SECTION 3: FIELD METHODS AND DATA ANALYSIS REQUIREMENTS

General Guidelines

The purpose of this section is to describe the field methods and data analysis techniques that are required to use the biological criteria for the purposes of the Ohio Water Quality Standards (WQS). Standardized methods and data analysis techniques are a critical requirement and ensure the comparability of results from site to site. Some basic problems in sampling aquatic biota and using biological data that can affect the applicability and accuracy of the results are summarized, as follows:

1) The purpose for which data were collected is especially important when the use of "existing" data is being contemplated. Biological samples that were collected for the purposes of determining the presence/absence of species and/or taxa only will have little value for the purposes of the biological criteria. This is especially true if relative abundance data (which in itself implies standardization of sampling effort) is lacking.

2) "Partial" collections will not suffice because the Index of Biotic Integrity (IBI), Modified Index of Well-Being (I_{wb}), and the Invertebrate Community Index (ICI) require as complete a breakdown of the community as is possible with the methods used. Specific requirements are discussed later.

3) Sampling gear and water conditions affect sampling effectiveness and ultimately data analysis and interpretation. Specific fish and macroinvertebrate sampling gear are required for conformance to the Ohio WQS. Appropriate data collection conditions are also important.

4) Appropriate taxonomic refinement is important, particularly for macroinvertebrates, as "lumping" of species and taxa into larger groups makes the data unusable for the purposes of the biological indices.

5) Sampling sites must be representative of the surface water being sampled. For example, localized areas of impoundment, "bridge effect" areas, etc. should be avoided if the stream or river is predominantly free-flowing.

Persons using the biological criteria approach should be aware of these basic problems and take steps to ensure that study design, sampling methods, and data analysis conform to the procedures outlined by or refered to in this manual. Finally, the methods and techniques described here require the involvement of a trained biologist who is familiar with the field methods, laboratory techniques, data analyses, and the local fauna.

Fish Sampling Methods Summary

The fish sampling methods routinely used by Ohio EPA are summarized in Table 3-1. Detailed descriptions of these and other fish sampling gear and methods are available in Ohio EPA (1987a). The wading methods (sampler types D, E, and F) were developed by Ohio EPA. Boat methods (sampler type A) are based primarily on the work of Gammon (1973, 1976) on the Wabash River (Indiana) and the experience of the Ohio EPA. Unlike other biological monitoring disciplines, surprisingly little standardized guidance is available from state or federal agencies regarding appropriate methods. Therefore, Ohio EPA has used what can be considered a state-of-the-art approach in the development of standardized, systematic methods for sampling fish in rivers and streams. The requirements for all aspects (sampling frequency and duration, relative effort, etc.) of the fish sampling program are based on eight years of practical application in Ohio. On-going Ohio EPA monitoring programs have been designed to address fish sampling methods, gear selectivity, and sampling design.

It is apparent from the literature (e.g. Vincent 1971; Gammon 1973, 1976; Novotny and Priegel 1974) and our own experience that pulsed DC electrofishing is the most comprehensive and effective single method for collecting river and stream fishes that is currently available. Certainly a survey that employs a number of different gear types will likely yield more species than any one single method. Such surveys, however, are more costly and time consuming and do not generate equivalent information per unit of effort. Gammon (1976) emphasized this point when it was observed that one day of electrofishing was equal to 20-25 hoop-net days and included a much broader representation of the fish community. We have opted to use a sampling strategy that emphasizes methods designed to obtain a representative sample of the fish community at a particular site. This means that each site is sampled with an appropriate method (i.e. wading methods and boat methods) in a consistent and reproducible manner. Although this approach may not yield a complete inventory of all species at a site, sample sizes large enough to permit comparisons between sites are obtained. This is particularly true of the boat methods used to sample the larger streams and rivers. This is somewhat in contrast to the labor intensive "inventory" sampling procedures advocated by Karr *et al*. (1986) and others for these habitats.

