SECTION 2: DEFINING BACKGROUND CONDITIONS

In order to establish biological criteria that are reflective of the legislative goal of attaining biological integrity in surface waters a "calibration" of the methods used to establish the criteria is needed. The practical definition of biological integrity as the biological performance exhibited by the natural or "least impacted" habitats of a particular region provides the underlying basis for a sampling design to provide such information. It should be noted that this is not an attempt to characterize "pristine" or totally undisturbed environmental conditions as such conditions exist in only a very few places if at all (Hughes et al. 1982). Thus our expectations of how a biological community should perform are determined by the demonstrated attainability of natural communities at "least impacted" or reference sites within a particular biogeographical region.

Ecoregion Concept

The selection of control or reference sites from which attainable biological conditions can be defined is a key component in establishing biological criteria. Hughes et al. (1986) described at least seven different approaches that have been used to estimate attainable biological conditions in surface waters. Two of these include the use of forested watershed models (Vannote et al. 1980) and the classic upstream-downstream approach. Some problems with these approaches include too narrow of a focus (e.g. forested watersheds), selection of unrepresentative control sites, or a subjective selection of control sites. In some situations adequate control sites simply do not exist. Ideally, reference sites for estimating attainable biological conditions should be as "undisturbed" as possible and be representative of the watershed for which they are to serve as a control. Such sites can serve as references for a large number of streams if the sites typify the range of physical characteristics within a particular geographical region (Hughes et al. 1986). While it is recognized that all individual water bodies differ to some degree from each other, the basis for having regional reference sites is the similarity of watersheds within defined geographical regions. Generally less variability is expected among surface waters within a particular region than between regions. This is because surface waters, particularly streams, derive their basic characteristics from their watersheds. Thus streams draining comparable watersheds of a region are much more likely to be similar than those from less comparable watersheds located in a different region.

In order to accomplish the selection of reference sites it was first necessary to define "ecoregions" within the state. An ecoregion is a relatively homogenous area where the boundaries of several key geographic variables more or less coincide (Hughes et al. 1986). The delineation of ecoregions is accomplished by simultaneously examining patterns in the relative homogeneity of several terrestrial variables (Omernik 1987). This is done because several watershed variables, not just one or two, are presumed to have major and controlling influences on aquatic ecosystems (Hughes et al. 1986).

Omernik (1987) mapped the aquatic ecoregions of the conterminous United States from maps of land-surface form, soils, potential natural vegetation, and land use. These maps were then analyzed to identify areas of combined, regional homogeneity. This method seems most appropriate for classifying aquatic ecoregions because of the integrative ecological (versus technological and reductionist) way it was developed, its level of resolution, its incorporation of mapped physical, chemical, and biological information, and because it requires no further data collection (Hughes et al. 1986).

Ecoregions provide a geographical basis for estimating ecosystem responses to management action assuming that most sites within each will respond similarly to those actions (Bailey 1983). In using the ecoregion/reference site approach the reference sites serve as benchmarks for measuring the condition of other sites within the same ecoregion. Thus reference sites are used to develop expectations about surface waters that are as protective of the environment as is ecologically and socioeconomically possible. This fits well with the definition of biological integrity as the ecological performance of the least disturbed habitats within an ecoregion. This does not mean that the attainable conditions within an ecoregion cannot improve over time with changes in population, land use, progress with nonpoint pollution abatement, etc. However, it does reflect what is currently and reasonably attainable given current societal activities.

In Ohio parts of five ecoregions occur (Fig. 2-1) and the distinguishing features of each are given in Table 2-1. A detailed narrative description of these ecoregions is available in Whittier et al. (1987).

Criteria for Selecting Reference Sites

The process of selecting watersheds and reference sites is outlined in Larsen et al. (1986) and Whittier et al. (1987). While the 1983-84 Stream Regionalization Project (SRP) focused on watersheds with drainage areas of 10-300 square miles these were supplemented with additional data from sites sampled from 1981-1986. Reference sites from locations with drainage areas of 300-6000 square miles were also selected from the Ohio EPA data base (1979-1986). These latter sites include the larger streams and rivers from across the state. The lake level affected sections of Lake Erie tributaries, the Ohio River, and inland lakes and reservoirs are not included in the current analysis. However, we plan to address these areas within the next two to three years.

