United States
Environmental Protection
Agency

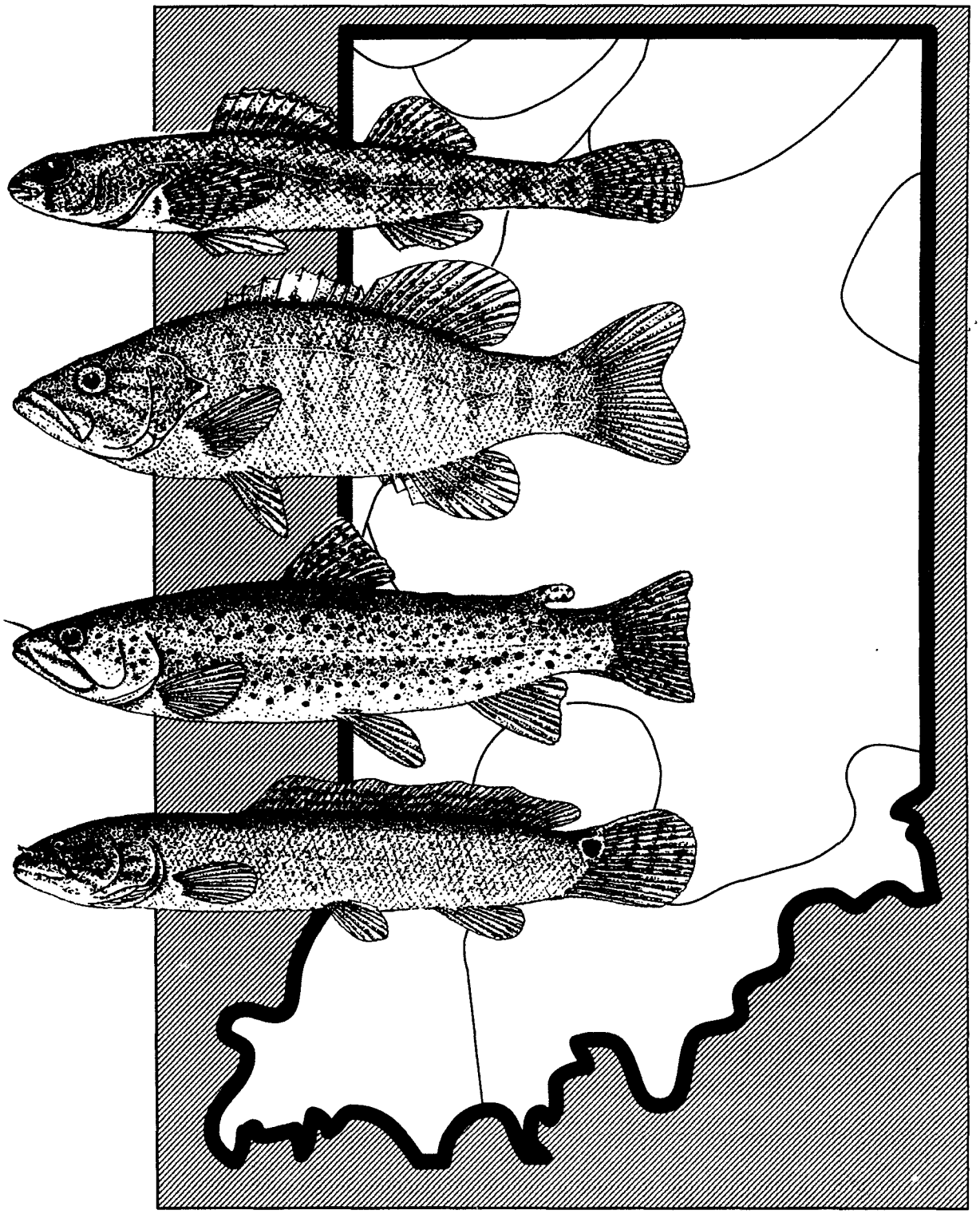
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

EPA 905-R-96-002
NTIS
September 1997

C.2

EPA

Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana III. Northern Indiana Till Plain



EPA 905/R-96/002

Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana: III. Northern Indiana Till Plain

Thomas P. Simon
U.S. Environmental Protection Agency
Watershed and Non-Point Source Branch
77 West Jackson, WW-16J
Chicago, IL 60604

In cooperation with:
Indiana Department of Environmental Management
Assessment Branch
100 North Senate Ave., P.O. Box 6015
Indianapolis, IN 46206-6015

July 1, 1997

NOTICE

Use of this document is intended for the objective facilitation of information exchange between the States and Federal Water Pollution Control Biologists for which it was intended. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

When citing this document:

T.P. Simon. 1997. Development of Index of Biotic Integrity expectations for the Ecoregions of Indiana. III. Northern Indiana Till Plain. U.S. Environmental Protection Agency, Region V, Water Division, Watershed and Non-Point Source Branch, Chicago, IL EPA 905/R-96/002.

If requesting copies of this document:

U.S. Environmental Protection Agency
Publication Distribution Center, DDD
11027 Kenwood Road, Bldg. 5 - Dock 63
Cincinnati, OH 45242

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

EXECUTIVE SUMMARY

The Clean Water Act Amendments of 1987 suggest the development of biological criteria for evaluating the quality of the nation's surface waters. The St. Joseph River drainage was investigated in Indiana to determine water resource expectations for the Southern Michigan-Northern Indiana Till Plain. A total of 104 sites were sampled in the St. Joseph River drainage in order to develop and calibrate an Index of Biotic Integrity for use in this region of Indiana. Based on anticipated variance within the St. Joseph River basin, sub-drainages were established using natural divisions as recognized by Homoya et al (1985).

Three sub-drainages are recognized and include the major drainage units of the St. Joseph River: St. Joseph River, Elkhart River, and Little Elkhart River drainages. Graphical analysis of the data enabled the construction of maximum species richness lines for calibrating the Index of Biotic Integrity for 12 metrics, as modified for application to headwater and mid-sized wadable rivers. Metrics were primarily based on the previous works of Karr (1981), Karr et al. (1986), Ohio EPA (1987), and Simon (1991). Metrics are similar to those developed for the East Branch Little Calumet Division of the Lake Michigan drainage, Central Corn Belt Plain. This includes the number of minnow species, sunfish species, and a combination of sensitive benthic insectivores, e.g. darters, madtoms, and sculpins.

Separate metrics were developed for headwater streams (< 20 miles^2) and wadable river (20-1000 miles^2) drainage area. Scoring criteria modifications were instituted when less than 50 individuals were collected from a sampling location. This affected the trophic composition, tolerance, simple lithophil, and DELT proportional metrics. Stations with drainage areas less than 20 miles^2 used a metric which included darters, madtoms, and sculpins (all benthic insectivores). These species are sensitive indicators of a high quality aquatic resource. In reaches with drainage areas greater than 20 miles^2 a metric evaluating only darter species was used following the original IBI. The proportion of pioneer species was substituted for the proportion of carnivores in small headwater streams. The number of sunfish species was retained for both categories of stream sizes.

The distribution of IBI scores represented a normal curve for all St. Joseph River subdrainages. The trend was towards increasing biological integrity with increasing drainage area in all subdrainages. The only exception was the St. Joseph River mainstem which possessed considerably better fish community structure and function characteristics in the headwaters.

ACKNOWLEDGEMENTS

The U.S. Environmental Protection Agency wishes to express their appreciation to Wayne Davis, Valerie Jones, and Boniface Thayil, USEPA-Region V, Ambient Monitoring Section, and John Winters, Dennis Clark, and Lee Bridges, Indiana Department of Environmental Management (IDEM) who enabled this project to be completed by managing and facilitating logistics and sampling needs. Thomas Lauer, Fisheries Scientist, Indiana Department of Natural Resources provided information from the Department's stream reports that enabled sampling at reference sites. Field assistance was provided by Andrew Ellis, Doug Campbell, and Gregory Nottingham, Steve Newhouse, James Stahl, and Stephen Wente, IDEM biologists. John Dustman, Indiana University-Northwest, provided work space to process the large volume of samples. Hydrologic unit and ecoregion maps were prepared by George Graettinger, USEPA, Water Division, GIS Section. Numerous professional courtesies were provided by colleagues which facilitated completion of this project: Shelby Gerking, Arizona State University, Chris Yoder, Marc Smith, and Ed Rankin, Ohio EPA Historic records were provided by Susan Jewett, National Museum of Natural History, Douglas Nelson and Gerald Smith, University of Michigan Museum of Zoology; and William Eschmeyer, California Academy of Science. Special thanks to Wayne Davis, Lee Bridges, and Steve Newhouse for constructive review comments on a previous draft of the manuscript. The project manager, chief scientist, and author of this report was Thomas P. Simon, Ph. D., Regional Biocriteria Coordinator.

Guest Reviewers:

Dr. Marc Oemke, Michigan Department of Environmental Quality
Mr. Marc Smith, Ohio Environmental Protection Agency
Dr. Lizhu Wang, Wisconsin Department of Natural Resources
Dr Dennis Clark, Indiana Department of Environmental Management
Mr. Steve A. Newhouse, Indiana Department of Environmental Management
Mr. James Stahl, Indiana Department of Environmental Management

Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana. III. Northern Indiana Till Plain

1.0 INTRODUCTION

The term "biological integrity" originated in the Water Pollution Control Act Amendments of 1972 (PL 92-500) and has likewise appeared in subsequent versions (PL 95-217; PL 100-1). Karr and Dudley (1981) defined biological integrity as, "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the best natural habitats within a region". The use of a biological component to evaluate the ambient lotic aquatic community of our nations surface waters has been well discussed elsewhere (Karr *et al.* 1986; Ohio EPA 1987; Whittier *et al.* 1987; Simon *et al.* 1988; Davis 1990; Fausch *et al.* 1990; Karr 1991).

An assessment of the St. Joseph River drainage enabled the objective evaluation of specific metrics performance and evaluation of reference conditions for the Northern Indiana Till Plain. The St. Joseph River drainage has impacts associated with channelization and damming, agriculture, and municipal and point source dischargers. The primary point sources are municipal facilities, chemical manufacturers, and hydro-electric power generating stations distributed in the main population centers of the basin. The affects of channelization and agriculture have been well documented including thermal increases (Raney and Menzel 1969; Brown 1976; Brungs and Jones 1977; Hokanson and Biesinger 1980; USEPA 1980; McCormick *et al.* 1981; EPRI 1981); increased nutrient and allochthanous input, and runoff and riparian zone clearing.

The objective of this study was to evaluate the biological integrity of Indiana water resources based on "least impacted" reference conditions for establishing baseline conditions (Hughes *et al.* 1986). Least impacted reference sites are representative of the watershed under study and reflect the better sites with minimum anthropogenic change. Least impacted is not synonymous with pristine. Rather, sites are selected for their representativeness of the area. The St. Joseph River drainage and the historical Great Marsh have been dramatically changed over the last 250 years with the draining of the wetland and the intensive ditching projects that completely changed the landscape. The following project goals were addressed during the Southern Michigan-Northern Indiana Till Plain biological criteria project:

- o Develop biological criteria for headwater, mid-size, and large river reaches using the Index of Biotic Integrity;
- o Identify areas of least disturbance within the Northern Indiana Till Plain for establishing reference conditions;
- o Develop maximum species richness (MSR) lines from the reference database for each IBI metric as a log function of drainage area.
- o Compare biocriteria to State of Michigan expectations for ecoregion

This technical report includes specific Index of Biotic Integrity criteria including the development of metrics and maximum species richness lines, to delineate areas of least disturbance in the Northern Indiana Till Plain ecoregion.

Limited field collection has been conducted in Indiana since the completion of Gerking's distribution of Indiana fishes. Less than 2% of Indiana's surface waters had been assessed at the beginning of this study. Since limited information was available for the selection of least disturbed stations, we attempted to sample representative stream types of this region in order to determine where least impacted stream segments occurred.

Definition of Reference Conditions

In order to make accurate evaluations of the biological condition of the region, various baseline geological, geographic, and climatic differences need to be assessed. The goal is not to provide a definition of pristine conditions, since these types of conditions are either few in number or nonexistent in heavily populated states (Hughes *et al.* 1982; Whittier *et al.* 1987). Our expectations are determined from the structural and functional attainable natural conditions of "least impacted" or reference conditions. Assessment of these criteria need to be modified nationally, since regional differences can be attributed to the expectations based on structure and function that determine the distribution of fishes. The ecoregion concept is useful for clustering large homogeneous regions, since these areas are influenced by different physical processes (Omernik 1987).

In order to select stations for sampling it is necessary to know the geographical boundary of the "ecoregions" within the State of Indiana. A valid ecoregion has boundaries where ecosystem variables and patterns emerge (Hughes *et al.* 1986). Omernik (1987) mapped the ecoregions of the conterminous United States from maps of land-surface form, soil types, potential natural vegetation, and land use. Each ecoregion was then based on areas of regional homogeneity. Ecoregions became a very useful mechanism for determining community complexity and for establishing boundaries associated with various land forms.

Ecoregions provide a geographical framework for determining the appropriate response for streams of similar proportion and complexity. Reference conditions are used for establishing the areas of "least impact", and will reveal the current conditions of the surface waters of Indiana Once ecoregional expectations are determined it is important to consider that conditions do not remain static. On the contrary, repeat monitoring and sampling of stations, both reference and site specific will need to be conducted in order to document change over time and further refine the IBI.

Reference conditions are not the same as reference sites. Reference conditions are the subtle patterns that emerge from the regional database. Few if any nonimpacted sites occur in North America, thus in order to determine the extent of degradation important attributes of stream fish communities are analyzed to determine the patterns of "least impacted" communities. The relevance of including some sites which are not considered pristine or "reference sites" is not important because it is only the upper 5% of the sites that determine the maximum species richness lines or 95th percentile lines.

Because of subregional differences, further demarcation was made by examining the role of the basin or the watersheds within ecoregions. Fish composition and community structure is determined, within a natural area by the availability of water of appropriate quality and quantity to ensure existence, provide routes of emigration, sustain growth, and increase fitness through reproduction. Likewise,

species-specific differences exist in community structure which may not reveal differences in current water quality but may be determined by historical geomorphic (Leopold *et al.* 1964) or zoogeographic processes (Hocutt and Wiley 1986). Trends in Indiana water quality were therefore evaluated using a watershed approach within an ecoregion framework.

Criteria for Selecting Reference Sites

Several procedures are available for determining reference conditions. Larsen *et al.* (1986) and Whittier *et al.* (1987) chose sites after careful examination of aerial photographs, watershed specific information review, on-site reconnaissance, and expert consultation. This procedure requires that a limited number of high-quality sites be sampled in order to predict regional expectations. The methods chosen for site selection were based on the evaluation of Regional Water Quality Planning Maps (USGS undated) that identified known impact sources and diffuse nonpoint sources that could potentially influence a site. A balanced distribution of sites within all parts of the St. Joseph River drainage was maintained against historic collections sites (Jordan 1877; Gerking 1945; IDEM 1990). All sites were rigorously sampled in order to get representative, distance specific, quantitative estimates of species richness and biomass. Maximum species richness lines were then compiled (see methods below), followed by calculations of the Index of Biotic Integrity values to reveal that stations that were the "least impacted" stations for the St. Joseph River drainage.

Reference sites are defined as the stations which cumulatively define the 95th percentile line of the individual metrics. Evaluation of habitat and other physical parameters refined the final list of reference sites. Sites that had habitat or water quality deficiencies, but still attained high index ratings would have been removed from the final list. This action was not required, since poor habitat and water quality affected various portions of the community resulting in a lowered index score. These sites are not pristine or undisturbed (few exist in Indiana), but they do represent the best conditions given the background activities (i.e. anthropogenic impacts; channelization; cultural eutrophication).

Sampling was conducted in all size classes of river reaches in the St. Joseph, Elkhart, Pigeon, and Little Elkhart Rivers from the headwater (<20 mile^2) to the largest mainstem drainage area (ca. 1,000 mile^2) in Indiana.

2.0 STUDY AREA

Indiana has an area of 36,291 square miles, and drains the Ohio, the upper Mississippi, and Great Lakes Regions (Seaber *et al.* 1984). These three regions were further subdivided into nine subregions (Fig. 1), five of which drain 86% of the State (USGS 1990). The State of Indiana lies within the limits of latitude 37° 46' 18" and 41° 45' 33" north, for an extreme length of 275.5 miles in a north-south direction; and between longitude 84° 47' 05" and 88° 05' 50" west with an extreme width in an east-west direction of 142.1 miles.

The State has a maximum topographic relief of about 900.9 ft, with elevations ranging from about 300.3 ft above mean sea level at the mouth of the Wabash River to slightly more than 1,201.2 ft in Randolph County in the east-central part of the state.

This report considers only the St. Joseph River drainage. The St. Joseph River

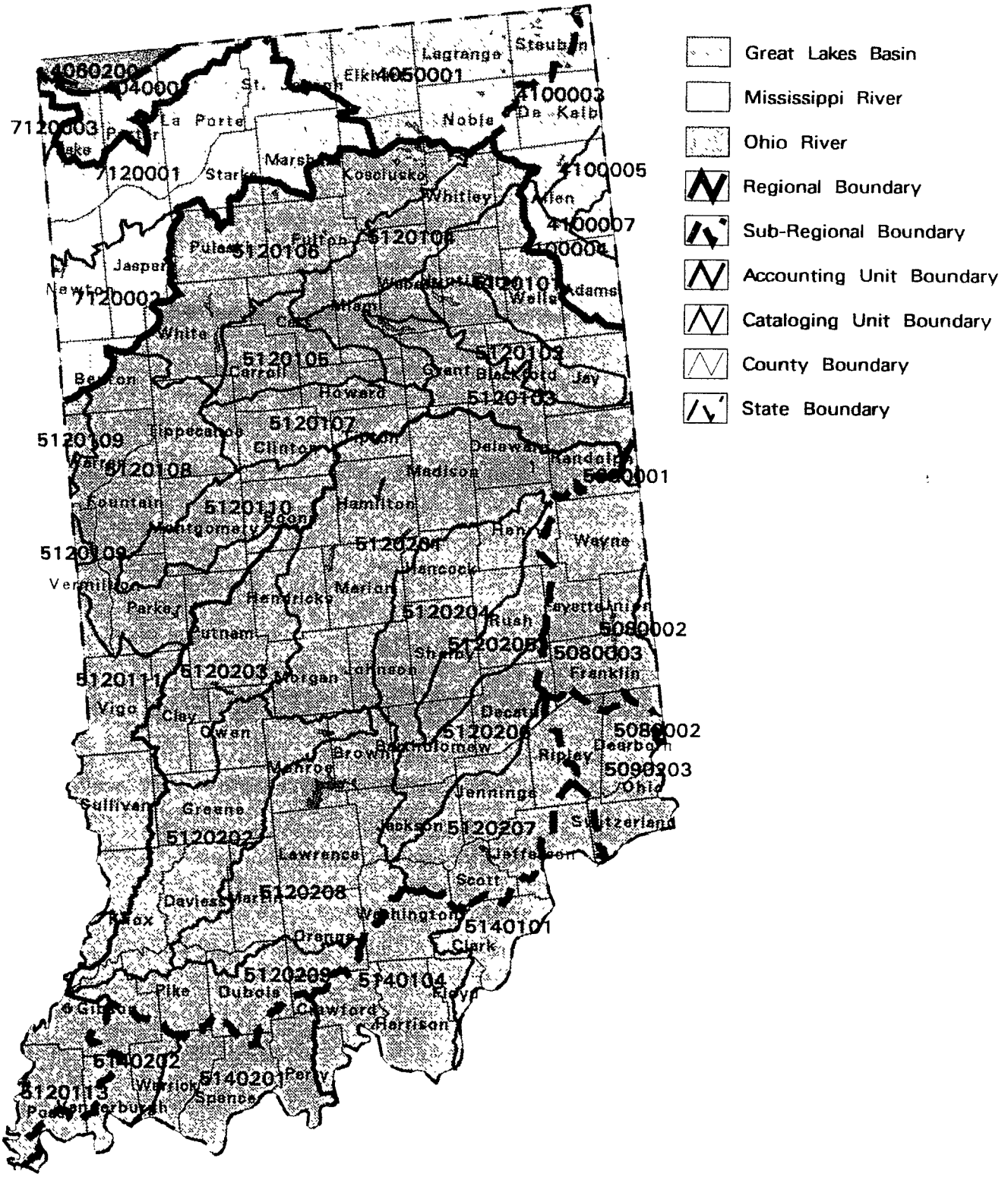


Figure 1. Map of Indiana showing Major and Minor drainage basins. (from USGS data).

drains an area of 4,285 mile^2 (Hoggatt 1975). It is contained within a single ecoregion and drains 4.7% of Indiana. The entire St. Joseph River watershed is contained within the Northern Indiana Till Plain ecoregion (Omernik and Gallant, 1988). The St. Joseph River is located in northcentral and northeastern Indiana and drains in a northeastern direction into Michigan and then Lake Michigan. The St. Joseph River is one of the largest tributaries of Lake Michigan.