Quantitative data includes repetitive sampling based on distance (rather than time), weighing individual fish (modified I_{wb} only), counting numbers by each species, and recording external anomalies. Two or three passes (on different dates) through each sampling zone are necessary to generate reliable catch data as specified by Gammon (1976) and Ohio EPA (1987a). The collection of biomass data is necessary for using the modified I_{wb} (restricted to sites >20 sq. mi.). We have found that using both the IBI and I_{wb} provides rigorous assessment, particularly where the evaluation includes use designations other than Warmwater Habitat (WWH), complex environmental impacts (toxics, combined sewers, multiple influences), and in larger streams and rivers. Karr *et al*. (1986) cite the need for biomass data as being a drawback to using the I_{wb}. However, we have found that subsampling techniques not

Table 3-1. Characteristics of electrofishing sampling methods most frequently used by the Ohio EPA to sample fish communities (see Ohio EPA 1987a for further details).

	Sampler Type		
	A	D or E	F
Gear Used:	12', 14', or 16' boat	D:Sportyak (7.5' boat) E:Longline (100m extension cord)	Backpack
Power Source:	Smith-Root Type VI-A electrofishing unit or Smith-Root 3.5 GPP generator/pulsator unit	Model 1736 VDC T&J generator/pulsator unit	Michigan DNR battery pack unit
Current Type:	Pulsed DC	Pulsed DC	Pulsed DC
Wattage: (AC Power Source)	3500	1750	12 V battery
Volts: (DC Output)	50-1000	100-300	100 or 200
Amperage: (Output)	4-11	2-7	1.5-2
Anode Location:	Front of boom	Net hoop	Net hoop
Distance Sampled (km):	0.50	0.20	0.15-0.20
Sampling Direction:	Downstream	Upstream	Upstream
Relative Abundance:	Based on 1.0 km	Based on 0.3 km	Based on 0.3km
Stream Size:	Moderate to large streams & rivers	Wadeable streams to headwater tributaries	Headwater tributaries

only reduce potential error (compared to weighing each individual fish), but add an insignificant amount of time to overall sample processing. Each collection must be sorted and counted anyway thus weighing is a minor component of this effort. The subsampling and catch processing procedures are detailed elsewhere (Ohio EPA 1987a).

Fish sampling should generally take place between mid-June and late September and include two or three passes total. It may be necessary to conduct sampling outside of this time period (May, early October), but certain precautions should be taken to ensure data comparability. We prefer to limit this sampling to simple, small stream situations. Late fall, winter, and early spring sampling is discouraged because of the effect of cold temperatures on sampling efficiency and changes in fish distribution. If three passes are planned each individual pass should be spaced at least three or four weeks apart. If only two passes are intended (recommended for wading methods only) this time should be five to six weeks. These requirements have been experimentally determined by repetitively sampling at "test sites" for both boat and wading methods. Putting this time between passes allows the community to stabilize and recover from any temporary perturbations that may have been induced by the sampling. This is particularly important in the wadable streams. Restricting sampling to the summer season minimizes the influence of spring spawning or other seasonal occurrences. Additionally, environmental stresses are potentially at their height because controlling influences such as temperature and dissolved oxygen are nearest chronic stress thresholds.

The condition of the surface water being sampled is another important item that affects electrofishing. Since sampling efficiency is in part dependent on the ability of the sampler to see stunned fish, two conditions need to be met. The first is that the netter(s) should wear polarized sunglasses to enhance the spotting of fish stunned beneath the surface. The second is that sampling should be performed during normal water clarity and flow conditions. High flow and turbid water can reduce sampling effectiveness.

Accurate identification of fish is essential and is required to the species level at a minimum. Identification to the sub-specific level may be necessary in certain situations (e.g. banded killifish). Field identifications are acceptable, but laboratory vouchers will be required for any new locality records, new species, and those specimens that cannot be field identified. It is recommended that specimens be retained for laboratory examination if there is <u>any</u> doubt about the correct identity of a fish. The collection techniques used are not consistently effective for fish less than 15-20 mm in length therefore identification and inclusion in the sample is not recommended. This follows the reasoning of Karr <u>et</u> <u>al</u>. (1986).

Study design and sampling site selection are discussed further in Section 8 and Ohio EPA (1987a).