The SRP study design (Larsen et al. 1986; Whittier et al. 1987) was initially limited to watersheds of less than 300 square miles drainage area. Candidate watersheds were generally contained entirely within an ecoregion, but selected "cross-boundary" streams were included for comparison. Watersheds with evidence of substantial human disturbance were eliminated. This was done by examining maps of human population density, current and past land uses, compiling a watershed disturbance ranking, and noting the size and location of point source discharges. From this exercise "least-impacted" watersheds were selected. These are not "pristine" or "undisturbed" watersheds (none really

Figure 2-1. The ecoregions of Ohio as determined by methodologies developed by Omernik (1987) and used to establish attainable biological criteria in Ohio (broken line and light shading indicates ecoregion boundaries).

Table 2-1. The physical and terrestrial characteristics of the five ecoregions of Ohio.

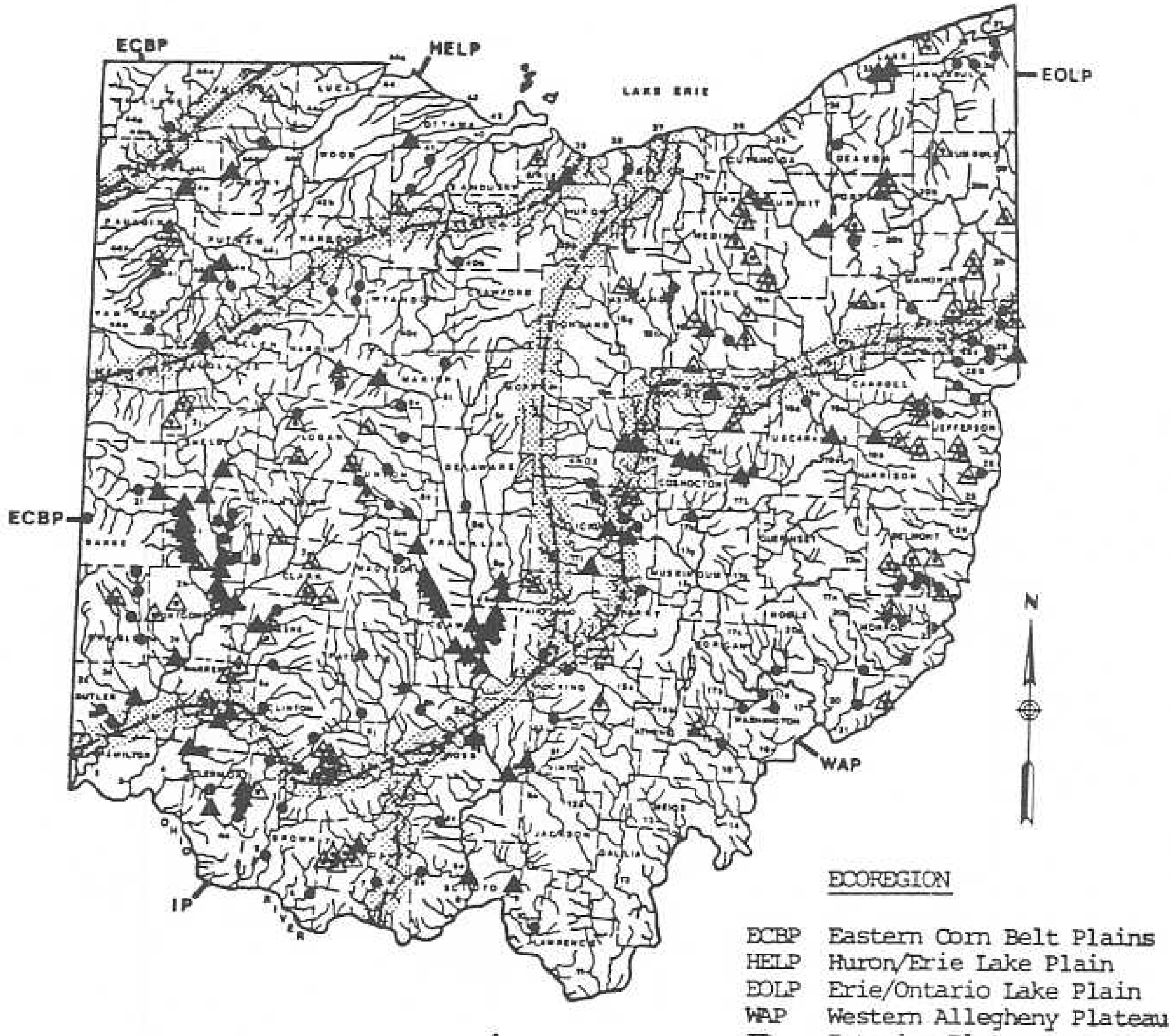
Component	Huron/Erie Lake Plain (Northwest) HELP	Interior Plateau (S. West) IP	Erie/Ontario Lake Plain (Northeast) EOLP	Western Allegheny Plateau (E./S. East) WAP	Eastern Corn Belt Plains (W./Central) ECBP
Land Surface Form (Hammond 1970)	Flat plains	Plains with hills, open hills, tablelands with moderate relief	Irregular plains	Low to high hills	Smooth plains
Land Use (Anderson 1967)	Cropland	Mosaic of cropland, pasture, woodland and forest	Cropland with pasture, woodland, forest, and urban	Woodland, forest with some cropland and pasture; woodland, forest mostly ungrazed	Cropland
Soil (various sources)	Humic-gley, low humic gley, gray brown podzolic/humic gley	Udalfs/udults	Alfisols	Alfisols	Alfisols, gray-brown podzolic/humic gley
Potential Natural Vegetation (Kuchler 1970)	Elm/ash forest	Oak/hickory forest	Beech/maple northern hardwoods (maple, birch, beech, hemlock)	Mixed mesophytic forest (maple, buckeye, beech, tulip, oak, linden), Appalachian oak	Beech/maple forest