Physiographic Provinces

Fenneman (1946) divided the State into two physiographic provinces based on the maximum extent of glaciation. The glaciated portion of the State contains the Central Lowland province, which includes the majority of the St. Joseph River drainage, and the unglaciated portion is termed the Interior Low Plateaus province.

Schneider (1966) further divided Indiana into three broad physiographic areas that closely reflect the surface-water characteristics of the State. The St. Joseph River drains a portion of the Northern Lake and Moraine Region.

The Northern Lake and Moraine Region covers the northern one-fourth of the State and is of variable relief. Its characteristic deep peat deposits and small lakes are restricted to the rugged, terminal moraines. Numerous broad lacustrine and outwash plains occur, often marked by wide marshes (or marshes now drained) broken by low sand ridges or knolls. The northern section of the State was covered during the most recent Wisconsinan glacial event.

The last major glaciation event dramatically altered northern Indiana during the Wisconsinan period (14,000 to 22,000 years ago). As glaciers advanced and retreated, the land surface was dramatically altered as the landforms were either scoured by advancing glacial ice or the scoured materials were deposited by retreating glaciers. Two distinct glacial lobes are known to have advanced into Indiana, from the northeast out of Lake Erie and Saginaw Bay basins and from the north from the Lake Michigan basin.

Ecoregions

Omernik and Gallant (1988) characterized the attributes of ecoregions of the midwestern states. Indiana has six recognized ecoregions: Central Corn Belt Plain, Huron-Erie Lake Plain, Southern Michigan-Northern Indiana Till Plain (referred to as Northern Indiana Till Plain), Eastern Corn Belt Plain, Interior Plateau, and Interior River Lowland (Fig. 2). The St. Joseph River basin drains the Northern Indiana Till Plain ecoregion (Omernik and Gallant (1988).

Northern Indiana Till Plain

Much of the ecoregion consists of extensive crop and livestock production. It is distinguished from other adjacent ecoregions by the natural forest cover, a high degree of urbanization, and extensive quarrying. The broad, nearly flat to rolling glaciated plain includes deeply mantled glacial till and outwash, sandy and gravelly beach ridges and flats, belts of morainal hills, and bog kettle depressions. Elevations range between a few feet in the flatter portions of the range to 600 ft along the shores of the Great Lakes to over a 1000 ft on some moraines. Streams are sluggish and are bordered by riverine wetlands throughout the 25,800 miles^2 of the ecoregion. Perennial streams include drainage ditches and channelized streams with a density of

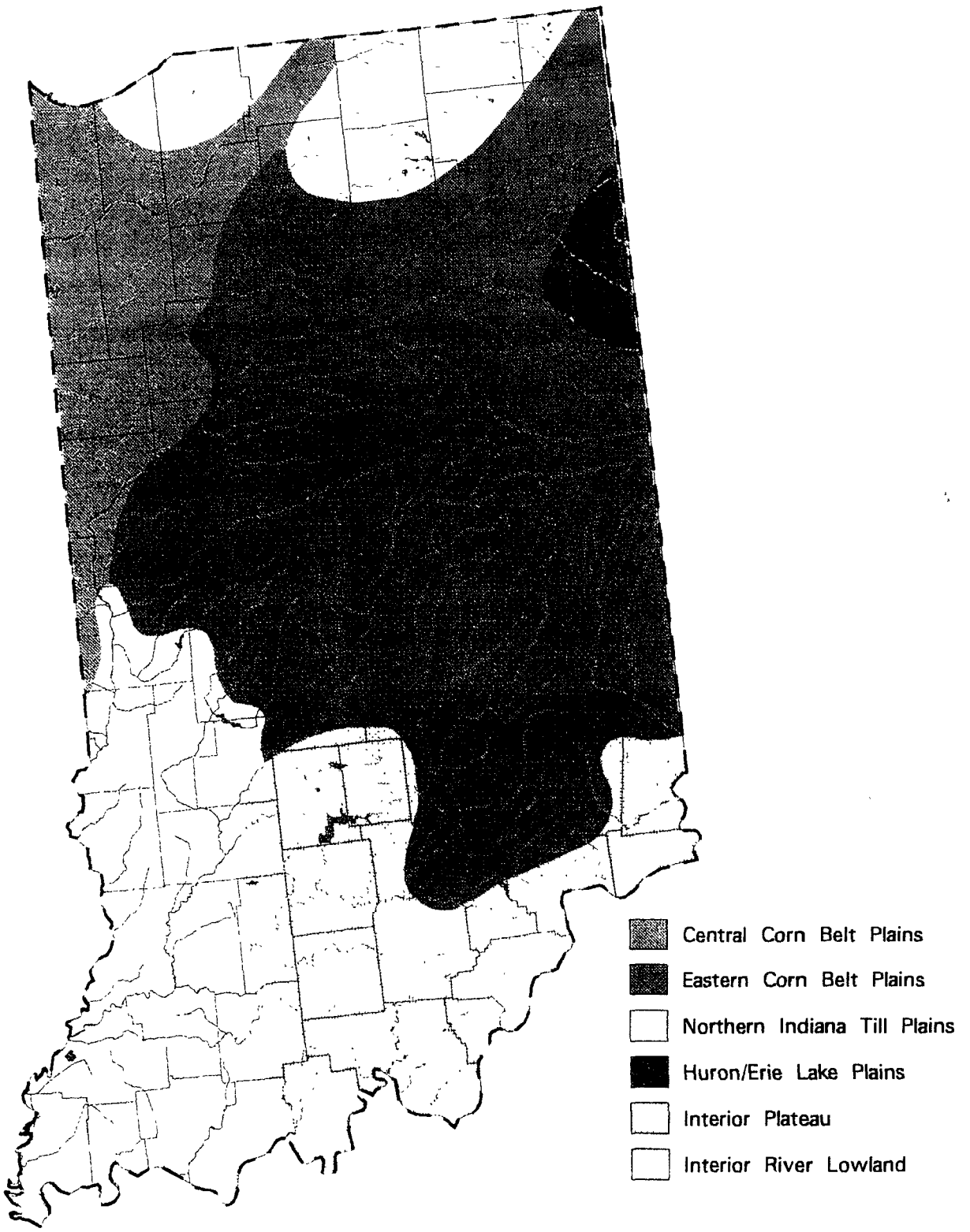


Figure 2. Map of Indiana showg the ecoregion designation from Omernik and Gallant (1988).

one half mile per square mile. Lakes are common in some areas, however, many depressions are filled with peat deposits or dark mineral soils. Precipitation occurs mainly during the growing season and averages from 35 to 46 inches annually.

Both perennial and intermittent streams are common in the ecoregion. Intermittent streams comprise between 10-15% of the streams. Constructed drainage ditches and channelized streams further assist in soil drainage in flat, poorly drained areas. Stream density is approximately one half mile per square mile in the most typical portions of the ecoregion.

The ecoregion is managed for cropland, livestock, forest and woodland, and urban use. Crops are mainly in corn, other feed grains, soybeans, and hay for livestock. Emphasis on livestock includes the dairy cattle, but beef cattle, swine, sheep, and poultry are also important. Approximately 25% of the ecoregion is urbanized.

Most of the soils were developed under the influence of deciduous forest vegetation. The soils are derived from loamy glacial drift and till. Hapludalfs and Ochraqualf's are the dominant soil groups, while, poorly drained soils include Argiaquolls, Haplaquolls, Haplaquepts, and Psammaquents. Udipsamments form on better drained outwash plains. Mediprists and other organic soils can be found on depressions.

The natural vegetation of the area consists of diverse hardwood forests, predominantly oak and hickory. However, a significant amount of white oak, red oak, black oak, bitternut hickory, shagbark hickory, sugar maple, and beech exists. This vegetation is not common in the mixed forest to the north or on the poorly drained lake plain to the south and east. Wetter sites include red maple, white oak, American elm, and basswoods. White ash, red maple, quaking aspen, and black cherry grow along rivers and stream corridors.

Drainage Features

Three major drainage units occur in the Northern Indiana Till Plain of Indiana: the St. Joseph River, Elkhart River, Pigeon River, and the Little Elkhart River drainages. Further mention of the St Joseph River basin will refer only to that contained in Indiana.

St. Joseph River

The St. Joseph River basin drains 1699 square miles in northern Indiana and 2586 square miles in southern Lower Michigan (IDNR 1987). The Indiana portion of the basin contains a unique combination of natural lakes, wetlands streams with well-sustained flows, and extensive sand and gravel aquifer systems. During dry years ground water contributes 70% of the stream flow (Indiana Department of Natural Resources 1980). The St. Joseph River basin is characterized by more than 200 natural lakes, approximately 27,000 wetlands, and low-gradient streams develop on outwash and till deposits. The St. Joseph River drains 4.7% of the State. The St. Joseph River begins near Hillsdale, Michigan, and generally flows to the southwest. In South Bend, Indiana, the river turns sharply to the north, then flows northwest until it enters Lake Michigan near Benton Harbor, Michigan. Approximately 41 miles (19%) of the St Joseph mainstem is in Indiana. Average channel slope is 2.5 feet per mile. Minor tributaries include Christiana Creek, Juday Creek, Baugo Creek, and Cobus Creek. Average discharge for the St. Joseph River during the period of record (1947-present), at Elkhart, was 3,176 cfs Flow ranged from a minimum daily discharge of

336 cfs, the 7 day, 10 year low flow of 818 cfs, to 18,600 cfs during maximum discharge during the period of record (Arvin, 1989).

Elkhart River

The Elkhart River drainage is the major southwestern segment of the St. Joseph River (comprising 699 miles^2) mainly in Noble and Elkhart Counties. The Elkhart River has been impounded by numerous low-head dams upstream of the City of Elkhart, and receives a substantial amount of its streamflow from groundwater The major tributary segments of the Elkhart River in Indiana includes North Branch and South Branch Elkhart Rivers, Solomons Creek, Yellow Creek, Stony Creek, and Rock Run Creek-Horn Ditch. The average discharge of the Elkhart River near Goshen (Elkhart County) during the period of record (1931 to present) was 514 cfs. Discharge ranged from a minimum daily low of 7.0 cfs, 81 cfs during the 7 day, 10 year low flow, to 6,180 cfs during maximum flow periods (Arvin, 1989).

Little Elkhart River

The Little Elkhart River drainage is the major central segment (draining 129 miles^2) which connects with the St Joseph River near Bristol, Elkhart County. The Little Elkhart River is unaffected by man-made regulation, and receives a substantial amount of its streamflow from groundwater The River emanates southeast from Lagrange County and flows northwest. Major tributary segments of the Little Elkhart include Mathur Ditch, Rowe-Eden Ditch, and Emma Creek. The average discharge of the Little Elkhart River at Middlebury (Elkhart County) was 100 4 cfs during the period of record (1971-1979, new station 1979-present). Discharge records ranged from 32 cfs during minimum daily flow, 8 0 cfs during the 7 day, 10 year low flow, to 1,690 cfs during maximum flow periods (Arvin, 1989).

Pigeon River

The Pigeon River drainage is the major northern segment (draining 374 miles^2) connecting with the St Joseph River in southwestern Michigan. The Pigeon River is unaffected by man-made regulation, and receives a substantial amount of its streamflow from groundwater The headwater of the River is in Steuben County and flow is northwest. Major tributary segments of the Pigeon River include Fawn Creek, Fly Creek, and Turkey Creek The average discharge of Pigeon River near Angola (Steuben County) was 78.9 cfs during the period of record (1945-present). Discharge records ranged from 3.4 cfs during minimum daily flow, 5.8 cfs during the 7 day, 10 year low flow, to 795 cfs during maximum flow periods (Arvin, 1989).

Historical St. Joseph River Data

The St. Joseph River is the largest Indiana tributary to Lake Michigan and historically was stated to be one of Indiana's highest quality resources The first use of the St. Joseph River was as a commercial connection for fur traders between the Great Lakes and the Mississippi River Portage between the Great Lakes and Mississippi River was through the Great Marsh of the Kankakee River. Since then the St. Joseph River has been intensively examined including its importance as a trade route (Fatout 1985); hydrology (Bailey *et al*. 1985; Crompton et al. 1986; Hoggatt 1981); surficial geology and physiography (Indiana DNR 1987; Gray in preparation); Paleozoic and Quarternary geology (Gooding 1973; IDNR 1987); drainage characteristics (IDNR 1987).

stream-flow (Stewart 1983; Glatfelter 1984); groundwater flow (IDNR 1987); limnology and chemistry of lakes (Scott, 1931; Eberly, 1959; Pearson, 1986; Bell and Spacie 1978, 1979, 1988); nutrient and sediment transport (IDEM, unpublished data from 1985-86).

The aquatic communities of the St. Joseph River drainage have been correlated with water quality (Simon and Newhouse, *in preparation*). Various components of the aquatic community of St Joseph River and tributaries have been studied including the microbial community (IDEM 1994), plankton community (Mueller, 1959; IDEM 1994), macroinvertebrates (Scott, *et al.* 1928, 1938; Stahl, 1959; Newhouse, *unpublished data*), while the mussel fauna was studied by Watters (1988). The fish community has also been well studied in lakes and streams including distribution (Gerking 1945; Gulish, 1973); population dynamics of stocked fish (Ledet 1989a; Ricker, 1942a,b,c,d,e, 1955); and fisheries potential of the St Joseph River (Ledet, 1979, 1986, 1989, 1990), and tributaries (Peterson, 1971, 1973, 1974a,b, 1979; Pearson, 1981; Peterson and Ledet, 1982; Ledet, 1989, 1991a,b). Sport fishes have been studied (Parks, 1949) including cisco (Gulish, 1973, 1974), bluegill (Ricker, 1942b), and smallmouth bass (Ledet, 1989; Stefanavage, 1987).

The St. Joseph River possesses a highly diverse fish community. The earliest records of Jordan (1877) suggest the river was abundant with both food and non-game species. The St. Joseph River received a relatively small amount of collection effort by early ichthyologists. Jordan (1890) collected at a single site on the St. Joseph River at Mishawaka and South Bend. Eigenmann (1896) collected from Turkey Creek and several lakes. Gerking (1945) collected at approximately 30 localities in the watershed.

3.0 MATERIALS AND METHODS

Sampling

Site Specific

In order to answer basin-specific questions and to calibrate an IBI for evaluating ecosystem health, a sufficient number of samples were required from each of the various drainages. A total of 104 locations (Fig. 3) were surveyed during June through August 1991 in order to compile the data needed to evaluate the maximum species richness lines for calibration of the Index of Biotic Integrity. Site and collection records are maintained within the State of Indiana files. Since the primary purpose of this study was to evaluate the water quality of Indiana using biological methodology, no further evaluation of site specific data, (e.g. site specific taxonomic species lists) will be included other than an overall taxa list for each sub-drainage.

To ensure repeat sampling at the exact same site, all locations are based on latitude and longitude. Narrative descriptions for mileage are from the center point rather than the edge of the nearest town since the boundaries of many Indiana towns will change over the next century. All sites were evaluated based on drainage area, since this provides a reliable quantification (Hughes *et al.* 1986) of stream size. As drainage area increases fewer locations are available for comparative analysis

Habitat

The diversity of habitats sampled has a major effect on data collection. A "representative" sample always requires that the entire range of riffle, run, pool, and extra-channel habitat be sampled, especially when large rivers are

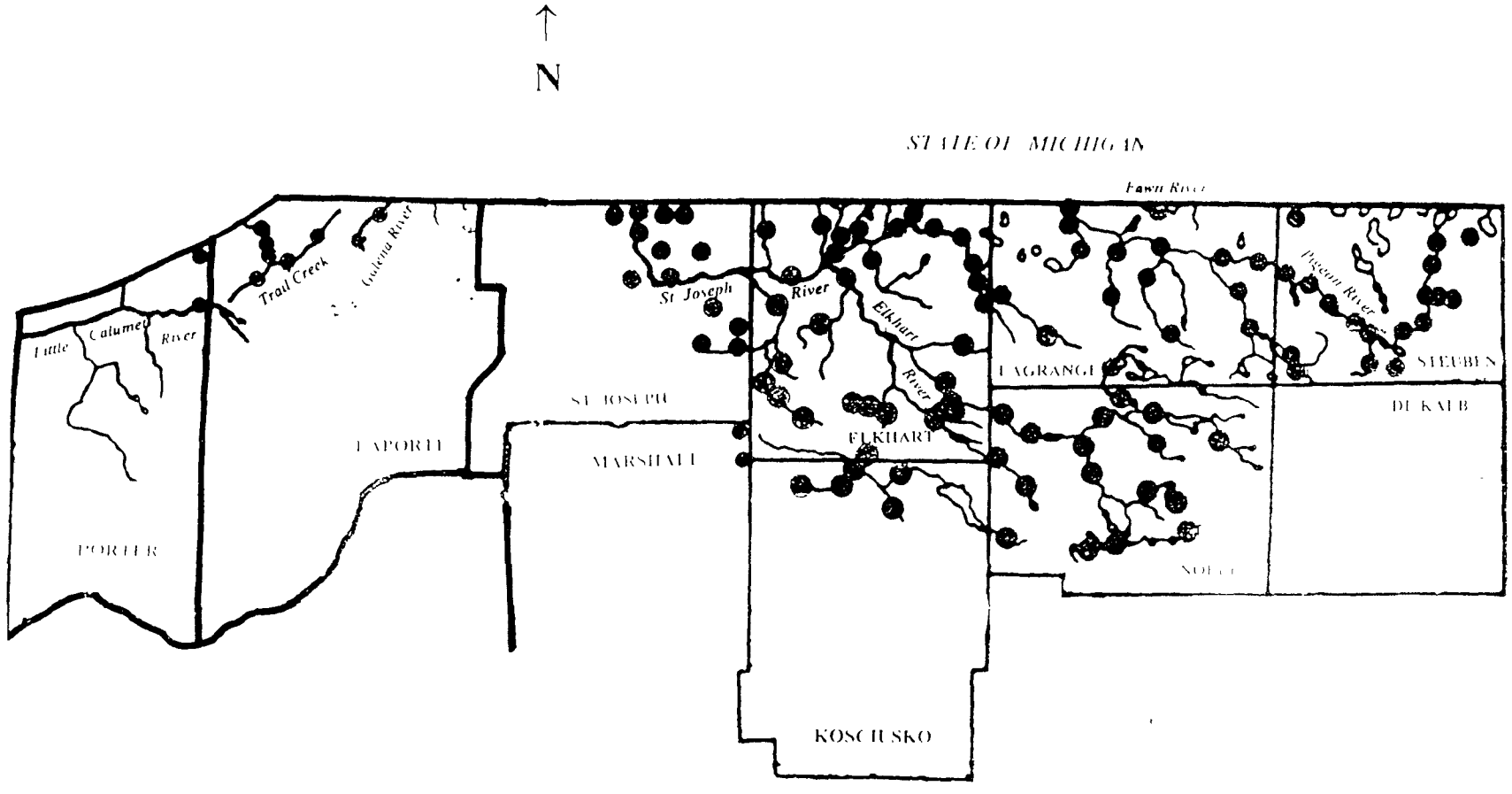


Figure 3 St Joseph River drainage indicating the location of sampled locations during 1990 and 1991.

surveyed. Atypical samples result when unrepresentative habitats are sampled adjacent to the sampling site Species richness near bridges or near the mouths of tributaries entering large rivers, lakes, or reservoirs are more likely to be characteristic of large-order habitats than the one under consideration (Fausch *et al.* 1984)

A general site description of each established sampling location was conducted using the field observation procedure of Ohio EPA (1989) and Rankin (1989). The Quality Habitat Evaluation Index (QHEI) takes into account important attributes of the habitat which increases heterogeneity. Scoring incorporates information on substrate composition, instream cover, channel morphology, riparian zone and bank erosion, and pool and riffle quality. Physical/chemical parameters were recorded for each sample site to assist in assessing the biological data further: dissolved oxygen, pH, temperature, and specific conductivity. Equipment utilized for physical water quality analysis was a Hydrolab SVR2-SU meter following the specifications of the manufacturer.