Macroinvertebrate Methods Summary

The primary sampling gear used by the Ohio EPA for the quantitative collection of macroinvertebrates in streams and rivers is the modified multiple-plate artificial substrate sampler originally described by Hester and Dendy (1962). The sampler is constructed of 1/8 inch tempered hardboard cut into three inch square plates and one inch square spacers. A total of eight plates and twelve spacers are used for each sampler. The plates and spacers are placed on a 1/4 inch eyebolt so that there are three single spaces, three double spaces, and one triple space between the plates (Figure 3-1). The total surface area of the sampler, excluding the eyebolt, is 145.6 square inches or roughly one square foot. A routine monitoring sample consists of a composite of five substrates that are colonized instream for a six week period normally falling between June 15 and September 30. Detailed descriptions of the placement, collection, and processing of the artificial substrates are available in Ohio EPA (1987a). In addition to the artificial substrate sample, routine monitoring also includes a qualitative collection of macroinvertebrates that inhabit the natural substrates at the sampling location. All available habitat types are sampled and voucher specimens retained for laboratory identification. More specific information for the collection of this sample can also be found in Ohio EPA (1987a). For the purpose of generating an ICI value, both a quantitative and qualitative sample must be collected at a sampling location.

A good source of information regarding the practical application of artificial substrates can be found in Cairns (1982). The use of artificial substrates for monitoring purposes has a number of advantages. According to Rosenberg and Resh (in Cairns, 1982) the major advantages in using artificial substrates are that they 1) allow collection of data from locations that cannot be sampled effectively by other means, 2) permit standardized sampling, 3) reduce variability compared with other types of sampling, 4) require less operator skill than other methods, 5) are convenient to use, and 6) permit nondestructive sampling of an environment. The authors also list a number of disadvantages, but, generally, these problems can be minimized by adhering to strict guidelines concerning sampler placement, collection, and analysis.

A composited set of five artificial substrate samplers has been used by the Ohio EPA in collecting macroinvertebrate samples since 1973. At this level of effort, it has been found that a consistent, reproducible sample can be collected. Results of analyzing replicate sets of five artificial substrates have shown that variability among calculated ICI values is low. Details of that analysis can be found elsewhere in this document (Appendix D).

The reliability of the sampling unit not only depends on the fact that colonization surface areas are standard, but equally important are the actual physical conditions under which the units are placed. It is imperative that the artificial substrates be located in a consistent fashion with particular emphasis on current velocity over the set. With the exception of water

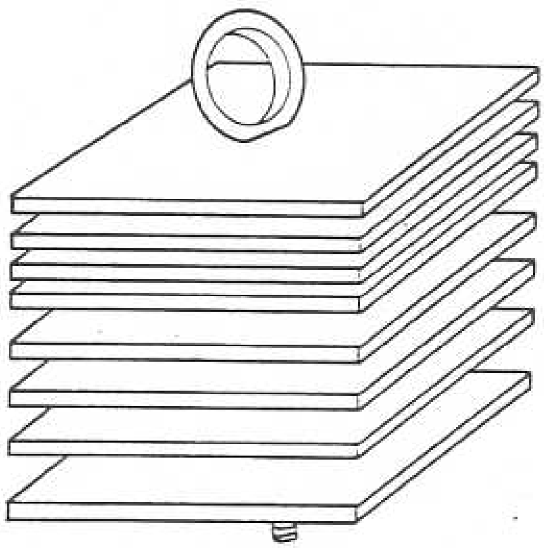

Figure 3-1. Modified Hester-Dendy multiple-plate artificial substrate sampler used by the Ohio EPA for the quantitative collection of aquatic macroinvertebrates.

quality, amount of current tends to have the most profound effect on the types and numbers of organisms collected. For a literal interpretation of the ICI, current speeds should be no less than 0.3 ft/sec under normal flow regimes. These conditions can usually be adequately met in all but the smallest of permanent streams (<10 sq mile drainage) or those streams so highly modified for drainage that dry weather flows maintain pooled habitats only. In these situations, sampling can be accomplished, but some interpretation of the ICI value may be necessary.

An additional area of some importance concerns the accuracy of identification of the sample organisms. The ICI has been calibrated to a specific level of taxonomy that is currently being employed by the Ohio EPA. It is imperative that accurate identifications to the levels specified be accomplished. Otherwise, problems may arise in many of the ICI metrics where number of kinds of a particular organism group is the parameter used. Inaccurate identifications can also be a problem in the ICI metric dealing with percent abundance of pollution tolerant organisms. As new information and taxonomic keys become available, adjustments to the ICI scoring may be necessary. A listing of current taxonomic keys and a phylogenetic table indicating level of taxonomy used for specific organism groups can be found in Ohio EPA (1987a).