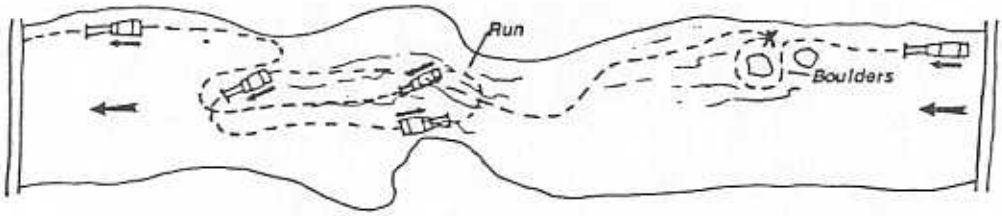
Boat Electrofishing Techniques

Each boat sampling zone is electrofished two or three times during the sampling season starting (whenever possible) at the farthest upstream zone and sampling sequentially downstream until one pass is completed. The remaining one or two sequential passes occur later in the sampling season. Sampling passes should take place at least three to four weeks apart for a three pass effort. If only two passes are planned, five to six weeks should elapse between individual sampling passes. Individual sampling zones are electrofished from upstream to downstream by slowly and steadily maneuvering the electrofishing boat as close to the shore and submerged objects as possible. It is absolutely critical to sample *carefully*, particularly at difficult sites where there is extensive woody debris *or* moderately fast to swift current. Figure V-4-2 provides a diagrammatic portrayal of how two different boat electrofishing zones should be sampled. In zones with extensive woody debris and slow current it is necessary to maneuver the boat in and out of the "pockets" of habitat formed by the debris. If the water depth approaches 100-200 cm it is usually necessary to "wait" for the fish to appear. In moderately fast or swift current it is necessary to conduct fast turns and maneuvers in order to put the netter in a good position to capture stunned fish. The efficiency is enhanced if the electrofishing boat and electric field can be kept moving downstream at a pace just slightly greater than the current velocity. Fish are usually oriented into the current and must either swim into the approaching electrical field or turn sideways to escape downstream. This latter movement presents an increased voltage gradient making the fish more susceptible to the electric current. It is often necessary to pass over the fast water sections of these zones twice. Also, portions of zones with continuous fast current can be effectively sampled by "backing" the boat downstream and occasionally pausing to allow the netter to capture stunned fish. The driver may need to assist with netting when large numbers of fish are stunned. Attempting to electrofish such fast water areas in an upstream direction *only* will greatly diminish sampling efficiency.

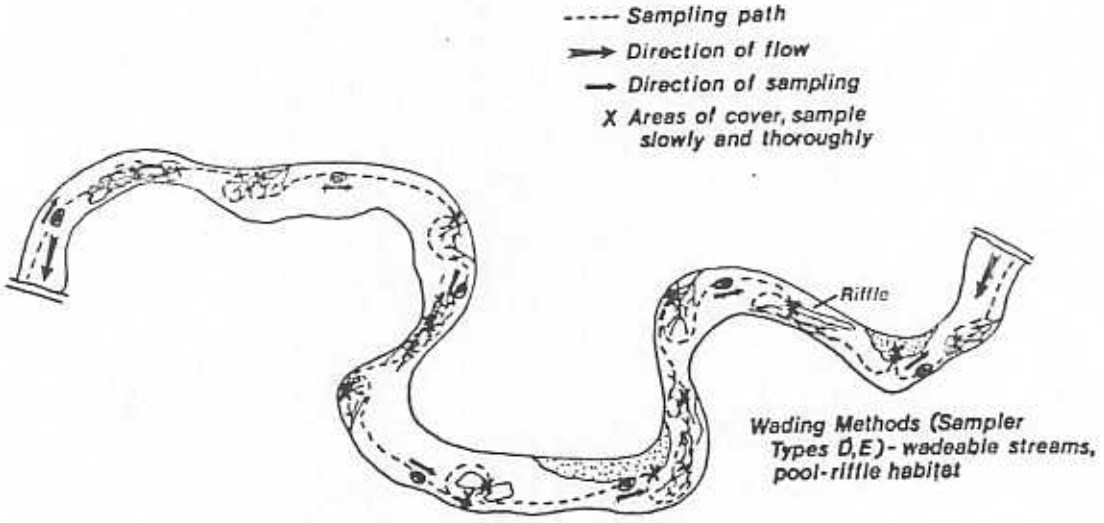
Although sampling is done according to zone length, the amount of time spent electrofishing each zone is an equally important consideration. Time fished can legitimately vary depending on the current, number of fish being collected, and amount and type of cover within a zone. However, there is a general *minimum* amount of time that should be spent sampling each boat zone.



Boat Electrofishing (Sampler Type A) - slow current, woody debris cover abundant



Boat Electrofishing (Sampler Type A) - moderate to fast current, swift runs, boulders



Wading Methods (Sampler Types D,E) - wadeable streams, pool-riffle habitat

Figure V-4-2. Diagramatic portrayal of proper boat electrofishing technique at two different river sampling locations and wading methods technique in a typical pool-run-riffle stream habitat.