Community Analysis

Sample Considerations

Only one electrofishing gear type is needed at each location to collect a representative sample (Jung and Libosvarsky 1965, Ohio EPA 1989). A T&J pulsed-DC generator capable of 300 volt output, 1750 watts was mounted in a Coleman Sport-canoe, floated in a Sport-Yak, or attached to a long-line (see Ohio EPA 1989 or USEPA 1988 for discussion of gear) We collected by wading in shallow riffles and runs, and floated through pools and unwadeable habitat Sampling included both shorelines in streams > 5 m or followed a serpentine pattern on both shores for streams < 5 m.

All fish encountered were collected at each site. Adult and juvenile specimens from each stream reach were identified to species utilizing the taxonomic keys of Gerking (1955), Trautman (1981), and Becker (1983). Cyprinid taxonomy follows Mayden (1989), changes in species nomenclature are listed in Appendix C for comparability with previous investigations. The young-of-the-year fish less than 20 mm in length are not included in Index of Biotic Integrity or composite totals analysis. Early life stages exhibit high initial mortality (Simon 1989) and are difficult to collect with gear designed for larger fish (Angermeier and Karr 1986). Collection of fish from this category will be retained for possible future use in State water monitoring programs (e.g. ichthyoplankton index (I^2)). Specimens greater than 20 mm TL are easily collected using our gear. Juvenile specimen survival at lengths > 20 mm TL also show many species begin to function in distinct trophic guilds and reflect mature species attributes.

Many different study designs can be employed to assimilate a reference database. Two broad categories of random and nonrandom designs can enable sampling localities to be targeted for specific habitat types or provide a representative picture of the area under consideration. We used a nonrandom study design since our intentions were to avoid known point and non-point sources of pollution.

An additional consideration for choosing a non-random designs include spatial coverage. Numerous studies (Ohio EPA, 1989) have utilized a reference site approach that compares the very best an area has to offer against typical or representative portions of the region Additional study is needed to evaluate

site variation and seasonal trends causing sites to have to be repeat sampled. Ohio has had a significant advantage in determining where "least impacted" or reference sites exist because of the extensive work of Trautman (1981), and other ichthyologists before him. Unfortunately, the historic record for Indiana begins in the late 1800's and ends at approxiamtely 1945 with the published work of Shelby Gerking. Little sampling of the fish community of Indiana has been completed since this time Based on information presented in the National 305(b) report to Congress, Indiana had less than 2% of the surface waters assessed prior to 1990. We initiated this project to determine where these "least impacted" sites occurred and assimilated a database to address immediate data needs for biocriteria development. We suggest that the criteria presented in this document is a "first attempt" to evaluate Indiana surface waters.

During 1991, drought conditions prevailed for the Southern Michigan-Northern Indiana Till Plain Further research is needed to evaluate the response of the criteria under differing water cycles.

The length of stream reach sampled is an important consideration. Karr *et al.* (1986) recommended in larger streams to select several contiguous riffle-pool sequences rather than relying on a standard length. When electrofishing equipment was employed in larger rivers (i e. > 1.000 mi^2), samples were taken in units of 0.5 to 1.0 km (Gammon *et al.* 1981) The length of the sample reach was long enough to include all major habitat types. Distances of 11 to 15 stream widths were generally adequate to sample two cycles of habitat (Leopold *et al.* 1964). Ohio EPA (1989) suggested that after 150-200 m of stream length no significant increases in the IBI are observed, however species richness may still increase until 250-300 m. The additional increase in effort is not justified by the assessment capability of the index so the minimum distance of 15 times the mean stream width was adopted. Additional site information (e.g. photographs· latitude and longitude) were recorded on the data sheet.

Selecting the appropriate time of year for sampling is critical. Karr *et al* (1986) found that periods of low-to moderate stream flow are preferred and the relatively variable flow conditions of early spring and late autumn/winter should be avoided. Species richness tends to be higher later in summer due to the presence of young-of-the-year of rare species, but this can be avoided if data analysis does not incorporate young-of-the-year species. Samples of limited area may be less variable in early summer than comparable samples taken later in the year Each site was sampled for a single pass on both shorelines for nonwadeable locations.

Sample Site Selection

Fish sample sites were selected based upon several factors

1) Choosing stream reaches not affected by point source dischargers that were typical of the region under study.

2) Stream use issues (i.e. municipal treatment works, non-point source, nutrient reduction),

3) Location of physical stream features (e.g. dams, changes in geology, changes in stream order, presence of stream confluence, etc.);

4) Location of non-point sources of pollution (e.g. urban areas or obvious farm runoff);

5) Variations in habitat suitability for fish;

6) Atypical habitat not representative of River reach or basin.

Whenever possible, sites were located upstream from pollution sources and adjacent tributaries (Gammon 1973). Stations were selected to include natural areas, parks (Federal, State, County, and Local), exceptional designated streams, and from historical sampling locations whenever available.

When non-impacted areas were not present, "least impacted" areas were selected based on the above criteria. Sites were chosen which indicated recovery from channelization or potential non-point source areas, and which had a suitable riparian buffer on the shoreline. When a series of point source dischargers were located on a river, every effort was made to sample upstream of the discharger or to search for areas of recovery between dischargers (Krumholz 1946).

When impoundments or other physical habitat alterations had been imposed on a river, sampling was conducted in the tailwaters of a dam (area immediately downstream). Tailwaters possess the greatest resemblance of the lotic habitat The serial discontinuity concepts of Stanford *et al.* (1988) predicts that the thermal character of a stream below a dam will be "reset" toward that typical of the stream reaches above the dam. In areas where sampling could not be accomplished downstream of the physical structure due to lack of access, stream tributary segments were located upstream of the dam away from the immediate influence of the pooled portion. Likewise, bridges were sampled on the upstream side, away from the immediate vicinity of the structure and latent bridge construction effects. If downstream sampling was conducted because of better habitat considerations, sampling was terminated at least 50 m downstream of the bridge.

Fish from each location were identified to species and enumerated. Smaller and more difficult to identify taxa were preserved for later examination and identification in the laboratory. All fish were examined for the presence of gross external anomalies. Incidence of these anomalies was defined as the presence of externally visible morphological anomalies (i.e. deformities, erosion, lesions/ulcers) Specific anomalies include: anchor worms; leeches; pugheadedness; fin rot; Aeromonas (causes ulcers, lesions, and skin growth, and formation of pus-producing surface lesions accompanied by scale erosion); dropsy (puffy body); swollen eyes; fungus; ich; curved spine; and swollen-bleeding mandible or opercle. Incidence is expressed as percent of anomalous fish among all fish collected. Incidence of occurrence was computed for each species at each station.

Hybrid species encountered in the field (e.g. hybrid centrarchids, cyprinids) were recorded on the data sheet, and when possible, potential parental combinations recorded.

Index of Biotic Integrity

The ambient environmental condition was evaluated using the Index of Biotic Integrity (Karr 1981; Karr *et al.* 1986) This index relies on multiple parameters (termed "metrics") based on community concepts, to evaluate a complex biotic system. It incorporates professional judgement in a systematic and sound manner, but sets quantitative criteria that enables determination of a continuum between very poor and excellent based on species richness and composition, trophic and reproductive constituents, and fish

Table 1. Attributes of Index of Biotic Integrity (IBI) classification, total IBI scores, and integrity classes from Karr *et al.* (1986).

Total IBI score	Integrity Class	Attributes
58-60	Excellent	Comparable to the best situation without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of age (size) classes; balance trophic structure
48-52	Good	Species richness somewhat below expectations, especially due to the loss of the most intolerant forms, some species are present with less than optimal abundances or size distributions, trophic structure shows some signs of stress
40-44	Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g. increasing frequency of omnivores and other tolerant species); older age classes of top predators may be rare.
28-34	Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
12-22	Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.
0	No Fish	Repeated sampling finds no fish.

abundance and condition. The twelve original Index of Biotic Integrity metrics reflect insights from several perspectives and cumulatively are responsive to changes of relatively small magnitude, as well as broad ranges of environmental degradation.

Since the metrics are differentially sensitive to various perturbations (e.g. siltation or toxic chemicals), as well as various degrees or levels of change within the range of integrity, conditions at a site can be determined with considerable accuracy. The interpretation of the index scoring is provided in six narrative categories which have been tested in the midwestern United States (Karr 1981, Table 1).

Several of the metrics are drainage size dependent and require calibration to determine numerical scores (Tables 2-3). Drainage size effects were determined by evaluating trends in species or proportions of individuals with increasing (log adjusted) drainage area The

Table 2. Index of Biotic Integrity metrics used to evaluate headwater streams (<20 miles^2 drainage area) sites in the St. Joseph River drainage.

Metric Category	Metric	Scoring Classification 5	3	1
Species Composition	Total Number of Species	Varies with drainage area (Fig. 4)		
	Number Darter/Madtom/Sculpin Spp	Varies with drainage area (Fig. 5)		
	% Headwater Species	≥ 50%	25- <50	< 25 (Fig. 6)
	Number of Minnow Species	Varies with drainage area (Fig 8)		
	Number Sensitive Species	Varies with drainage area (Fig. 10)		
	% Tolerant Individuals	<33%	33-66%	>66% (Fig.11)
Trophic Composition	% Omnivore Individuals[1] ≤ 20 square miles	<33%	33-66%	>66% (Fig. 12)
	% Insectivores Individuals[1] ≤ 20 square miles	>60%	30-60%	<30 (Fig. 13)
	% Pioneer Species Individuals[1]	< 33%	33-66%	>66% (Fig. 14)
Fish Condition	Catch per Unit Effort[1]	Varies with drainage area (Fig. 16)		
	% Simple Lithophil Individuals[1]	>45%	15-45%	<15% (Fig. 17)
	% DELT Individuals[1]	<0.1%	0.1-1.3%	>1.3% (Fig 18)

[1] Special scoring procedures are required when less than 50 individual fish are collected

Table 3. Index of Biotic Integrity metrics used to evaluate wadable river (>20 - <1,000 miles^2 drainage area) sites in the St. Joseph River drainage.

Metric Category	Metric	Scoring Classification 5	3	1
Species Composition	Total Number of Species	Varies with drainage area (Fig 4)		
	Number of Darter Species	> 3	2	< 2 (Fig. 5)
	Number of Sunfish Species	Varies with drainage area (Fig 7)		
	Number of Sucker Species	Varies with drainage area (Fig. 9)		
	Number of Sensitive Species	Varies with drainage area (Fig. 10)		
	% Tolerant Individuals	<33%	33-66%	>66% (Fig. 11)
Trophic Composition	% Omnivore[1] Individuals < 1,000 square miles	<33%	33-66%	>66% (Fig. 12)
	% Insectivores[1] Individuals < 1,000 square miles	>60%	30-60%	<30% (Fig. 13)
	% Carnivores[1] Individuals	>16%	8-16%	<8% (Fig. 15)
Fish Condition	Catch per Unit Effort	Varies with drainage area (Fig. 16)		
	% Simple Lithophils Individuals	>45%	15-45%	<15% (Fig. 17)
	% DELT [1] Individuals	<0.1%	0.1-1.3%	>1 3% (Fig 18)

[1] Special scoring procedures are required when less than 100 individual fish are collected.

ecoregion approach developed by USEPA-Corvallis, Oregon, was utilized to compare "least impacted" zones within the region (Omernik 1987). Ohio EPA (1987), modified several of the original 12 metrics in order to make them more sensitive to environmental effects based on their experiences in Ohio and to account for stream and river size, faunal differences, and sampling gear selectivity. The current study utilizes the experiences of the Ohio EPA and Karr *et al.* (1986) in developing an IBI for Indiana streams and rivers in the Northern Indiana Till Plain

Metrics

In general, the metrics utilized for the current study are those developed by the State of Ohio (Ohio EPA 1989) for analysis of surface water designated use-attainment. This includes modification of several of the original Index of Biotic Integrity metrics as proposed by Karr (1981).

Although the methodology and application of the ecoregional expectations are similar in approach to Ohio and much of the information below is taken directly from the Ohio document (Ohio EPA 1989), a significant difference exists between the Indiana and Ohio reference conditions. This difference exists in how the metric expectations are developed. In Ohio, the ecoregional reference stations were combined into a single data set for the entire State, and later modifications were developed for a single ecoregion.

In Indiana, "least impacted" conditions are being developed on a regional basis, with *a priori* recognition of basin differences within ecoregion, based on the natural division classification of Homoya *et al.* (1985). Further evaluation at the completion of the of the study will determine if differential metric treatment is warranted for basin specific or larger scale criteria development.

The Index of Biotic Integrity is sensitive to differences in collection effort and gear type. In order to account for these inherent biases, separate expectations are developed for each of the two stream classification types utilized in the current study. Headwater stream sites (< 20 miles^2) were primarily sampled for 50-100 m using wading techniques. These sites were sampled using a long-line configuration usually off bridges, while larger wadable rivers (> 20-1000 miles^2) were sampled using the sport-yak configuration. This technique requires a sampling distance of 100-300 m and wading in all available habitats.

Below is an explanation of each of the twelve metrics utilized for the calibration of the Indiana Index of Biotic Integrity for the Northern Indiana Till Plain. Due to inherent differences at approximately 20 miles^2 drainage area, different metrics were necessary to evaluate both headwater (<20 miles^2 drainage area) and wadable rivers (>20-1000 miles^2 drainage area) No differences were observed between the ecoregions and subbasins for most metrics. This was anticipated due to the limitations of the gear type chosen and that large rivers tend to be integrators of the upstream drainage area. Maximum species richness lines were drawn following the procedure of Fausch *et al.* (1984) and Ohio EPA (1987). Scatter plot data diagrams of individual metrics were first evaluated for basin specific patterns. The trisection method was used to depict the maximum species richness lines. This requires the uppermost line to be drawn so that 95% of the data area lies beneath. The other two lines are then drawn so the remainder of the area beneath the 95th percentile line is divided into three equivalent areas In situations where no significant deviation in relationship was observed within the three basin segments, the segments were pooled to reflect an ecoregional consensus. Likewise, if no relationship with increasing drainage area was observed, the maximum species richness lines either leveled off at the point where no additional increases were exhibited or horizontal plots were delineated indicating no increase with drainage area.

Differentiation between headwater and wadable stream and river sites are indicated on the graphs by a vertical dashed line on the appropriate metrics

This relationship was determined by searching for bimodal patterns in the basin specific data set plots. The tails of distribution of the data are not significant. However the point where the data differentiates into two distinct peaks suggest that the transition between headwater and wadable streams is at 20 miles^2 (% headwater taxa) and between wadable and large rivers at 1,000 miles^2 (% large river individuals). Finally, a comparison was made between criteria established for the ecoregion between Michigan and Indiana

Metric 1. Total Number of Fish Species (Headwater and Wadable Sites)

Impetus

This metric is utilized for all of the stream classification types used for calibrating the Indiana Index of Biotic Integrity. Unlike the Ohio metric, exotic species are included in the total number of taxa. The premise behind this metric is based on the observation that the number of fish species increases directly with environmental complexity and quality of the aquatic resource (Karr 1981; Karr *et al.* 1986). Although the number of exotic or introduced species may be indicative of a loss of integrity (Karr *et al.* 1986; Ohio EPA 1989), the differences between lower levels of biotic integrity resolution may be due to colonization of habitats by pioneer or tolerant taxa which tend to incorporate exotic species.

This single metric is considered to be one of the most powerful metrics in resolving water resource issues since a direct correlation exists between high quality resources and the numbers of species for warmwater assemblages (Ohio EPA 1987; Davis and Lubin 1989; Plafkin *et al* 1989; Simon, 1991). As total number of species increases, species become more specialized and have narrower niche breadths, numerous higher level interactions occur and presumably enable greater efficiency in resource utilization. The delimitation between headwater and wadable Indiana streams in the Central Corn Belt Plain ecoregion was made primarily on the data from this metric. Headwater and wadable streams are differentiated at 20 miles^2 drainage area.

Headwater and Wading Sites

The number of species is strongly correlated with drainage area at headwater, wadable stream, and river sites up to ca. 1,000 miles^2. Determining the Index of Biotic Integrity scoring criteria for this metric did not require the recognition of watersheds. Comparison of maximum species richness lines for the appropriate basin and drainage area did not reveal any significant differences between ecoregion or subwatershed (Fig. 4, headwater and wading sites).

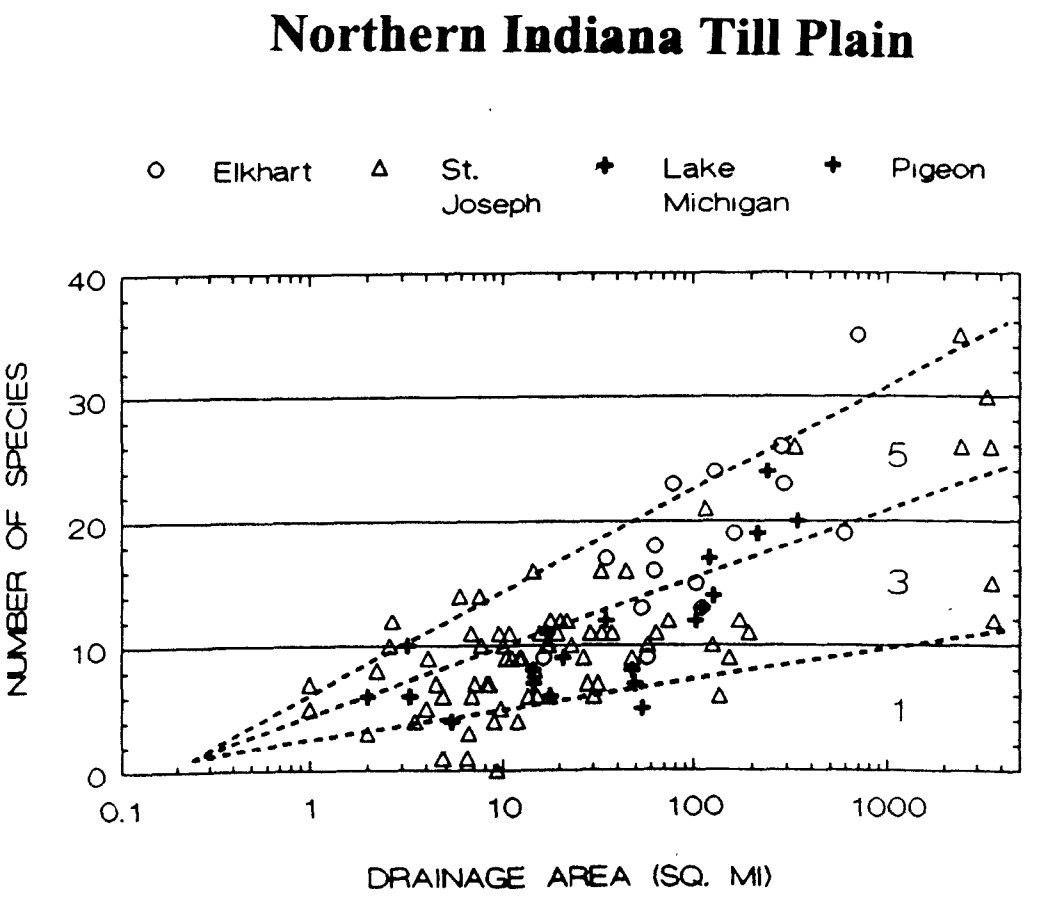


Figure 4. Maximum species richness lines for determining trends in total number of species with increasing drainage area for the St. Joseph River drainage

Metric 2. Number of Darter/Madtom/Sculpin Species (Headwater ≤ 20 miles^2) Number of Darter Species (Wadable Rivers > 20- ≤1,000 miles^2)

Impetus

Karr *et al.* (1986) indicated that the presence of members of the tribe Etheostomatini are indicative of a quality resource Darters require high dissolved oxygen concentrations, are intolerant of toxicants and siltation, and thrive over clean substrates.

