III. BIOLOGICAL CRITERIA DEVELOPMENT

Three biological indices, the Index of Well-Being (Gammon 1976; Gammon et al. 1981), the Index of Biotic Integrity (Karr 1981; Fausch et al. 1984), both of which are based on fish, and the Invertebrate Community Index (DeShon et al., unpublished), which is based on macroinvertebrates, are used by Ohio EPA. Criteria for each index are defined by organism group, biological index, site type (fish), ecoregion, and aquatic life use designation. The concept has as its basis the design of the Stream Regionalization Project (SRP) and the ecoregion approach (Hughes et al. 1986; Whittier et al. 1987; Ohio EPA 1987a). Modified Iwb and IBI criteria were defined for each of the five ecoregions for three site types; headwaters (drainage area <20 sq. mi.), wading sites (streams sampled with wading methods, usually 20-300 sq. mi.), and boat sites (streams and rivers sampled with boat methods, usually 200-6000 sq. mi). ICI criteria are based primarily on an artificial substrate sampling method and consider the effect of stream and river size. A general rationale and basis for developing these criteria can be found in Volume II of this series (Ohio EPA 1987a) and Whittier et al. (1987).

In 1980 Ohio EPA developed narrative and numerical criteria based on biological evaluation at the sub-community level. Fish (Table 3) and macroinvertebrate (Table 4) criteria were based on the best professional judgement of Ohio EPA biologists and their experiences with a data base including about 150 sampling locations. Some revisions have occurred since 1980, but the approach remained essentially the same. The purpose of the classification system represented by Tables 3 and 4 was essentially two-fold: 1) to provide an objective, systematic basis for assigning aquatic life uses to surface waters, and 2) to provide an objective, standardized approach for determining the magnitude and severity of surface water impacts on the aquatic biota. These criteria also provided the basis for designating stream and river segments as attaining, partially attaining, or not attaining their designated aquatic life uses in the 1982, 1984, and 1986 Ohio 305b reports.

In 1983, Ohio EPA and the U.S. EPA Environmental Research Laboratory in Corvallis, Oregon, initiated a joint effort designated the Stream Regionalization Project (SRP). Conceptual methods for identifying regional patterns in aquatic ecosystems based on the commonality of a variety of physiographic characteristics in a region (i.e. ecoregion) were applied. It was expected that ecoregions could provide a useful framework for examining the potential aquatic life attainabilities for various sizes of flowing waters (Whittier et al. 1987). This approach has been successfully tested in Arkansas (Rohm et al. 1987) and Oregon (Hughes et al. 1987) and is currently being applied in a number of other states. The first phase of the SRP involved delineating the principal ecoregions of Ohio and identifying watersheds within each that are representative of "least disturbed" conditions. This planning effort provided the basis for choosing reference sites (Hughes et al. 1986) that were sampled for fish and macroinvertebrates to determine the biological expectations of the "least impacted" or "reference" sites within each ecoregion. This design is in keeping with the adopted definition of biological integrity. The process for the selection of regional refernce sites is described in Volume II (Ohio EPA 1987a).

Table 3. Ohio EPA biological criteria (fish) that were used for determining water quality use designations and attainment of Water Quality Act (WQA) goals during 1980-1987 (November 1980; revised January 1987).

Category	--- MEETS WQA GOALS ---		------ DOES NOT MEET WQA GOALS ------		
	"Exceptional" Class I (EWH)	"Good" Class II (WWH)	"Fair" Class III	"Poor" Class IV	"Very Poor" Class V
1.[a]	Exceptional, or unusual assemblage of species	Usual association of expected species	Some expected species absent, or in low abundance	Many expected species absent, or in low abundance	Most expected species absent
2.	Sensitive species abundant	Sensitive species present	Sensitive species absent, or in very low abundance	Sensitive species absent,	Only most tolerant species remain
3.	Exceptionally high species richness	High species richness	Declining species richness	Low species richness	Very low species richness
4.[b]	Composite index Greater than 9.0 - 9.5	Composite index Greater than 7.5 - 8.0, Less than 9.0 - 9.5	Composite index Greater than 6.0 - 6.5, Less than 7.5 - 8.0	Composite index Greater than 4.0 - 4.5, Less than 6.0 - 6.5	Composite index Less than 4.0 - 4.5
5.	Outstanding recreational fishery		Tolerant species increasing, beginning to predominate	Tolerant species predominate	Community organization lacking
6.	Species with an endangered, threatened, or special concern status are present				