exist in Ohio), but they do represent the best watershed conditions within an ecoregion given the background activities prevalent in our society (see Trautman 1981 for a description of changes during the period 1750 - present). These watersheds represent the least-impacted conditions thus they should have the least-impacted streams from an ecoregional viewpoint. The character of these streams should reflect the reasonably attainable biological conditions and water quality within a particular ecoregion given the prevailing background conditions.

Final SRP site selection was made after making an aerial and local reconnaissance of each candidate site and watershed. Factors considered in this inspection included the amount of stream channel modification (if any), the condition of the vegetative riparian buffer, water volume, channel morphology, substrate character and condition, obvious color/odor problems, amount of woody debris, and the general "representativeness" of the site within the ecoregion. Field sampling was conducted for macroinvertebrates, fish, and chemical/physical water quality at 109 sites during 1983-84 following Ohio EPA standardized methods (Ohio EPA 1987a). Detailed descriptions of the instream habitat were made by the biological field crews. Chemical water quality data were also collected; the results are described elsewhere (Larsen and Dudley 1987; Whittier et al. 1987).

Following the field sampling portion of the project several sites were deleted because watershed and stream characteristics were discovered that showed these sites to be unrepresentative of least-impacted conditions. These are listed in Appendix A. Complete avoidance of small stream (i.e. drainage areas less than 300 square miles) sites with any history of channel modification was not possible in the Huron/Erie Lake Plain ecoregion because of the extensive stream channel modification work that has been done in this area. Given the amount of the land surface that is devoted to row crop agriculture coupled with the poor drainage characteristics of this ecoregion, this condition could arguably be termed a "background" condition for the small streams of this ecoregion. This particular problem is described in more detail in Section 6. An examination of the entire Ohio EPA statewide data base (1979-1986) resulted in the addition of nearly 200 sites that also qualified as reference sites. Most of the added sites less than 300 square miles in size were sampled during 1981-1986. The location of fish and macroinvertebrate sites appear in Figs. 2-2 and 2-3.

Large stream and river sites were also selected and included sampling conducted since 1980 for fish and 1981 for macroinvertebrates. The original SRP study design did not include these areas. The criteria for choosing large stream and river reference sites was basically the same as the SRP study design, except that using some sites located downstream from urban centers and point sources could not be completely avoided. These consisted of sites located well downstream from these potential disturbances and below known biological recovery points. No sites in direct proximity to any point sources or within impounded or extensively modified areas were used.



ECOREGION

ECBP Eastern Corn Belt Plains
HELP Huron/Erie Lake Plain
EOLP Erie/Ontario Lake Plain
WAP Western Allegheny Plateau
IP Interior Plateau

METHOD

▲ Boat
● Wading
△ Headwaters

SCALE

0 10 20 30
MILES

0 16 32 64
KILOMETERS

Figure 2-2. Location of Ohio reference sites for fish within each of the five ecoregions and the three principal stream and river sizes (termed boat methods, wading sites, and headwaters sites - each are indicated by different symbols; dashed lines and shading indicates ecoregion boundaries).

ECOREGION

ECBP Eastern Corn Belt Plains
HELP Huron/Erie Lake Plain
EOLP Erie/Ontario Lake Plain
WAP Western Allegheny Plateau
IP Interior Plateau

METHOD

• Artificial Substrate

SCALE

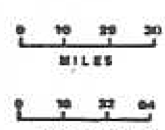


Figure 2-3. Location of Ohio reference sites for macroinvertebrates within each of the five ecoregions and the principal collection methods (artificial substrates sites only; dashed lines and shading indicates ecoregion boundaries).