Life history information for all of the 28 Indiana species indicates darters are insectivorous, habitat specialists, and sensitive to physical and chemical environmental disturbances (Page 1983; Kuehne and Barbour 1983). Darters are excellent indicators of a quality resource, and are generally found in riffle habitats.

Headwater and Wadable Streams and Rivers

The darters include the genera: Ammocrypta, Crystallaria, Etheostoma, and Percina. Of the 28 species recorded from Indiana, six are commonly found throughout the State and are not restricted to a particular stream size (Gerking 1945). Thirteen of these 28 species are confined to the Ohio River basin; none of the species are restricted to the Mississippi River basin; and a single species occurs only in the Great Lakes drainage.

For sites having drainage areas less than 20 miles^2, this metric also includes members of the family Cottidae and Ictaluridae (madtoms; genus Noturus)(Table 4). The sculpins and madtoms are benthic insectivores and functionally occupy the same type of niche as darters. Their inclusion enables a greater degree of sensitivity in evaluating streams that naturally have significantly fewer darter species. By adding madtoms and sculpins this metric does not asymptote with increased drainage area for headwater sites (<20 miles^2)(Fig. 5). The number of darter, madtom and sculpin species was found to increase with increasing drainage area for each of the four watersheds. No differences in ecoregion or watershed expectations were observed between sites of the Northern Indiana Till Plain.

Wadable River Sites

Madtoms and sculpins are more difficult to collect with increasing drainage area, since madtoms are typically nocturnal in their habits. The expected number of sculpin and madtom species declines in the St. Joseph River drainage with increasing drainage area. Thus, only the number of darter species are included in cumulative scoring for drainage areas greater than 20 miles^2 due to sampling bias and the patchy distribution of sculpins and madtoms in wadeable rivers (>20-1000 mi^2). This conforms with the original IBI and is consistent with Karr's original intentions (Karr 1981).

Table 4. The distributional characteristics of Indiana darter (Etheostomatini), madtom (Noturus), and sculpin (Cottus) species.

Species	Distribution in Indiana Drainages			
	Statewide	Ohio River	Great Lakes	Mississippi River
Ammocrypta pellucida	X			
A. clara		X		
Crystallaria asprella		X		
Etheostoma asprigene	X			
E. blennioides	X			
E. caeruleum	X			
E. camurum		X		
E. chlorosoma	X			
E. exile			X	
E. flabellare	X			
E. gracile		X		
E. histrio		X		
E. maculatum		X		
E. microperca[1]	X			
E. nigrum	X			
E. spectabile		X		X
E. squamiceps		X		
E. tippecanoe		X		
E. variatum		X		
E. zonale		X		X
Percina caprodes	X			
P. copelandi		X		
P. evides		X		
P. maculata	X			
P. phoxocephala			X	X
P. sciera		X		
P. shumardi		X		X
P. vigil		X		
Noturus eleutherus		X		
N. flavus	X			
N. gyrinus	X			
N. exilis		X		
N. miurus		X		X
N. nocturnus		X		
N. stigmosus	X			
Cottus bairdi	X			
C. carolinae		X		
C. cognatus			X	

[1] Restricted to northern portions of these drainages.

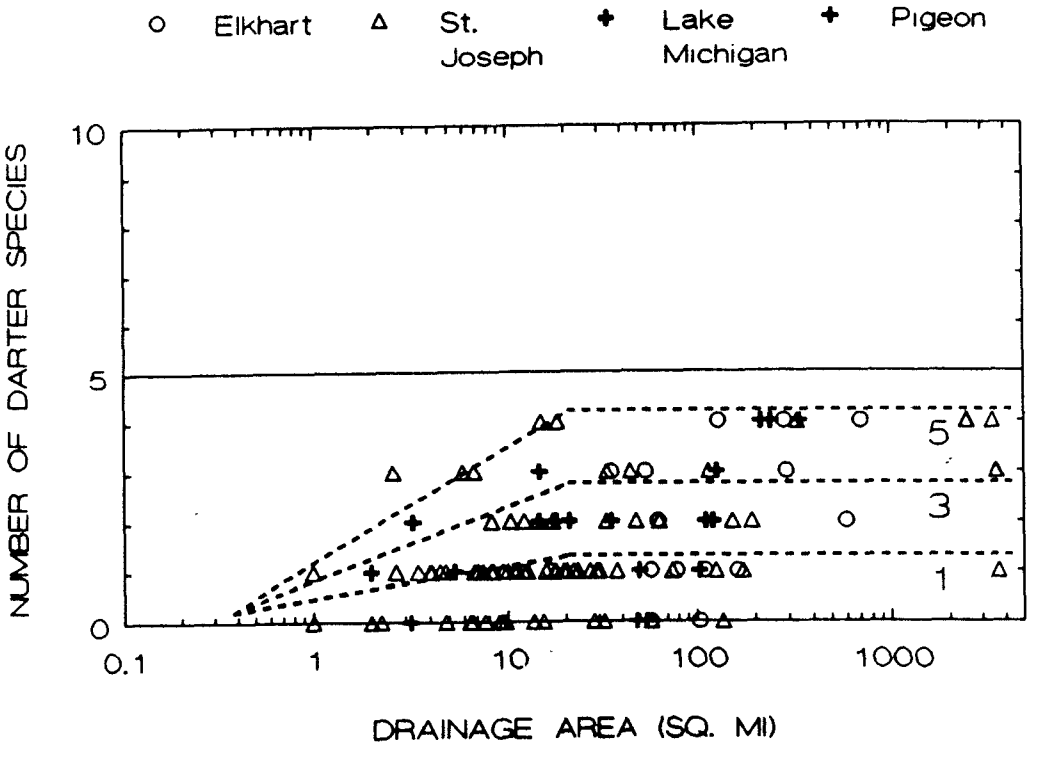


Figure 5. Maximum species richness lines for determining trends in number of darter/madtom/sculpin species with increasing drainage area for the St. Joseph River drainage.

Metric 3. Percent Individuals as Headwater Species (Headwater ≤20 miles^2) Number of Sunfish Species (Wadable Sites >20 - ≤1,000 miles^2)

Impetus

This metric followed Karr (1981) and Karr *et al.* (1986) by including the number of sunfish species (family Centrarchidae) and excluding the black basses (Micropterus spp). Unlike the Ohio metric, the redear sunfish Lepomis microlophus is included because it is native to Indiana (Table 6). Hybrid sunfish are not included in this metric following Ohio EPA (1989).

This metric is an important measure of pool habitat quality. It includes all members of the sunfish genera Ambloplites (rock bass), Centrarchus (round sunfish), Lepomis (sunfish), and Pomoxis (crappies), as well as, the ecological equivalent Elassomatidae (Elassoma zonatum). Sunfish normally occupy slower moving water which may act as "sinks" for the accumulation of toxins and siltation. This metric measures degradation of rock substrates (i.e. gravel and boulder) and instream cover (Pflieger 1975; Trautman 1981), and the associated aquatic macroinvertebrate community which are an important food resource for sunfish (Forbes and Richardson 1920; Becker 1983). Sunfish are important components of the aquatic community since they are wide ranging, and distributed in most streams and rivers of Indiana. They are also very susceptible to sampling using electrofishing gear. Karr *et al.* (1986) found sunfish to occupy the intermediate to upper ends of sensitivity of the index of biotic integrity (IBI).

Headwater Streams

Pool habitat is a limiting factor in many headwater streams This prohibits sunfish colonization by because of their deep-bodied morphology I replaced the number of sunfish species with the proportion

Table 5. List of Indiana fish species considered to be headwater species for evaluating permanent habitat in streams (Smith, 1971).

Common Name	Scientific Name
Least brook lamprey	Lampetra aepyptera
American brook lamprey	L. appendix
Redside dace	Clinostomus elongatus
Blacknose dace	Rhinichthys atratulus
So Redbelly dace	Phoxinus erythrogaster
Brook stickleback	Culaea inconstans
Fantail darter	Etheostoma flabellare
Mottled sculpin	Cottus bairdi
Banded sculpin	C. cognatus

of headwater species at sites with drainage areas less than 20 miles^2 (Ohio EPA, 1987). Nine headwater species were defined by Ohio EPA (1987) and their presence indicates permanent habitat with low environmental stress (Table 5). The presence of headwater species does not show a trend with increased drainage area (Fig. 6).

Wadable Streams and Rivers

Sunfish colonization is limited by the amount of pool habitat in many river reaches. This metric did not show any difference in scoring based on sub-basin. The number of sunfish species increased with increasing drainage area (Fig. 7).

Table 6. List of Indiana sunfish species for evaluating quality pool habitat.

Common Name	Scientific Name
Rock bass	Ambloplites rupestris
Flier	Centrarchus macropterus
Green sunfish	Lepomis cyanellus
Pumpkinseed	L. gibbosus
Warmouth	L. gulosus
Orangespotted sunfish	L. humilis
Bluegill	L.macrochirus
Longear sunfish	L. megalotis
Redear sunfish	L.microlophus
Spotted sunfish	L. punctatus
Bantam sunfish	L. symmetricus
White crappie	Pomoxis annularis
Black crappie	P. nigromaculatus
Banded pygmy sunfish	Elassoma zonatum

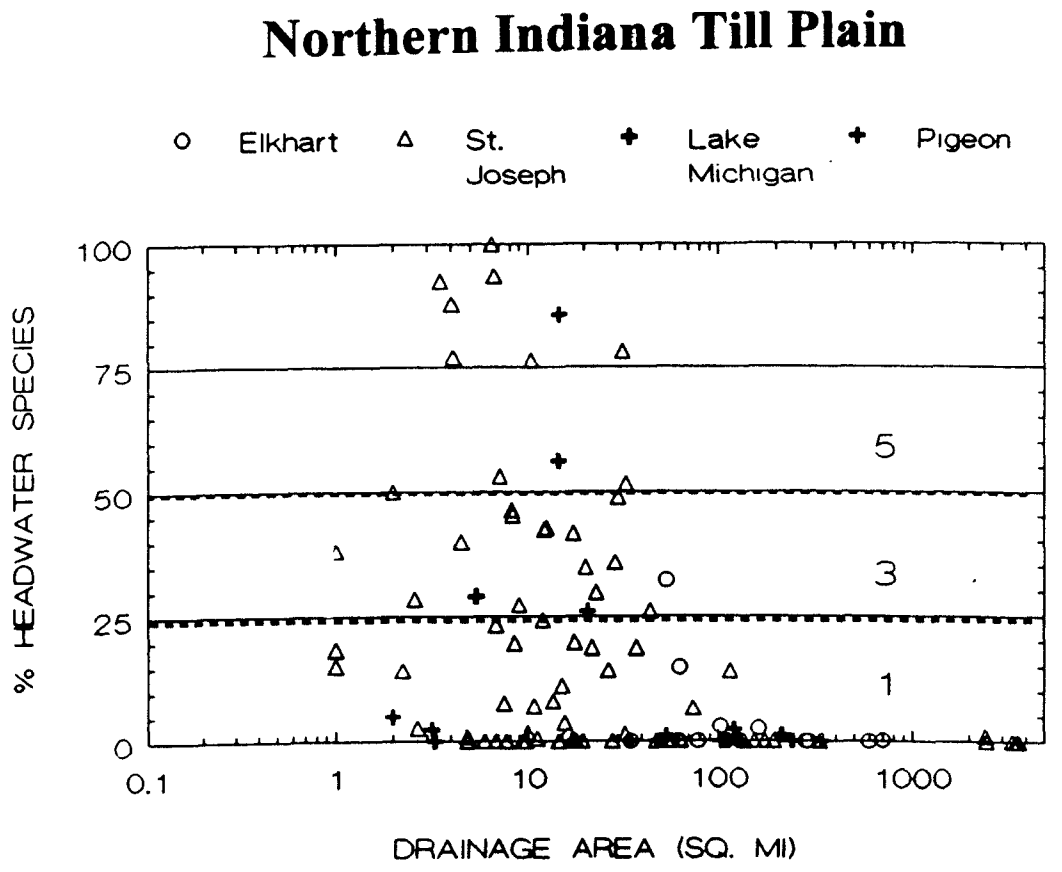


Figure 6. Maximum species richness lines for determining trends in the proportion of headwater species with increasing drainage area for the St. Joseph River drainage.

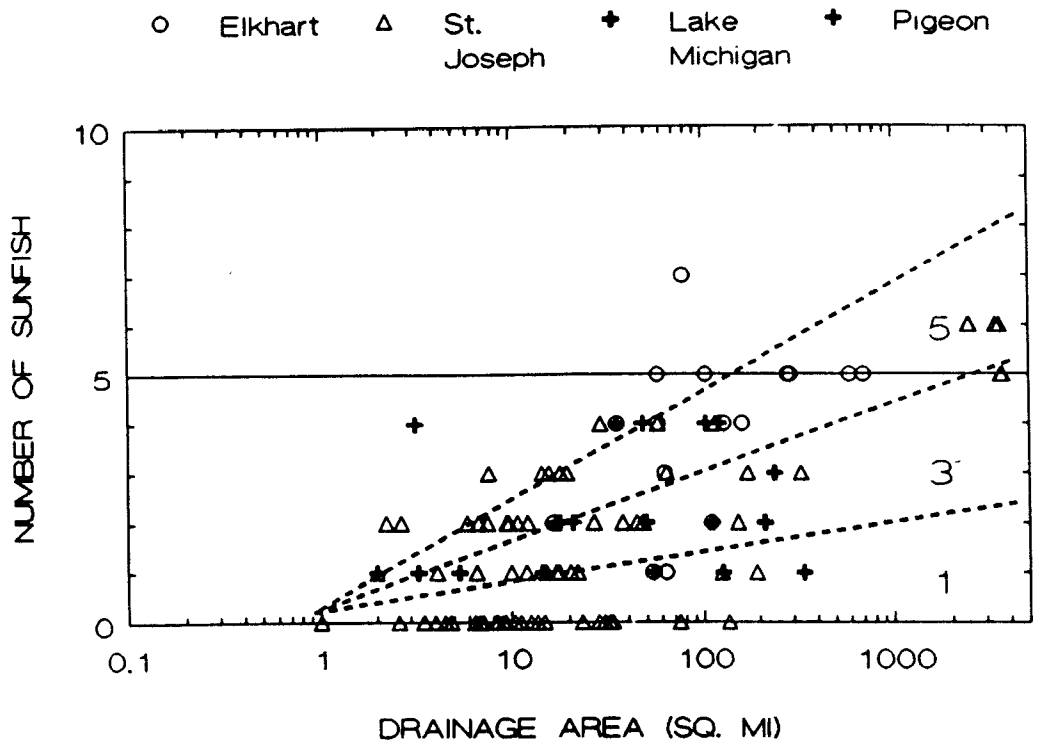


Figure 7. Maximum species richness lines for determining trends in number of sunfish species with increasing drainage area for the St. Joseph River drainage.

Metric 4. Number of Minnow Species (Headwater Sites < 20 miles^2) Number of Sucker Species (Wadable Sites (>20-≤ 1000 miles^2)

Impetus

The original Index of Biotic Integrity metrics included the number of sucker species (Karr 1981, Karr *et al* 1986). Suckers represent a major component of the Indiana fish fauna since their total biomass usually ranks them among the highest biomass contributors in the community. Most sucker species are intolerant to habitat and water quality degradation (Phillips and Underhill 1971; Karr *et al*. 1986; Trautman 1981; Becker 1983) and this results in metric sensitivity at the higher end of environmental quality. Suckers, due to their long life span (10-20 years), provide a long-term assessment of past environmental conditions. Of the 19 species historically found in Indiana, Lagochila lacera is considered extinct, seven species are widely distributed throughout the State (Table 7). Extant sucker genera include: Cycleptus, Carpiodes, Catostomus, Erimyzon, Hypentelium, Ictiobus, Minytrema, and Moxostoma.

Headwater Sites

The number of minnow species is substituted for the number of sucker species in headwater sites (Fig. 8). The number of sucker species decreases rapidly with declining drainage area (Fig. 9). While few different sucker species have been observed at locations with drainage areas less than 20 miles^2. The number of minnow species generally correlates with increased environmental quality. This metric includes members able to represent a wide variety of biological integrity. Species such as the hornyhead chub (Nocomis biguttatus) and rosyface shiner (Notropis rubellus) are examples of minnow species which can occur in high quality headwater streams Minnow species represent both ends of the biological integrity continuum. A direct relationship exists between increasing number of minnow species and increasing drainage area (Fig. 8).

Wadable River Sites

The number of sucker species, with the exception of Catostomus commersoni, Ictiobus and Carpiodes, represent sensitive species intolerant to thermal, siltation, and toxins stresses. The redhorses are particularly important indicator organisms in rivers. The most sensitive suckers include members of the genera Cycleptus, Hypentelium, Moxostoma, Minytrema, and Erimyzon. These species are effectively sampled with electrofishing gear and comprise a significant component of riverine fish faunas. Their feeding and reproductive requirements are sensitive to turbidity and marginal to poor water quality The number of species were not significantly different among the four watersheds (Fig. 9)

Table 7. Distribution characteristics of Indiana sucker species (family Catostomidae).

Species	Statewide	Large Rivers	Rare Taxa
Cycleptus elongatus		X	X
Carpiodes carpio	X	X	
C. cyprinus	X		
C. velifer		X	X
Catostomus catostomus			X
Catostomus commersoni	X		
Erimyzon oblongus	X		
E. sucetta			X
Hypentelium nigricans		X	X
Ictiobus bubalus	X	X	
I. cyprinellus		X	X
I. niger			X
Lagochila lacera	EXTINCT		
Minytrema melanops	X		
Moxostoma anisurum	X	X	
M. carinatum		X	X
M. duquesnei	X	X	
M. erythrurum	X	X	
M macrolepidotum	X	X	
M. valenciennesi		X	X

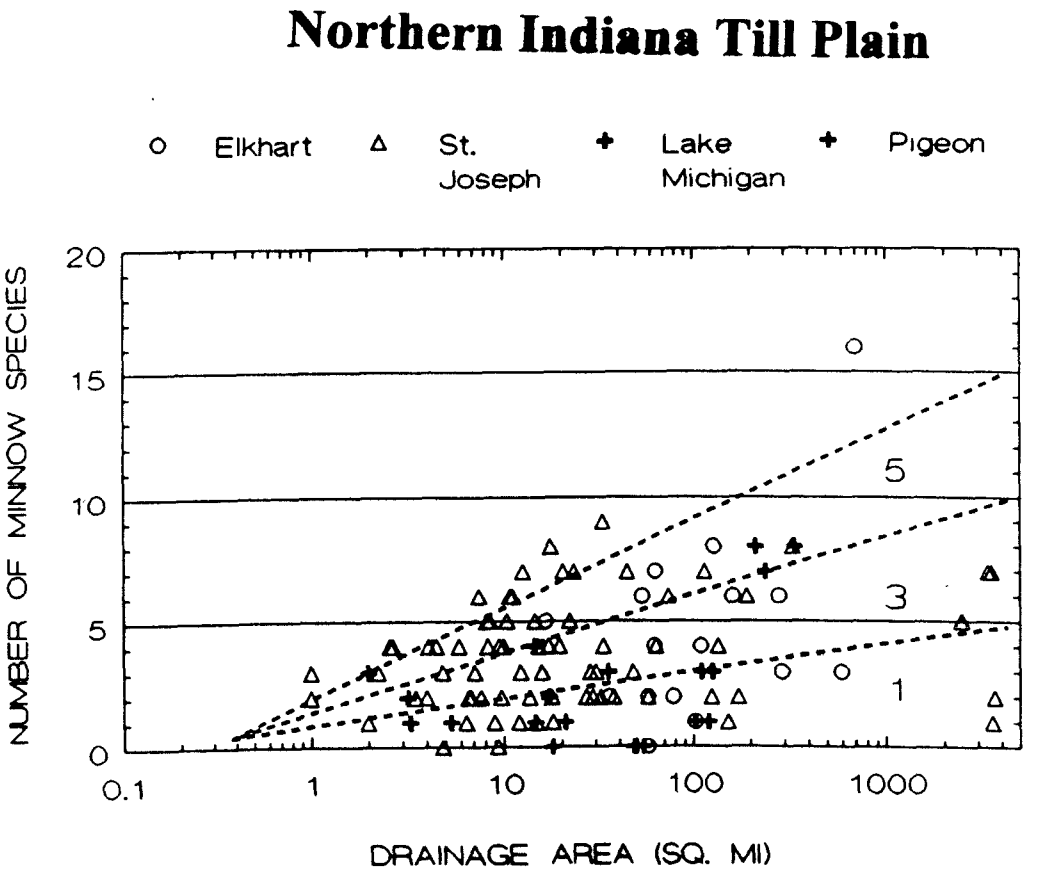


Figure 8. Maximum species richness lines for determining trends in number of minnow species with increasing drainage area for the St. Joseph River drainage.