[a] Conditions: Categories 1, 2, 3 and 4 (if data is available) must be met and 5 or 6 must also be met in order to be designated in that particular class.

[b] Based primarily on electrofishing samples, ranges may vary for other sampling methods; does not apply to the Coldwater Habitat (CWH) use designation.

Table 4. Biological criteria (macroinvertebrate) that were used for determining aquatic life use designations and attainment of Water Quality Act goals during 1981-1987 (March 1981).

	CWA GOALS MET		CWA GOALS NOT MET	
Evaluation Class Category	"Exceptional" Class I (EWH)	"Good" Class II (WWH)	"Fair" Class III	"Poor" Class IV
1.	Pollution sensitive species abundant	Pollution sensitive species present in moderate numbers	Pollution sensitive species present in low numbers	Pollution sensitive species absent
2.	Intermediate species present in low numbers	Intermediate species present in moderate numbers	Intermediate species abundant	Intermediate species present in low numbers or absent
3.	Tolerant species present in low numbers	Tolerant species present in low numbers	Tolerant species present in moderate numbers	Tolerant species abundant (all types may be absent if extreme toxic conditions exist)
4.	Number of taxa 30	Number of taxa 25-30	Number of taxa 20-25	Number of taxa 20
5.	Exceptional diversity Shannon index 3.5	High diversity Shannon index 2.9-3.5	Moderate diversity Shannon index 2.3-2.9	Low diversity Shannon index 2.3

The choice of using both fish and macroinvertebrates as the routine organism groups to monitor was made because both groups have been widely used in environmental assessment and there is an abundance of information about their life history, distribution, and environmental tolerances. The need to use both groups is apparent in the ecological differences between them, differences that tend to be complimentary in an environmental evaluation. The value of having both groups independently showing the same result cannot be overstated and lends considerable strength to the evaluations. Apparent differences in the responses of these two groups has usually led to the definition of problems that would have otherwise gone undetected in the absence of information from either organism group. The differing sensitivities of the two groups is not the same to all substances or in every situation. For example representatives of one group may be able to tolerate and metabolize some toxic substances that are highly detrimental to representatives of the other. This information can influence the decision to control certain substances or processes that may have been either overlooked or underrated in relying on an evaluation of only one group. The use of these two groups is somewhat analogous to the use of a fish species and an invertebrate species as standard bioassay test organisms. However, biological field evaluations by definition include a broad range of organism sensitivities and trophic levels from each of the two groups.

Other organism groups such as algae, diatoms, zooplankton, macrophytes, naiad mollusks, and others are not routinely included. However, this does not diminish the ability of Ohio EPA to evaluate and quantify surface water conditions. Fish and macroinvertebrates not only provide some of the most sensitive components of the aquatic biota, but their functioning and overall well-being are dependent on the primary and secondary productivity of the aquatic ecosystem. Thus problems that occur in the lower trophic groups that result in a loss of biological integrity will likely show up in these higher organism groups. It may be necessary on occasion to monitor and evaluate other organism groups for specific purposes such as refining our understanding of cause/effect relationships or verifying the presence of specific chemical contaminants. Our primary goal in using biosurveys is to measure attainment/non-attainment of aquatic life uses. Thus focusing on two of the better understood, higher organism groups will adequately satisfy that goal.