Supplement to Figs. 2-2 and 2-3. Major Ohio streams and rivers (≥100 sq. mi. drainage area).

OHIO RIVER BASIN

1. Wabash R.
   a. Beaver Cr.
2. Great Miami R.
   a. Whitewater R.
   b. Indian Cr.
   c. Four Mile Cr.
   d. Sevenmile Cr.
   e. Twin Cr.
   f. Mad R.
   g. Buck Cr.
   h. Stillwater R.
   i. Greenville Cr.
   j. Loramie Cr.
3. Mill Cr.
4. Little Miami R.
   a. East Fork
   b. Todd Fork
   c. Ceasar Cr.
5. Whiteoak Cr.
6. Eagle Cr.
7. Ohio Brush Cr.
   a. West Fork
8. Scioto R.
   a. Scioto Brush Cr.
   b. South Fork
   c. Sunfish Cr.
   d. Salt Cr.
   e. Little Salt Cr.
   f. Middle Fork
   g. Paint Cr.
   h. North Fork
   i. Rocky Fork
   j. Rattlesnake Cr.
   k. Deer Cr.
   l. Big Darby Cr.
   m. Little Darby Cr.
   n. Walnut Cr.
   o. Big Walnut Cr.
   p. Alum Cr.
   q. Olentangy R.
   r. Whetstone Cr.
   s. Mill Cr.
   t. Little Scioto R.
   u. Rush Cr.
9. Little Scioto R.
10. Pine Cr.
11. Symes Cr.
12. Raccoon Cr.
   a. L. Raccoon Cr.
13. Leading Cr.
14. Shade R.
15. Hocking R.
   a. Federal Cr.
   b. Sunday Cr.
   c. Monday Cr.
   d. Rush Cr.
16. Little Hocking R.
17. Muskingum R.
   a. Wolf Cr.
   b. West Branch
   c. Meigs Cr.
   d. Salt Cr.
   e. Moxahala Cr.
   f. Jonathan Cr.
   g. Licking R.
   h. North Fork
   i. South Fork
   j. Raccoon Cr.
   k. Wakatomika Cr.
   l. Wills Cr.
   m. Salt Fork
   n. Seneca Fork
18. Walhonding R.
   a. Killbuck Cr.
   b. Kokosing R.
   c. Mohican R.
   d. Lake Fork
   e. Muddy Fork
   f. Jerome Fork
   g. Black Fork
   h. Clear Fork
19. Tuscarawas R.
   a. Stillwater Cr.
   b. L. Stillwater Cr.
   c. Sugar Cr.
   d. South Fork
   e. Conotton Cr.
   f. Sandy Cr.
   g. Nimishillen Cr.
   h. Chippewa Cr.
20. Duck Cr.
   a. West Fork
   b. East Fork
21. Little Muskingum R.
22. Sunfish Cr.
23. Captina Cr.
24. Wheeling Cr.
25. Short Cr.
26. Cross Cr.
27. Yellow Cr.
28. Little Beaver Cr.
   a. North Fork
   b. West Fork
   c. Middle Fork
29. Pymatuning Cr.
30. Mahoning R.
   a. Mosquito Cr.
   b. Eagle Cr.
   c. West Branch

LAKE ERIE BASIN

31. Conneaut Cr.
32. Ashtabula R.
33. Grand R.
   a. Mill Cr.
34. Chagrin R.
35. Cuyahoga R.
36. Rocky R.
   a. West Branch
37. Black R.
   a. West Branch
   b. East Branch
38. Vermilion R.
39. Huron R.
   a. West Branch
40. Sandusky R.
   a. Wolf Cr.
   b. Honey Cr.
   c. Tymochtee Cr.
41. Muddy Cr.
42. Portage R.
   a. South Branch
   b. Middle Branch
43. Toussaint Cr.
44. Maumee R.
   a. Swan Cr.
   b. Beaver Cr.
   c. Cutoff Ditch
   d. S. Turkeyfoot Cr.
   e. Auglaize R.
   f. Blue Cr.
   g. L. Auglaize R.
   h. Praire Cr.
   i. Middle Cr.
   j. Blanchard R.
   k. Ottawa R.
   l. Tiffin R.
   m. Lick Cr.
   n. Bean Cr.
   o. St. Marys R.
   p. St. Joseph R.
   q. Ottawa R.