Northern Indiana Till Plain

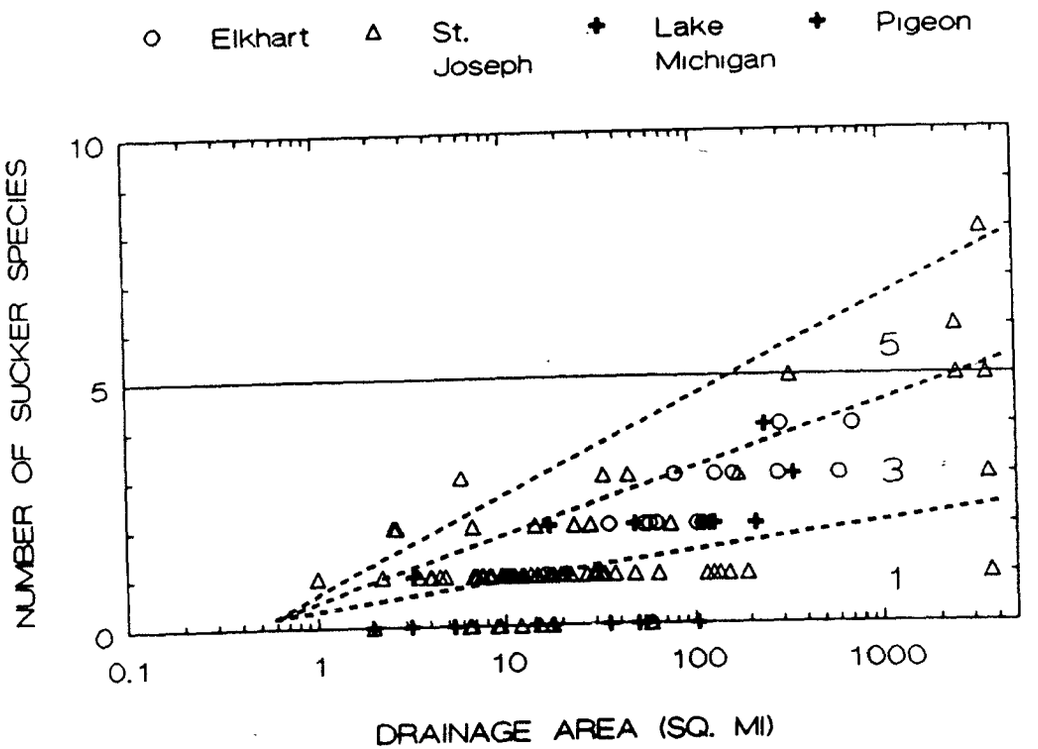


Figure 9. Maximum species richness lines for determining trends in number of sucker species with increasing drainage area for the St. Joseph River drainage.

Metric 5. Number of Sensitive Species (Headwater and Wadable Sites)

Impetus

The number of sensitive species metric distinguishes between streams of highest quality. Designation of too many species as intolerant will prevent this metric from discriminating among the highest quality resources. However, Karr (1981) and Karr *et al.* (1986) calibrated expectations based on watershed scales and not regional or state scales. Only species that are highly intolerant to a variety of disturbances were included in this metric so it will respond to diverse types of perturbations (Table 8; see Appendix A for species-specific information).

The number of intolerant taxa is a modification of the original index as developed by Ohio EPA (1987). The number of intolerant taxa, proposed by Karr (1981), is not synonymous with the sensitive species metric. The metric includes moderately intolerant species when sampling at headwater sites. This combination is called sensitive species since few intolerant taxa are expected. The moderately intolerant species meet most of the established criteria of Ohio EPA (1987). An absence of these species would indicate a severe anthropogenic stress or loss of habitat.

The criteria for determining intolerance is based on the numerical and graphical analysis of Ohio's regional data base. Gerking's (1945) documentation of historical changes in the distribution of Indiana species, and supplemental information from regional ichthyofaunal texts (Pflieger 1975; Smith 1979; Trautman 1981, Becker 1983; Burr and Warren 1986). Intolerant taxa are those which decline with decreasing environmental quality and disappear, as viable populations, when the aquatic environment degrades to the "fair" category (Karr *et al.* 1986). The intolerant species list was divided into three categories, all are included in this metric for scoring:

1). common intolerant species (I) species that are intolerant, but are widely distributed in the best streams in Indiana;

2). uncommon or geographically restricted species (S): species that are infrequently captured or that have restricted ranges;

3). rare or possibly extirpated species (R):intolerant species that are rarely captured or that lack recent status data.

Commonly occurring intolerant species made up 5-10% of the common species in Indiana, however represent 35-40% of the entire statewide list. This was a recommended guideline of Karr (1981) and Karr *et al.* (1986). Although the addition of species designated as uncommon or rare sensitive species (categories 2 and 3), inflates the number of intolerant species above the 10% guideline, nowhere in the State do all of the species coexist at the same time In order to evaluate streams in the headwater and wadable site categories, only the sensitive species metric will be used until further resolution is possible with the addition of adjacent ecoregion sampling. Until more sampling is completed or improvements in water quality warrant it, the sensitive species metric (Ohio EPA 1987) will be used for all headwater streams and wadable river sites in Indiana.

Headwater and Wadable Streams and Rivers

The number of intolerant species increases with drainage area among headwater and wading sites (Fig. 10). Intolerant taxa are scarce in headwaters of the Northern Indiana Till Plain and increase at larger wading sites. In order to provide meaningful stream reach comparisons in Indiana, the sensitive species metric is currently retained until further evaluation can be completed.

Table 8. List of Indiana fish species considered tc be sensitive to a wide variety of environmental disturbances including water quality and habitat degradation.

Common Name	Scientific Name	Common Name	Scientific Name
Ohio lamprey	Ichthyomyzon bdellium	Mountain madtom	Noturus eleutherus
Northern brk lamprey	I. fossor	Slender madtom	N. exilis
Least brook lamprey	Lampetra aepyptera	Stonecat	N. flavus
American brk lamprey	L. appendix	Brindled madtom	N. miurus
		Freckled madtom	N. nocturnus
Paddlefish	Polyodon spathula	Northern madtom	N. stigmosus
Goldeye	Hiodon alosoides	Southern cavefish	Amblyopsis spelaea
Mooneye	H. tergisus	Southern cavefish	I subterraneus
		Northern studfish	Fundulus catenatus
Redside dace	Clinostomus elongatus	Starhead topminnow	F. dispar
Streamline chub	Erimystax dissimilis		
Gravel chub	E. x-punctata	Brook silverside	Labidesthes sicculus
Speckled chub	Extrarius aestivalis		
Bigeye chub	Hybopsis amblops	Rock bass	Ambloplites rupestris
Pallid shiner	H. amnis	Longear sunfish	Lepomis megalotis
Rosefin shiner	Lythrurus ardens	Smallmouth bass	Micropterus dolomieui
Hornyhead chub	Nocomis biguttatus		
River chub	N. micropogon	Western sand darter	Ammocrypta clara
Pugnose shiner	Notropis anogenus	Eastern sand darter	A. pellucida
Popeye shiner	N. ariommus	Greenside darter	E blennioides
Bigeye shiner	N. boops	Rainbow darter	E. caeruleum
Ironcolor shiner	N. chalybaeus	Bluebreast darter	E. camurum
Blackchin shiner	N. heterodon	Harlequin darter	E. histrio
Blacknose shiner	N. heterolepis	Spotted darter	E. maculatum
Sand shiner	N. ludibundis	Spottail darter	E. squamiceps
Silver shiner	N. photogenis	Tippecanoe darter	E. tippecanoe
Rosyface shiner	N. rubellus	Variegate darter	E. variatum
Weed shiner	N. texanus	Banded darter	E zonale
Mimic shiner	N. volucellus	Logperch	Percina caprodes
Pugnose minnow	Opsopoeodus emiliae	Channel darter	P copelandi
Longnose dace	Rhinichthys cataractae	Gilt darter	P. evides
Blue sucker	Cycleptus elongatus	Slenderhead darter	P. phoxocephala
Highfin carpsucker	Carpiodes velifer	Dusky darter	P sciera
Northern hogsucker	Hypentelium nigricans	Saddleback darter	P vigil
Silver redhorse	Moxostoma anisurum		
River redhorse	M. carinatum		
Black redhorse	M. duquesnei		
Golden redhorse	M erythurum		
Shorthead redhorse	M. macrolepidotum		
Greater redhorse	M. valenciennesi		

Northern Indiana Till Plain

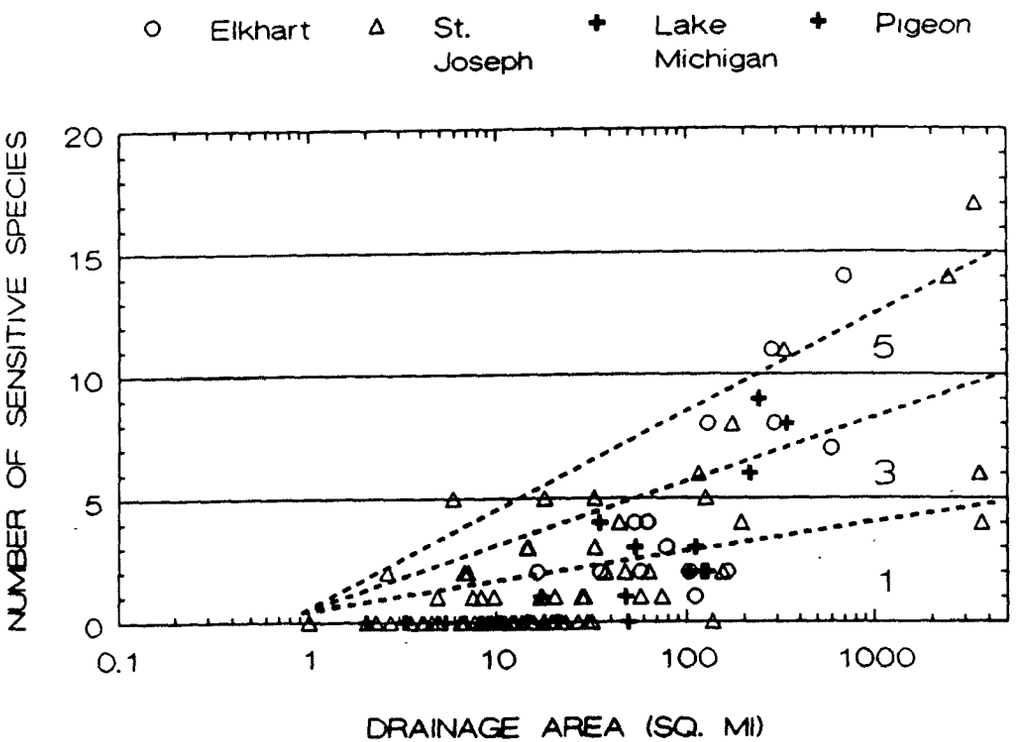


Figure 10. Maximum species richness lines for determining trends in number of sensitive species with increasing drainage area for the St. Joseph River drainage.

Metric 6. Percent Abundance of Tolerant Individuals (All Sites)

Impetus

This metric is a modification of the original index metric, the percentage of green sunfish (Karr *et al.* 1986), by Ohio EPA (1989) This metric detects a decline in stream quality from fair to poor categories The green sunfish, Lepomis cyanellus, is a species that is often present in moderate numbers in many Midwest streams and can become a dominant member of the community in cases of degradation or poor water quality. Competitive advantage in disturbed environments enables the green sunfish to survive and reproduce even under perturbed conditions. Although the green sunfish is widely distributed in the Midwest, it is most commonly collected in headwater streams. This introduces an inherent bias for moderate to large rivers. Karr *et al.* (1986) suggested additional species could be substituted for the green sunfish if they responded in a similar manner. Several species in Indiana meet this criteria of increasing in proportion with increasing degradation of stream quality. This increase in the number of tolerant species increases the sensitivity of this metric for various sized streams and rivers. Since different species have habitat requirements that are correlated with stream size, compositional diversity of the tolerant species metric does not change with drainage area.

Indiana's tolerant species are listed in Table 9. This list is based on a numerical and graphical analysis of Ohio EPA (1989) and checked against Indiana catch data and historical changes in the distribution of fishes throughout Indiana (Gerking 1945) Species listed as tolerant taxa exhibit diverse tolerance to thermal loadings, siltation, habitat degradation, and certain toxins (Gammon 1983; Ohio EPA 1989). Tolerant species were selected based on the following criteria:

1) present at poor or fair sites: Based on our data base of Indiana collections these species are commonly collected at sites ranked either fair or poor.

2) historically increases in abundance: Based on historical collection information (Gerking 1945) these species increase in abundance and have not indicated any reduction in distribution.

3) increased tolerance to degraded conditions: these species increased in community dominance when environmental conditions shifted from good to fair or poor environmental quality.

Headwater and Wadable Streams and Rivers

No relationship was evident for drainage areas between 20-1000 miles^2 (Fig. 11), nor was there any relationship with ecoregion or sub-basin apparent for the St. Joseph River drainage.

Table 9. List of Indiana fish species considered to be highly tolerant to a wide variety of environmental disturbances including water quality and habitat degradation for Headwater and Wadable River sites.

Tolerant Species Common Name	Scientific Name
Longnose gar[1]	Lepisosteus osseus
Shortnose gar[1]	L. platostomus
Gizzard shad	Dorosoma cepedianum
Central mudminnow	Umbra limi
Carp	Cyprinus carpio
Goldfish	Carrasius auratus
Red shiner	Cyprinella lutrensis
Golden shiner	Notemigonus crysoleucas
Bluntnose minnow	Pimephales notatus
Fathead minnow	P. promelas
Blacknose dace	Rhinichthys atratulus
Creek chub	Semotilus atromaculatus
River carpsucker[1]	Carpiodes cyprinus
Quillback[1]	C. carpio
Smallmouth buffalo[1]	Ictiobus bubalus
Bigmouth buffalo[1]	I. cyprinellus
White sucker	Catostomus commersoni
Channel catfish[1]	Ictalurus punctatus
Flathead catfish[1]	Pylodictis olivaris
Yellow bullhead	Amieurus natalis
Brown bullhead	A. melas
Banded killifish	Fundulus diaphanus
Freshwater drum[1]	Aplodinotus grunniens
White bass[1]	Morone chrysops
Green sunfish	Lepomis cyanellus

[1] Species indicated are considered tolerant only for drainage areas > 2300 mi^2

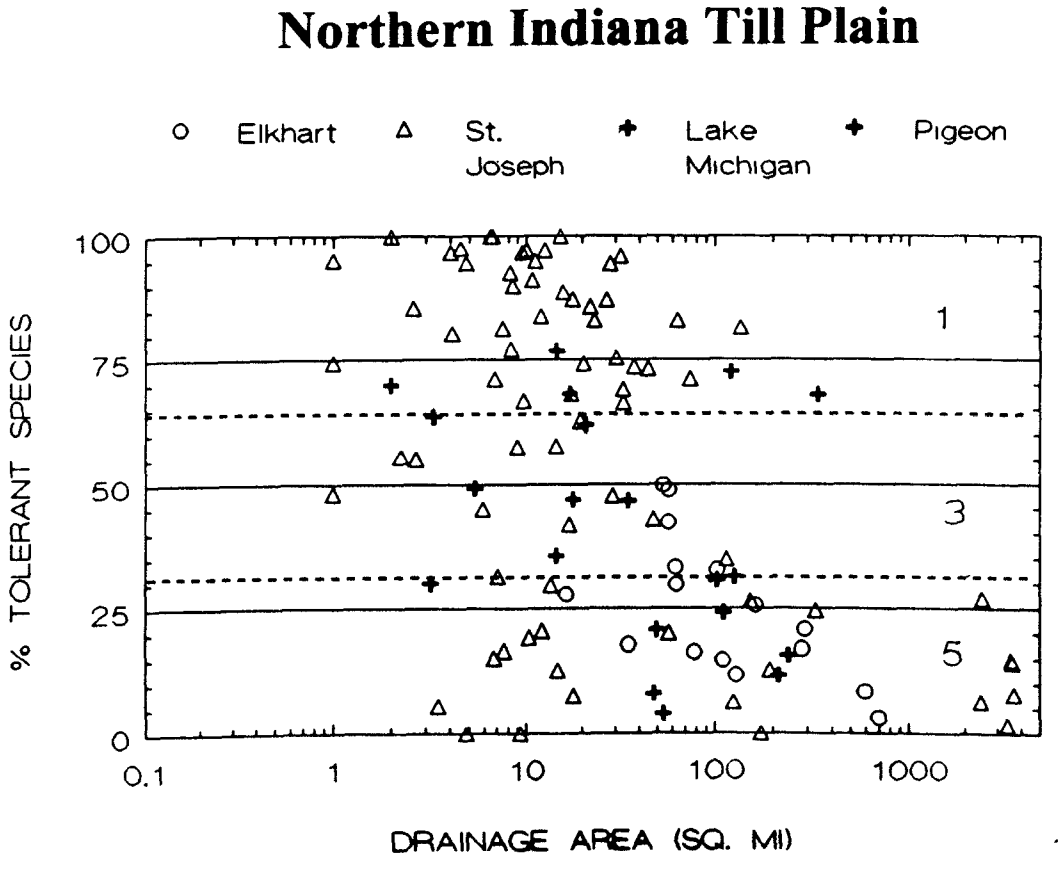


Figure 11. Maximum species richness lines for determining trends in the proportion of tolerant species with increasing drainage area for the St. Joseph River drainage.

Metric 7. Proportion of Omnivores (Headwater and Wadable Rivers)

Impetus

The definition of an omnivore follows that of Karr (1981) and Karr *et al.* (1986), which requires species to consume significant quantities of both plant and animal materials (including detritus) and have the ability (usually indicated by the presence of a long gut and dark peritoneum) to utilize both. Omnivores are species whose diets include at least 25% plant and 25% animal foods. Fishes which do not feed on plants but on a variety of animal material are not considered omnivores. Dominance of omnivores suggests specific components of the food base are less reliable, increasing the success of more opportunistic species. Specialized filter-feeders are not included in this metric after Ohio EPA (1989) since these species are sensitive to environmental degradation, e.g. paddlefish, Polyodon spathula and lamprey ammocoetes, Lampetra and Ichthyomyzon. Facultative species which shift diet due to degraded environmental conditions are also not considered omnivores, e.g. Semotilus atromaculatus and Rhinichthys atratulus. This metric evaluates the intermediate to low categories of environmental quality (Table 10; see Appendix A for species-specific feeding guild classification).

Headwater and Wadable Streams and Rivers

Only those species which consistently feed as omnivores were included in our analysis. These values differ from the omnivore percentages of Karr *et al.* (1986) but resemble Ohio EPA's (1987) classification No relationship with drainage area was found for headwater or wadable stream and river sites (Fig. 12).

Table 10. List of Indiana fish species considered omnivores.

Common Name	Scientific Name
Gizzard shad	Dorosoma cepedianum
Threadfin shad	D. petenense
Central mudminnow	Umbra limi
Goldfish	Carassius auratus
Grass carp	Ctenopharyngodon idella
Carp	Cyprinus carpio
Cypress minnow	Hybognathus hayi
Miss. silvery minnow	H. nuchalis
Silver carp	Hypopthalmichthys molitrix
Black carp	Mylopharyngodon piceus
Bluntnose minnow	Pimephales notatus
Fathead minnow	P. promelas
Bullhead minnow	P. vigilax
Rudd	Scardinius erythrophthalmus
River carpsucker	Carpiodes carpio
Quillback	C. cyprinus
Highfin carpsucker	C. velifer
White sucker	Catostomus commersoni

The lack of a drainage area pattern is anticipated since degraded habitats are not exclusive to any particular size waterbody.

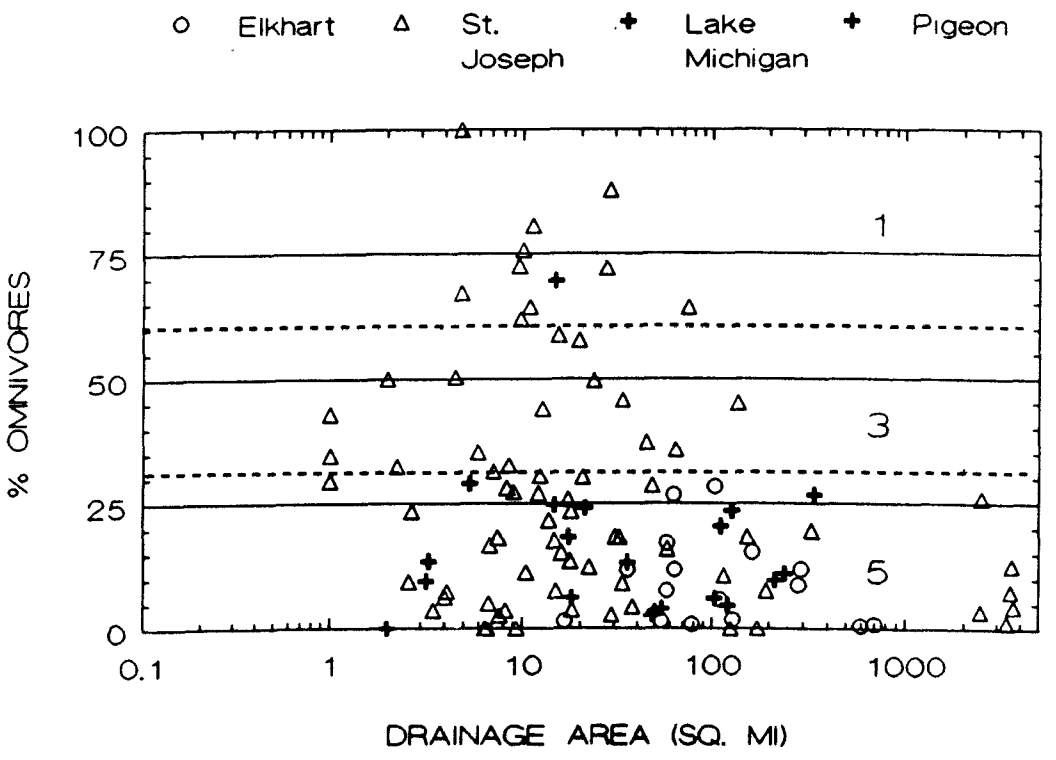


Figure 12. Maximum species richness lines for determining trends in the proportion of omnivores with increasing drainage area for the St. Joseph River drainage.

Metric 8. Proportion of Insectivore Individuals (Headwater and Wadable Sites)

Impetus

The proportion of insectivores is a modification of Karr *et al.*'s (1986) original metric, i.e. proportion of insectivorous cyprinidae. This metric is intended to respond to a depletion of the benthic macroinvertebrate community which comprises the primary food base for most insectivorous fishes. As disturbance increases, the diversity of insect larvae decreases, triggering an increase in the omnivorous trophic level. Thus, this metric varies inversely with metric 7 with increased environmental degradation. The inclusion of all insectivorous species was based on the observation that all regions of Indiana do not possess high proportions of insectivorous cyprinids in high quality streams, e.g. Central Corn Belt Plain and Interior Plateau ecoregions. This metric was recalibrated following the recommendation of Karr *et al.* (1986; see Appendix A for species-specific trophic level classifications).

Headwater and Wadable Streams and Rivers

Insectivorous species are an important link in transfering energy between lower trophic levels to keystone predator species. Species designations generally conforms to that provided in Karr *et al* (1986), however, I concur with Ohio EPA in the elimination of the opportunistic feeding creek chub, Semotilus atromaculatus, and blacknose dace, Rhinichthys atratulus, from the insectivore designation. Leonard and Orth (1986) felt that the current trophic definitions of Karr *et al.* (1986) were rather arbitrary since they observed a negative correlation between insectivores and biotic integrity in a West Virginia stream. Plots of the MSR lines showed no relationship existed between drainage area and proportion of insectivorous fishes in either ecoregion or sub-basin in the St. Joseph River drainage (Fig. 13).

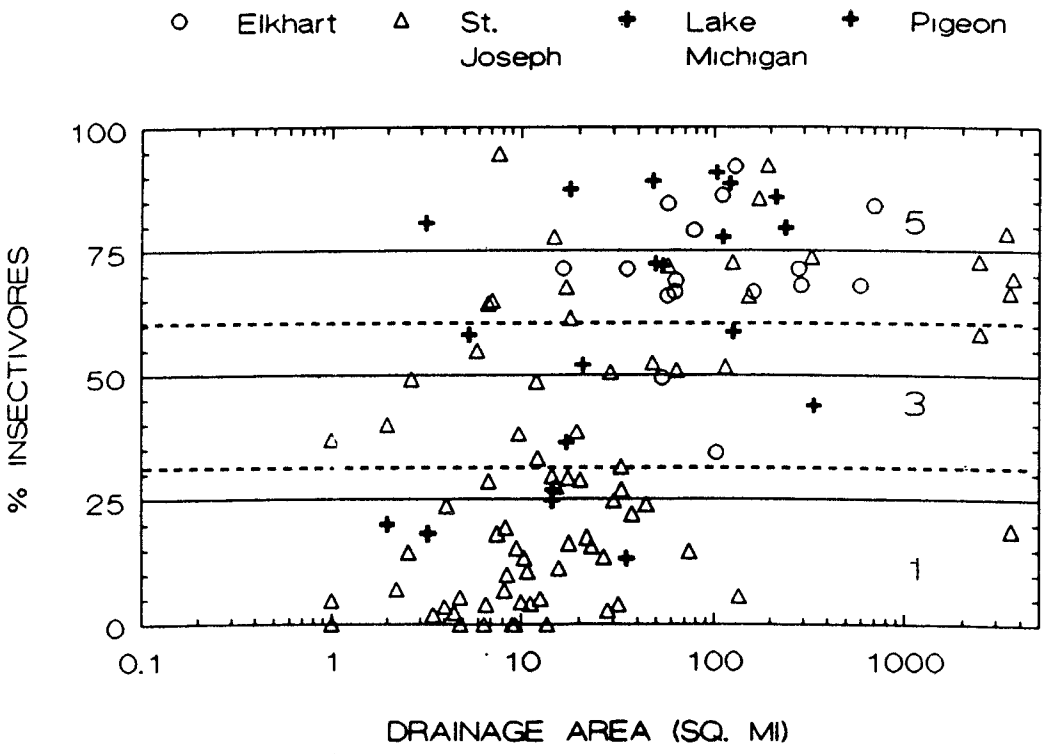


Figure 13. Maximum species richness lines for determining trends in the proportion of insectivores with increasing drainage area for the St. Joseph River drainage.

Metric 9. Proportion of Pioneer Species (Headwater Streams) Proportion of Carnivores (Wadable Rivers)

Impetus

Karr (1981) developed the carnivore metric to measure community integrity in the upper trophic levels of the fish community. It is only in high quality environments that upper trophic levels are able to flourish. This metric includes individuals of species in which the adults are predominantly piscivores, although some may feed on invertebrates and fish as larvae or juveniles. Species that are opportunistic do not fit into this metric, e.g. creek chub or channel catfish, Ictalurus punctatus (Karr *et al.* 1986; Ohio EPA 1987). Karr *et al.* (1986) suggest that some members of this group may feed extensively on crayfish and various vertebrates, *e.g.* frogs. Species-specific classifications are included in Appendix A and include piscivores (P) and carnivores (C).

Headwater Streams

Carnivores are generally not abundant in headwater streams. An alternate metric was developed by Ohio EPA (1987) to determine the permanence of the stream habitat. Smith (1971) identified a signature assemblage of small stream species which he termed "pioneer species" (Table 11). These are species which are the first to colonize sections of headwater streams after desiccation. These pioneer species predominate in unstable environments affected by anthropogenic stresses and temporal desiccation. A high proportion of pioneer species indicates an environment temporally unavailable or stressed. The metric does not change with increases in drainage area (Fig 14)

Table 11. List of Indiana fish species considered to be pioneer species indicators of temporal habitats (Larimore and Smith 1963; Smith 1971).

Common Name	Scientific Name
Central stoneroller	Campostoma anomalum
Largescale stoneroller	C. oligolepis
Silverjaw minnow	Ericymba buccata
Bluntnose minnow	Pimephales notatus
Fathead minnow	Pimephales promelas
Creek chub	Semotilus atromaculatus
Creek chubsucker	Erimyzon oblongus
Lake chubsucker	E sucetta
Green sunfish	Lepomis cyanellus
Johnny darter	Etheostoma nigrum
Orangethroat darter	Etheostoma spectabile

Wadable Sites

Karr (1981) suggested that the proportion of carnivores should be a reflection of drainage area. Such a correlation in streams greater than 20 miles^2 was not found by Ohio EPA or previous ecoregion studies (Simon, 1991). An increasing percent of individuals as carnivores was observed with increasing drainage area in the St. Joseph River drainage. The proportion of carnivores from the current data base was considerably higher than that approximated in Karr *et al.*'s (1986) original numbers (Fig. 15).

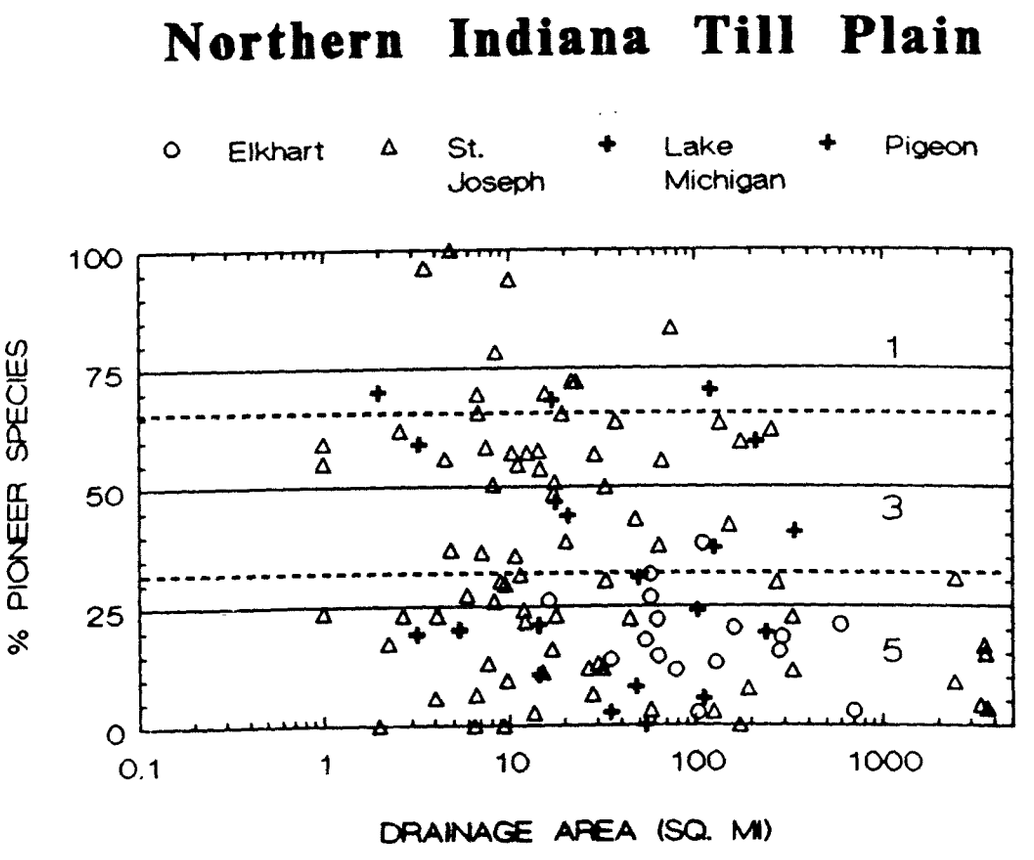


Figure 14. Maximum species richness lines for determining trends in the proportion of pioneer species with increasing drainage area for the St. Joseph River drainage.

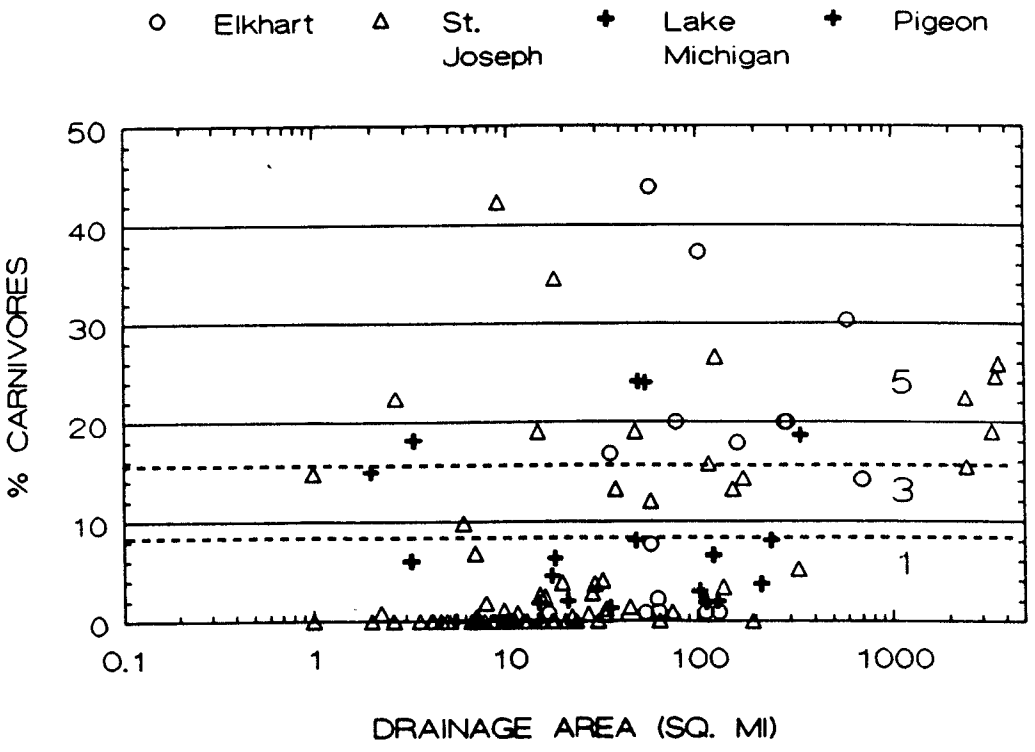


Figure 15. Maximum species richness lines for determining trends in the proportion of carnivores with increasing drainage area for the St. Joseph River drainage.

Metric 10. Relative Number of Individuals (Headwater and Wadable Sites)

Impetus

This metric evaluates population density and is expressed as catch-per-unit-effort. Effort is expressed by the relative number of individuals per length of reach sampled, per unit of area sampled, or per unit time spent depending on the gear used. Karr *et al.* (1986) suggest that this metric is most sensitive at intermediate to low ends of the sensitivity continuum. When low numbers of individuals are observed the normal trophic relationships are generally disturbed. Because of this effect, scoring adjustments are encouraged for sites when less than 50 individuals are collected (see next section for details). As integrity increases, total abundance increases and becomes more variable only depending on the level of energy and other natural chemical factors limiting production. Under certain circumstances, *e.g.* channelization, increases in the abundance of tolerant fishes can be observed (Ohio EPA 1987). Lyons (1992) found that abundance, excluding tolerant species, was greatest at fair quality sites in Wisconsin warmwater streams and lower at sites classified as excellent In this study, catch-per-unit-effort was determined based on the total number of individuals collected per 15 times the channel width without modification for tolerant taxa. The level of effort sampled within a reach was 50 m if the stream was < 3.4 m wide or 100 m minimum distance if the stream was > 3.4 m wide A maximum distance of 1000 m was sampled for stream widths > 66.7 m. Each shocking run was conducted with a standardized effort of 30 minutes of sampling per shoreline in 1000 m sites and 15 minutes per shoreline at 500 m sites including both shorelines.

Headwater and Wadable Streams and Rivers

A drainage area-dependent relationship was observed for the St. Joseph River drainage (Fig. 16). Lyons (1992) found in small streams in Wisconsin that excessive nutrients could artifically stimulate production in some degraded sites. In order to account for sites with inflated number of individuals, we adjusted scoring criteria to reflect declining quality with increasing numbers of individuals.

Based on our experience, if fewer than 50 fish are collected during a sampling event, alternate scoring procedures are required (see next section for details) Even at the river reach with the smallest drainage area I was able to collect a minimum of 100 fish

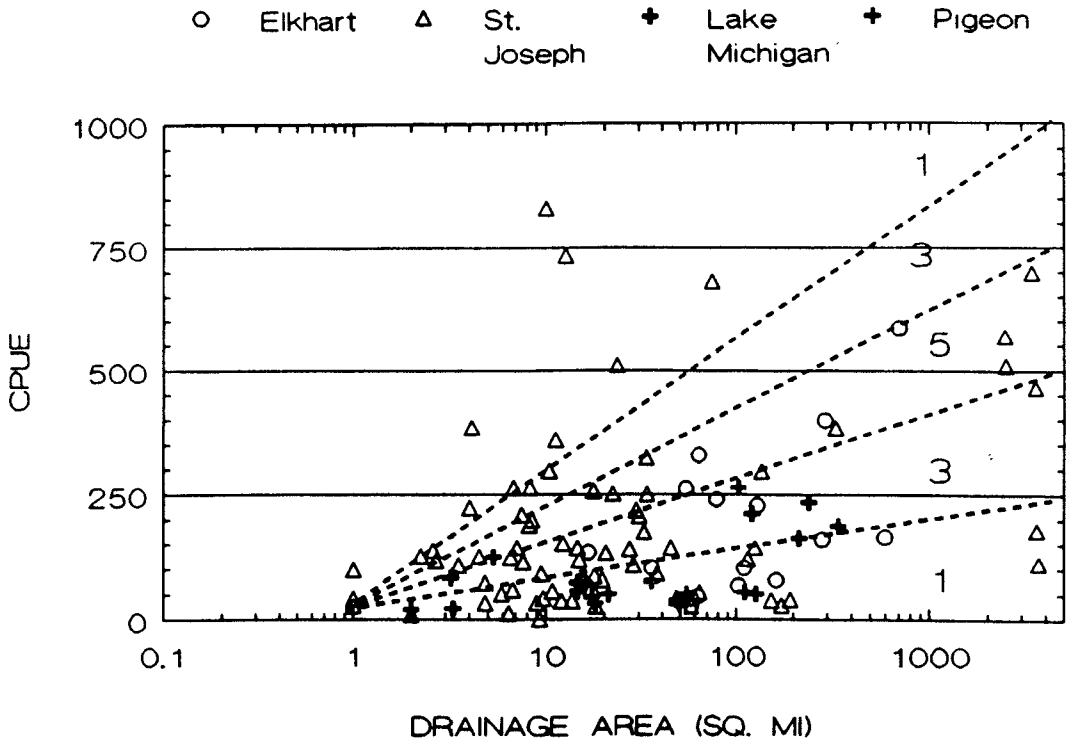


Figure 16. Maximum species richness lines for determining trends in the catch per unit effort with increasing drainage area for the St. Joseph River drainage.

Metric 11. Proportion of Individuals as Simple Lithophilic Spawners (Headwater and Wadable Rivers)

Impetus

Ohio EPA (1987) replaced the original index metric, proportion of hybrids (Karr *et al* 1986), with this metric. The hybrid metric was abandoned since the original intent of the metric was to assess the extent to which degradation has altered reproductive isolation among species. Difficulties of identification, lack of occurrence in headwater and impacted streams, and presence in high quality streams among certain taxa, e.g., cyprinids and centrarchids, caused a lack of sensitivity for the hybrid metric.

Spawning guilds have been shown to be affected by habitat quality (Balon 1975; Berkman and Rabeni 1987) and have been suggested as an alternative metric (Angermeier and Karr 1986). Reproductive attributes of simple spawning behavior requires clean gravel or cobble for success (i.e. lithophilous) and are the most environmentally sensitive (Ohio EPA 1987). Simple lithophils broadcast eggs which then come into contact with the substrate. Eggs develop in the interstitial spaces between sand, gravel, and cobble substrates without parental care Berkman and Rabeni (1987) observed an inverse correlation between simple lithophilic spawners and the proportion of silt in streams. Historically, some simple lithophilic spawners have experienced significant range reductions due to increased silt loads in streams. Some simple lithophils do not require clean substrates for reproduction. Larvae of these species are buoyant, adhesive, or possess fast developing eggs with phototactic larvae which have minimal contact with the substrate (Balon 1975) and are not included in the above designation. Simple lithophils are sensitive to environmental disturbance, particularly siltation. Designated lithophilic species are included in Table 12 (see Appendix A for species-specific ratings).

Headwater and Wadable Streams and Rivers

No relationship with drainage area was observed at stream and river sites for the proportion of lithophilic species in the St. Joseph River drainage (Fig. 17) Scoring was completed using the trisection method of Fausch *et al*. (1984). The lack of an increasing percentage of simple lithophils with increasing drainage area in the largest St. Joseph River drainage reaches was thought to be a reflection of degraded condtions. Best professional judgement was used in evaluating this metric. Simple lithophils are major components of fish communities indicating the importance of clean gravel and cobble substrates.

Table 12. List of Indiana species considered to be simple lithophilic spawners.

Simple Lithophils			
Common Name	Scientific name	Common Name	Scientific Name
Paddlefish	Polyodon spatula	Spotted sucker	Minytrema melanops
Lake sturgeon	Acipenser fulvescens	Silver redhorse	Moxostoma anisurum
Shovelnose sturgeon	Scaphirhynchus platorynchus	River redhorse	M. carinatum
		Black redhorse	M. duquesnei
Redside dace	Clinostomus elongatus	Golden redhorse	M. erythrurum
Lake chub	Couesius plumbeus	Shorthead redhorse	M. macrolepidotum
Streamline chub	Erimystax dissimilis	Greater redhorse	M. valenciennesi
Gravel chub	E. x-punctata		
Cent silvery minnow	Hybognathus hayi	Burbot	Lota lota
Miss. silvery minnow	H. nuchalis		
Bigeye chub	Hybopsis amblops	Western sand darter	Ammocrypta clara
Pallid shiner	H. amnis	Eastern sand darter	A. pellucida
Striped shiner	Luxilus chrysocephalus	Rainbow darter	Etheostoma caeruleum
Common shiner	Luxilus cornutus	Bluebreast darter	E. camurum
Rosefin shiner	Lythrurus ardens	Orangethroat darter	E. spectabile
Popeye shiner	N. ariommus	Tippecanoe darter	E. tippecanoe
River shiner	N. blennius	Variegate darter	E. variatum
Bigeye shiner	N. boops	Crystal darter	Crystallaria asprella
Silver shiner	N. photogenis	Logperch	Percina caprodes
Rosyface shiner	N. rubellus	Channel darter	P. copelandi
Silverband shiner	N. shumardi	Gilt darter	P. evides
Suckermouth minnow	Phenacobius mirabilis	Blackside darter	P. maculata
Southn redbelly dace	Phoxinus erythrogaster	Slenderhead darter	P. phoxocephala
Blacknose dace	Rhinichthys atratulus	Dusky darter	P. sciera
Longnose dace	R. cataractae	River darter	P. shumardi
		Saddleback darter	P. vigil
Blue sucker	Cycleptus elongatus	Sauger	Stizostedion
canadense			
Longnose sucker	Catostomus catostomus	Walleye	S. vitreum
White sucker	C. commersoni		
Northern hogsucker	Hypentilium nigricans		

Northern Indiana Till Plain

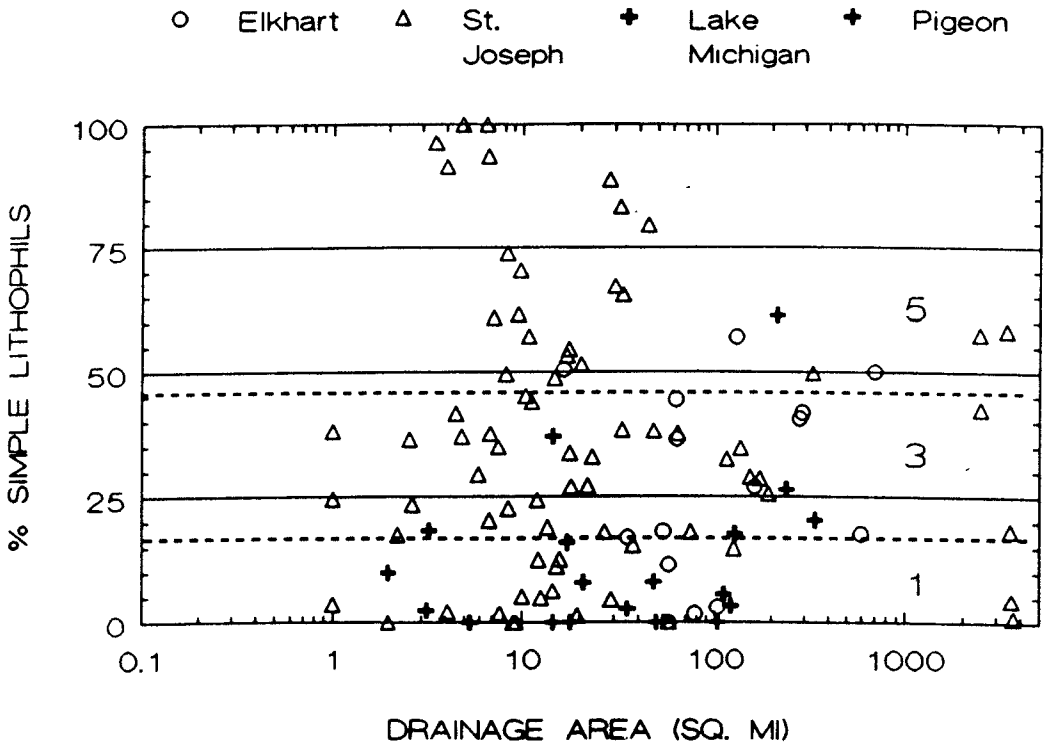


Figure 17. Maximum species richness lines for determining trends in the proportion of simple lithophil species with increasing drainage area for the St. Joseph River drainage.

Metric 12. Proportion of Individuals with Deformities, Eroded Fins, Lesions,and Tumors (Headwater and Wadable Sites)

Impetus

This metric evaluates the individual condition of fish based on the percent occurrence of external anomalies. DELT corresponds to the percent of diseased fish in Karr's (1981) original index. Studies of fish populations indicate that anomalies are either absent or occur at very low rates naturally, but reach higher percentages at impacted sites (Mills *et al.* 1966; Berra and Au 1981; Baumann *et al.* 1987). Common causes for deformities, eroded fins, lesions, and tumors are a result of bacterial, fungal, viral, and parasitic infections; neoplastic diseases; and chemicals (Allison *et al.* 1977; Post 1983; Ohio EPA 1987). An increase in the frequency of occurrence of these anomalies is an indication of physical stress due to environmental degradation, chemical pollutants, overcrowding, improper diet, excessive siltation, and other perturbations. The presence of black spot is not included in the above analyses since infestation varies in degree and is a function of the presence of snails, thus it is not solely related to environmental degradation (Allison *et al.* 1977; Berra and Au 1981). Whittier *et al.* (1987) showed no relationship between Ohio stream quality and black spot. Other parasites are also excluded due to the lack of a consistent relationship with environmental degradation.

In Ohio and in the current study, the highest incidence of deformities, eroded fins, lesions, and tumors occurred in fish communities downstream from dischargers of industrial and municipal wastewater, and areas subjected to the intermittent stresses from combined sewers and urban runoff. Leonard and Orth (1986) found this metric to correspond to increased degradation in streams in West Virginia. Karr *et al.* (1986) observed this metric to be most sensitive at the lowest ranges of the Index of Biotic Integrity.

Headwater and Wadable Streams and Rivers

The scoring criteria used for this metric follows the more extensive dataset developed by Ohio EPA (1987) which was developed by analyzing wading data. According to Ohio protocols, if a single fish in a sample of less than 200 fish was captured with anomalies this would have been enough to exceed the established criterion. Ohio EPA scoring modifications enable a single diseased fish to be present at a site to score a "5" and two fish at a site to score a "3" when less than 200 individuals are collected (Fig 18).

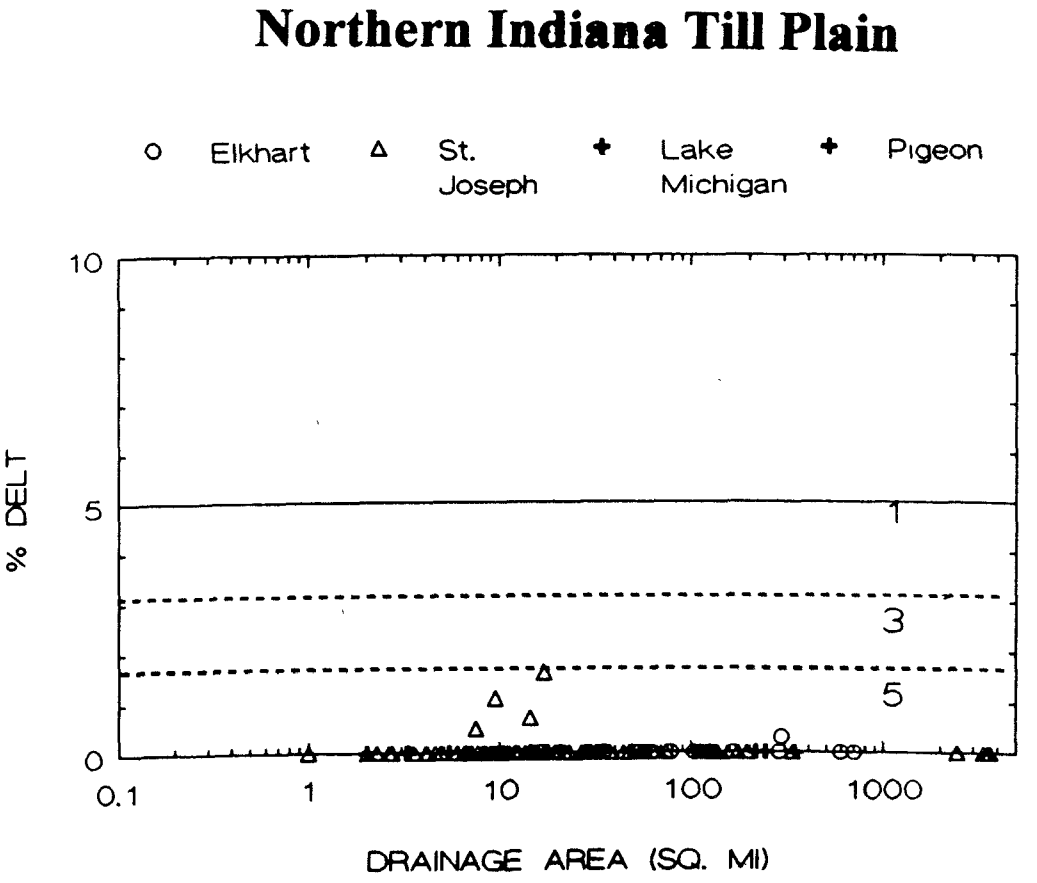


Figure 18. Maximum species richness lines for determining trends in the proportion of diseased, eroded fins, lesions, and tumors (DELT) with increasing drainage area for the St. Joseph River drainage.

Scoring Modifications

Samples with extremely low numbers in the catch can present a scoring problem in some of the proportional metrics unless adjustments are made to reduce the possibility of bias towards higher scoring of degraded sites. Aquatic habitats impacted by anthropogenic disturbances may exhibit a disruption in the food base and the sample will reflect very few individuals. At such low population sizes the normal structure of the community is unpredictable (Ohio EPA 1987). Based on Ohio EPA experiences, the proportion of omnivores, insectivorous fishes, and percent individuals affected by anomalies do not always match expected trends at these sample sizes. Although scores are expected to deviate strongly from those of high quality areas, this is not always observed. Rather, at these times the opposite deviation of metric score is achieved due to low numbers of individuals or absence of certain taxa.

Scoring very degraded sites without modifying scoring criteria for the proportional metrics can overestimate the total index score for these sites. The following scoring modifications proposed by Ohio EPA (1987) were adopted for evaluating Indiana sites with low numbers of individuals.

Proportion of omnivores for headwater streams and wadable river sites a score of "1" is assigned if less than 50 total individuals are collected. When less than 150 individuals are collected, but are dominated (>50%) by such species as creek chub and blacknose dace, a "1" can be assigned when dominated by generalist feeders. This is left up to the biologists best professional judgement.

Proportion of insectivores is scored a "1" when a high proportion of insectivores are observed and less than 50 individuals are collected. At sites with less than 150 individuals, this metric can be scored "1" if the community was dominated (>50%) by either striped shiner, common shiner, or spotfin shiner. These species can act as functional omnivores under certain conditions (Angermeier and Karr 1986).

Proportion of top carnivores metric should be scored a "1" when dominated by high numbers (> 50%) of grass pickerel in impacted wading areas.

Proportion of simple lithophils always scores a "1" at sites with less than 50 total individuals. Based on Ohio EPA data (1987) this is rarely different from the metric score without the adjustment.

Proportion of individuals with deformities, erosion, lesions and tumor anomalies is scored a "1" when less than 50 individuals are collected. A high proportion of young fishes may also be sufficient reason to score a "1" since they will not have had sufficient time to develop anomalies from exposure to chemical contaminants.

Proportion of pioneer species is scored a "1" at headwater site if less than 50 individuals are collected at drainage areas greater than 8 miles^2 or 25 individuals at drainage areas less than 8 miles^2.

No scoring adjustments are necessary for proportion of tolerant species.

RESULTS AND DISCUSSION

St. Joseph River Drainage

Species Composition: A total of 104 sites were sampled in the St. Joseph River drainage during 1991. A total of 77 species were collected (Table 13) and were numerically dominated by cyprinid, catostomid, and centrarchid species.

The St. Joseph River possesses several species unique to the entire drainage; silver shiner Notropis photogenis, pallid shiner Notropis amnis, brook stickleback Culaea inconstans: and Iowa darter Etheostoma exile. Of special interest was the collection of the greater redhorse Moxostoma valenciennesi, largescale stoneroller Campostoma oligolepis, and burbot Lota lota. Moxostoma valenciennesi is considered state endangered. The capture of Campostoma oligolepis is the first record for northeastern Indiana. Species such as the emerald shiner and river shiner are considered large river species. Several Lota lota were collected from Galena River and from the St. Joseph River.

Species Trends: Round-bodied suckers, minnows, and darters are good indicator taxa revealing good to exceptional biotic integrity. The St. Joseph River possessed a high number of round-bodied suckers, minnows, and darters.

Eleven species of suckers were collected from the St. Joseph River drainage. Round-bodied suckers are considered the most sensitive of the Catostomidae species. A total of 8 species, excluding the species Catostomus commersoni, which tends to be a ubiquitous species found in a variety of habitats, represented round-bodied suckers. Four species of redhorse and the northern hogsucker are regularly represented in catches from the St Joseph River and the larger tributaries These species are insectivores and are highly intolerant to thermal pollution (Gammon 1976).

The minnows are a diverse group of North American fish with close to 200 recognized species. Twent two species of the family Cyprinidae were collected from the St. Joseph portion of the drainage. Less than half (45%) of the species are considered to represent good-fair biotic integrity (Karr *et al.* 1986). Many (40%) of the species are representative of pioneering taxa which colonize recently disturbed or water limited stations (Ohio EPA 1989). The trophic composition of the species showed 25% of the species are omnivores. Omnivores can utilize a greater proportion of the resource, however, tend to dominate when the habitat is degraded and resources are unpredictable.

The darters are a group of small, benthic insectivores which require high dissolved oxygen conditions and clean substrates for reproduction (Page 1983; Kuehne and Barbour 1983). The darters have close to 150 recognized species. Many of the species exhibit simple lithophilic modes of reproduction, while a few species have evolved more complex reproductive behaviors A total of 6 darter species were collected from the St. Joseph River basin. This is what was expected for the mainstem of the River based on historical data.

Biocriteria Comparison of the Southern Michigan-Northern Indiana Till Plain

The States of Ohio and Michigan share the Northern Indiana Till Plain ecoregion with Indiana. Ohio in an attempt to develop the most stringent biological criteria evaluated statewide biological criteria for the ecoregions and sampled extensively in Michigan during the late 1980's in an attempt to find additional reference

Table 13. Species list of taxa collected in the St. Joseph River drainage: St. Joseph, Elkhart, Little Elkhart, and Pigeon River drainages, Indiana, during 1991.

Petromyzontidae - lampreys
Lampetra aepyptera, least brook lamprey
L. appendix, American brook lamprey
Ichthyomyzon bdellium, Ohio lamprey
I. castaneus, chestnut lamprey

Lepisosteidae - gars
L. osseus, longnose gar

Amiidae - bowfin
Amia calva, bowfin

Esocidae - pikes
Esox americanus, grass pickerel
E. lucius, northern pike

Umbridae - mudminnows
Umbra limi, central mudminnow

Salmonidae - salmon and trout
Oncorhynchus mykiss, rainbow trout
Salmo salar, Atlantic salmon
S. trutta, brown trout
Salvelinus fontinalis, brook trout

Cyprinidae - carps and minnows
Campostoma anomulum, stoneroller
C. oligolepis, largescale stoneroller
Cyprinella spiloptera, spotfin shiner
Cyprinus carpio, carp
Ericymba buccata, silverjaw minnow
Hybopsis amblops, bigeye chub
H. amnis, pallid shiner
Luxilus chrysocephalus, striped shiner
L. cornutus, common shiner
Nocomis biguttatus, hornyhead chub
Notemigonus crysoleucus, golden shiner
Notropis ludibundus, sand shiner
N. heterolepis, blacknose shiner
N. hudsonius, spottail shiner
N. photogenis, silver shiner
N. rubellus, rosyface shiner
N volucellus, mimic shiner
Pimephales notatus, bluntnose minnow
P. promelas, fathead minnow
Rhinichthys atratulus, blacknose dace
R. cataractae, longnose dace
Semotilus atromaculatus, creek chub

Catostomidae - suckers and buffalo
Carpiodes cyprinus, quillback
Catostomus commersoni, white sucker
Erimyzon oblongus, creek chubsucker
Hypentelium nigricans, northern hogsucker
Minytrema melanops, spotted sucker
Moxostoma anisurum, silver redhorse
M. carinatum, river redhorse
M. duquesnei, black redhorse
M. erythurum, golden redhorse
M. macrolepidotum, shorthead redhorse
M. valenciennesi, greater redhorse

Ictaluridae - bullhead and catfish
Ameiurus melas, black bullhead
A. natalis, yellow bullhead
Ictalurus punctatus, channel catfish
Noturus flavus, stonecat
N. gyrinus, tadpole madtom

Fundulidae - topminnows
Fundulus dispar, starhead topminnow
F. notatus, blackstripe topminnow

Atherinidae - silversides
Labidesthes sicculus, brook silverside

Aphredoderidae - pirate perch
Aphredoderus sayanus, pirate perch

Gadidae - cod
Lota lota, burbot

Gasterosteidae - sticklebacks
Culaea inconstans, brook stickleback

Table 13. (Continued)

Centrarchidae - black bass and sunfish
Ambloplites rupestris, rock bass
Lepomis cyanellus, green sunfish
L. gibbosus, pumpkinseed
L. gulosus, warmouth
L. humilis, orangespotted sunfish
L. macrochirus, bluegill
L. megalotis, longear sunfish
L. microlophus, redear sunfish
Micropterus dolomieu, smallmouth bass
M. salmoides, largemouth bass
Pomoxis annularis, white crappie
P. nigromaculatus, black crappie
Percidae - perch and darters
Etheostoma caeruleum, rainbow darter
E. exile, Iowa darter
E. nigrum, johnny darter
E. spectabile, orangethroat darter
Percina caprodes, logperch
P. maculata, blackside darter
Perca flavescens, yellow perch
Cottidae - sculpins
Cottus bairdi Girard, mottled sculpin
Total Number of Species 77

stations for the Huron-Erie Lake Plain (Simon, personal observation), however, the Northern Indiana Till Plain had not been considered a part of western Ohio until the most recent subregionalization of Ohio (Omernik and Woods, in preparation). Michigan Department of Environmental Quality (MDEQ) has formulated biological expectations for the ecoregion based on a state wide database. It was a primary goal of this study to determine if reference condition expectations developed from the Indiana portion of the ecoregion could advance biological criteria expectations for this region

Michigan DEQ developed sampling protocols and biological expectations for the Northern Indiana Till Plain as part of their Procedure 51 (Creal *et al.* 1996). The Michigan procedure uses a modified scoring expectation based on two standard deviations from the mean. Thus, scoring is either +1, 0, or -1 for sites performing outside those found at excellent sites. Sites are calibrated based on stream width, similar to Wisconsin (Lyons 1992). Maximum Species Richness (MSR) lines are developed using two approaches. Several metrics, such as the number of darter, sunfish, and suckers, were not found to have significant ranges in species richness and were divided following the approach of Karr (1981). The usually approach was to evaluate expectations based on two standard deviations from the mean. For several of the percentile metrics, modifications were made when two standard deviations were outside of the 0-100% range. The modification placed the expectation at either 1 or 99% for the percentage of piscivores, insectivores, simple lithophilic spawners, and tolerant species.

IBI Scoring ranges for Michigan fish assemblage procedures are between +10 and -10, since procedure 51 is based on only 10 metrics. Scores greater than +5 are considered excellent, while those less than -5 are classified as poor. Scores between ±4 are considered intermediate with scores of 0 being neutral (Creal *et al.* 1996)

Many places in the Northern Indiana Till Plain qualify as "least impacted" areas Streams such as the Pigeon River, Fawn River, Cobus Creek, St. Joseph River at Bristol, the lower four miles of Fish Creek, North and South Branches of the Elkhart River, and Galena River are typical reference streams for the Northern Indiana Till Plain The species

composition of the ecoregion is more typical of a coolwater fish community. This is undoubtably a function of zoogeography. The reduction of available dispersal routes post-glaciation required many species to reinvade the area only after the glaciers receeded some 10,000 years ago (Underhill 1986). Species recolonization of the Till Plain was aided by the glacial connection between the Wabash and Maumee Rivers by the Little Wabash River and by the Grand River connection across Michigan. As the Saginaw lobe retreated across Michigan a large pool of water remained that was the precursor of Lake Erie. Species capable of tolerating lentic, turbid, cold water was able to reinvade the system first. Many species were unable to disperse into the Great Lakes, thus, the Great Lakes as a whole are biologically limited in comparison to riverine systems such as the Mississippi and Ohio River systems. A study by Smith *et al.* (1981) in the Raisin River system demonstrates this effect with the headwaters of the system reflecting more structural and functional attributes of the Eastern Corn Belt Plain fish community, while lower sections of the river were dominated by the most tolerant species. The Northern Indiana Till Plain has riffles and other macronabitat features and still has a fair amount of riverine wetland habitat. The predominance of wetlands, low-gradient, seiche directed streams and rivers of this region would have precluded the majority of sensitive species. Thus, reference conditions need to reflect not only high gradient "least impacted" streams but also the typical low-gradient types of habitats which occurred along the Great Lakes.

In order to compare the criteria and direction of the individual metrics to determine if Michigan DEQ biological criteria could benefit from the effort conducted in Indiana it is necessary to compare the associated variance of the reference conditions. The State of Michigan developed biological criteria from the analysis of over 800 reference sites statewide. After careful analysis of the results, the various ecoregions are scored based on differences in stream width. In order to compare metric expectations, datasets from each of the 10 metrics was compared from Michigan DEQ (1996) to the current metric criteria The Indiana dataset is based on a 95th percentile of the reference condition. Results are summarized in Table 14 between Michigan Southern Michigan-Northern Indiana Till Plain criteria and Indiana's Northern Indiana Till Plain expectations.

In a comparison (student t-test, alpha = 0.05) between the two reference conditions equal amounts of similarities and differences exist. Metrics that did not differ statistically between Michigan criteria and Indiana Northern indiana Till Plain expectations include number of sunfish species, number of sucker species at headwater sites, proportion of tolerant species, proportion of carnivores, proportion of simple lithophils. The proportion of pioneer species, headwater species, catch-per-unit effort, and proportion of deformities, eroded fins, lesions, and tumors are not used in the Michigan version of the IBI.

Metrics that exhibited a statistical difference between Michigan criteria and Indiana's Northern Indiana Till Plain expectations included total number of species, number of darter species at headwater sites, number of sucker species at wadable sites, number of sensitive species, and proportion of omnivores. Of the seven metrics that had significant differences, 6 (85.7%) of the metrics were

Table 14. Comparison of Michigan DEQ (1996) reference conditions derived from Procedure 51 with reference conditions developed from Indiana's portion of the Northern Indiana Till Plain.

	Reference Conditions			
	Michigan DEQ (1996) SMNITP		Indiana NITP	
Metric	10 ft[a]	20 ft[b]	Headwater	Wadable Stream
1. Total Number of Species	> 9	>13	12	18
2. Number of darter species	> 2	>3	4	4
3. Number of Sunfish species	> 2	>3	2	> 3
Proportion of Headwater Species	--	--	> 25%	--
4. Number of Minnow species	--	--	6	--
Number of Sucker species	> 1	> 2	> 1	4
5. Number of Sensitive species	> 2	> 4	> 3	>7
6. Proportion Tolerant species	< 20%	< 20%	< 30%	< 30%
7. Proportion of Omnivores	< 16%	< 16%	< 30%	< 30%
8. Proportion of Insectivores	> 64%	> 64%	> 60%	> 60%
9. Proportion Pioneer species	--	--	50%	--
Proportion of Carnivores	> 14%	> 14%	> 16%	> 16%
10 Catch per unit of effort	--	--	200-275	275-500
11. % Simple Lithophils	> 41%	> 41%	> 45%	> 45%
12. Proportion of DELT	--	--	< 1 7%	< 1 7%

[a] Maximum value from 95th percentile of Maximum Species Richness lines at 20 mi^2;
[b] Maximum value from 95th percentile of Maximum Species Richness lines at 300 mi^2

more stringent when using Indiana's criteria. Only the proportion of omnivores were more stringent using Michigan's criteria.

The number of species metric showed differences at both sites perhaps because Michigan stops collecting after 100 specimens are sampled. This may have underestimates the species area curve for this metric. This would have been exaggerated at larger drainage areas where more habitat complexity would have been exhibited

The number of darter species differed at headwater sites. The Indiana IBI uses a combined metric of darters, madtoms, and sculpins for drainage areas less than 20 mi^2, while Michigan criteria does not modify the metric for smaller stream widths. The addition of two species per site is significant at $p = 0.10$.

The number of sensitive species showed similar trends with Michigan criteria at headwater sites, however, differnces in species membership to the list are the probable cause. For Indiana I used a modified metric that includes intolerant, as well as, sensitive species following Ohio EPA (1989) recommendations. Species such as longear sunfish, northern hogsucker, brook silverside, and redhorse species are taxa that did not appear on the Michigan list that were connonly collected in the Northern Indiana Till Plain. As stream size increases these additional species are more commonly collected increasing proportions.

The collection of data differently may have prohibiting further comparison. The catch-per-unit effort was expressed as the number of fish per 15 x the stream width or collected within the first 30 minutes of electrofishing. Samples from this collection included 15x the stream width with a minimum of 50 m sampled and the longest distance sampled was 500 m. The number of sensitive species at wadable sites also deviated in collection and categorizing strategy. Michigan DEQ uses the intolerant species designation even at headwater sites. At larger wadable sites, the Michigan IBI uses an intolerant species metric that reduces the number of recognized sensitive species from the headwater category. This makes the criteria inherently more stringent and prohibits comparison of reference conditions between the two datasets.

The result of this comparison suggests that the Northern Indiana Till Plain criteria developed during this study is directly comparable to Michigan biological criteria developed for the same ecoregion or more stringent in the protection of surface waters for a few metrics. It must be mentioned that differences in regional framework approaches may be the difference between these two State strategies. In only 16.7% of the metrics did the existing Michigan criteria provide more stringent expectations than what was observed from the Indiana portion of the Northern Indiana Till Plain. This shows that "least impacted" conditions can be estimated for the ecoregion based on reference conditions developed across political boundaries. Further evaluation of the Michigan dataset is necessary to evaluate the exact deviations from Indiana.

5.0 LITERATURE CITED

Allison, L.N., J.G. Hnath, and W.G. Yoder. 1977. Manual of common diseases, parasites, and anomalies of Michigan fishes. **Michigan Department of Natural Resources, Lansing. Fisheries Management Report No. 8**. 132 pp.

Angermeier, P.L. and J.R. Karr. 1986. Applying an index of biotic integrity based on stream fish communities: considerations in sampling and interpretation. ***N. Am. J. Fish. Man.*** 6: 418-429.

Arvin, D.V. 1989. Statistical summary of streamflow data for Indiana. **U.S. Geological Survey, Indianapolis, IN. Open File Report 89-62**. 964 pp.

Bailey, Z.C., T.K. Greeman, and E.J. Crompton. 1985. Hydrologic effects of ground- and surface-water withdrawals in the Howe area, LaGrange County. U.S. Geological Survey Water Resources Investigations Report 85-4163

Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. ***J. Fish. Res. Board Can.*** 32: 821-864.

Bauman, P.C., W.D. Smith, and W.K. Parland. 1987. Tumor frequencies and contaminant concentrations in brown bullhead from an industrialized river and a recreational lake. ***Trans. Am. Fish. Soc.*** 116: 79-86.

Becker, G.C. 1983. **Fishes of Wisconsin**. University of Wisconsin Press: Madison. 1052 p.

Bell, J.M. and A. Spacie. 1978. Trophic status of 15 Indiana lakes in 1977. Purdue University, Dept. Forestry & Wildl., West Lafayette, Indiana.

Bell, J.M. and A. Spacie. 1979. Trophic status of 16 Indiana lakes in 1978. Purdue University, Dept. Forestry & Wildl., West Lafayette, Indiana.

Bell, J.M and A. Spacie. 1988 Trophic status of 16 Indiana lakes in 1984. Purdue University, Dept. Forestry & Wildl., West Lafayette, Indiana.

Berkman, H.E and C.F. Rabeni. 1987. Effect of siltation on stream fish communities. ***Env. Biol. Fishes*** 18: 285-294.

Berra, T.M. and R. Au. 1981. Incidence of teratological fishes from Cedar Fork Creek, Ohio. ***Ohio J. Sci*** 81: 225

Brown, H.W. 1976. Handbook of the effects of temperature on some North American fishes. American Electric Power Corporation, Canton, OH. 524 pp + appendices.

Brungs, W.A. and B.R. Jones. 1977. Temperature criteria for freshwater fish. protocol and procedures. U.S. Environmental Protection Agency, Env. Res. Lab.-Duluth, MN. EPA 600/3-77/061 130 pp.

Burr, B M. and M L. Warren, Jr 1986. **A distributional atlas of Kentucky fishes** Kentucky Nature Preserves Commission Scientific and Technical Series No 4. Frankfort.

Creal, W., S. Hanshue, S. Kosek, M. Oemke, and M. Walterhouse. 1996. Update of GLEAS Procedure 51 metric scoring and interpretation. Michigan Department of Environmental Quality, Lansing. MI/DEQ/SWQ-96/068.

Crompton, E.J., J.G. Peters, R.L. Miller, J.A. Stewart, K.J. Banaszak, And R.J. Shedlock. 1986. **Review of the hydrologic data collection network in the St. Joseph River basin, Indiana**. U.S. Geological Survey Water Resources Investigation Report 86-4157

Davis, W.S. (ed.) 1990. **Proceedings of the 1990 Midwest Pollution Control Biologists Meeting**. U.S. Environmental Protection Agency, Region V, Environmental Sciences Division, Chicago, IL. EPA 905/9-90/005

Davis, W.S. and A. Lubin. 1989. Statistical validation of Ohio EPA's invertebrate community index. p 23-32 In W.S. Davis and T.P Simon (eds) **Proceedings of the 1989 Midwest Pollution Control Biologists Meeting, Chicago, Illinois**. U.S. Environmental Protection Agency, Region V, Chicago, IL. EPA 905/9-89-007

Eberly, M.R. 1959. The metalimnetic oxygen maximum in Myers Lake. ***Inv. Ind. Lakes & Streams*** 5: 1-46.

Eigenmann, C.L. 1896. Turkey Lakes as a unit of environment, and the variation of its inhabitants. Proc. Indiana Acad. Sci. 11: 204-278. 8 pl. and numerous tables.

Fatout, P. 1985. **Indiana Canals**. Purdue University Press: West Lafayette, Indiana. 216 p.

Fausch, K D., J.R. Karr, and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream-fish communities. ***Trans. Am. Fish. Soc.*** 113: 39-55.

Fausch, K.D., J. Lyons, J.R. Karr, and P.L. Angermeier. 1990. Fish communities as indicators of environmental degradation. ***Am Fish. Soc. Symposium*** 8: 123-144.

Fenneman, N.M. 1946. **Physical division of the United States**: Washington D.C., U.S. Geological Survey Special Map.

Forbes, S.A and R.E. Richardson. 1920. **The fishes of Illinois**. (2nd edition). State Natural History Survey of Illinois 3: 1-357.

Gammon, J.R. 1973. **The effects of thermal input on the populations of fish and macroinvertebrates in the Wabash River**. Purdue University Water Resources Research Center Tech. Rept. 32. 106 pp.

Gammon, J.R. 1976. **The fish populations of the middle 340 km of the Wabash River**. Purdue Univ. Water Resources Research Center Technical Report 86. 73 pp.

Gammon, J.R. 1983. Changes in the fish community of the Wabash River following power plant start-up: projected and observed. pp. 350-366. In W.E. Bishop, R.D. Cardwell, and B.B. Heidolph (eds). **Aquatic Toxicology and Hazard Assessment: Sixth Symposium**. ASTM STP 802.

Gammon, J.R., A. Spacie, J.L. Hamelink, and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River. p. 307-324. In J.M. Bates and C.I. Weber (eds.). **Ecological Assessments of Effluent Impacts on Communities of Indigenous Aquatic Organisms.** Am. Soc. Test. Materials, STP 730, Phil., PA.

Gerking, S.D. 1945. Distribution of the fishes of Indiana. ***Inv. Ind. Lakes and Streams*** 3: 1-137.

Gerking, S.D. 1955. Key to the fishes of Indiana. ***Inv. Ind. Lakes and Streams*** 4: 49-86.

Glatfelter, D.R. 1984. Techniques for estimating magnitude and frequency of floods on streams in Indiana. U.S. Geological Survey water Resources Investigations Report 84-4134.

Gooding, A.M. 1973. **Characteristics of late Wisconisan Tills in eastern Indiana.** Geological Survey Bull. 49: 1-28.

Gray,M. in preparation. Quarternary geologic map of Indiana. Indiana Geological Surv. Misc. Map.

Gulish, W J. 1973. Distribution and abundance of the cisco on the Elkhart River watershed. Indiana Department of Natural Resources, Indianapolis, Indiana

Gulish, W.J. 1974. A summary of Indiana cisco investigations, 1971-74. Indiana Department of Natural Resources, Indianapolis, Indiana.

Hocutt, C.H. and E.O. Wiley. 1986. **Zoogeography of North American freshwater fishes**. John Wiley and Sons Press: New York.

Hoggatt, R.E. 1975. **Drainage Areas of Indiana Streams**. U.S. Geological Survey, Indianapolis, IN. 231 pp.

Hoggatt, R.E. 1981. Floods of March 1978 in the Maumee River basin, northeastern Indiana. **U.S. Geological Survey Open File Report 81-695.**

Hokanson, K.E.F. and K.E. Biesinger. 1980. A national compendium of freshwater fish and water temperature requirements. U.S. Environmental Protection Agency, Env. Res. Lab., Duluth, MN. 142 pp.

Homoya, M.A., D.B. Abrell, J.R. Aldrich, and T.W. Post. 1985. The natural regions of Indiana. ***Proc. Indiana Acad. Sci. 94: 245-268.***

Hughes, R.M., J.H. Gakstatter, M.A. Shirazi, and J.M. Omernik. 1982. An approach for determining biological integrity in flowing waters. pp. 877-888. In T.B. Braun (ed.). **Inplace resource inventories: principles and practices, a National Workshop.** Soc. Am. Foresters, Bethesda, MD.

Hughes, R.M., D.P. Larsen, and J.M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. ***Env. Mgmt***. 10: 629-635.

Indiana Department of Environmental Management (IDEM) 1994 Indiana 305(b) report 1990-92 **Indiana Department of Environmental Management, Indianapolis.**

Indiana Department of Natural Resources (IDNR). 1987. **Water Resource Availability in the St. Joseph River Basin, Indiana.** IDNR, Division of Water, Indianapolis. 139 pp.

Indiana Department of Natural Resources (IDNR). 1980. The Indiana water resource: availability, uses, and needs. **Indiana Department of Natural Resources, Indianapolis.** 508 pp.

Jordan, D.S. 1877 On the fishes of northern Indiana. ***Proc. Acad. Nat. Sci., Phil.*** 29: 42-104.

Jordan, D.S. 1890. Report of explorations made during the summer and autumn of 1888, in the Allegheny region of Virginia, North Carolina, and Tennessee, and in western Indiana, with an account of the fishes found in each of the river basins of those regions. ***Bull. U.S. Fish. Comm.*** 1888, 8:97-173.

Jung, C.O. and J. Libovarsky. 1965. Effect of size selectivity on population estimates based on successive removals with electrofishing gear. ***Zoologicke Listy*** 14: 171-178.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities ***Fisheries*** 6:21-27

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. ***Ecological Applications*** 1 66-84

Karr, J.R. and D R Dudley. 1981. Ecological perspective on water quality goals. ***Env. Mgmt*** 5: 55-68

Karr, J.R., K D. Fausch, P.L. Angermeier, P.R Yant, and I J Schlosser 1986 Assessing biological integrity in running waters: a method and its rationale ***Ill. Nat. Hist. Surv. Sp. Publ. 5.*** 28 pp

Krumholz, L.A. 1946. Repopulation of the West Fork. ***Outdoor Indiana*** 13(2): 12.

Kuehne, R.A. and R.W. Barbour. 1983. **The American darters**. University of Kentucky Press: Lexington.

Larimore, R.W. and P.W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. ***Ill. Nat. Hist. Surv. Bull***. 28: 299-382.

Larsen, D.P., J M. Omernik, R.M. Hughes, C.M Rohm, T R. Whittier, A.J. Kinney, A.L. Gallant, and D.R. Dudley. 1986. Correspondence between spatial patterns in fish assemblages in Ohio streams and aquatic ecoregions. ***Env. Man***. 10: 815-828.

Ledet, N. 1979. **Galena River survey report**. Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1979. **A fisheries survey of the St. Joseph River in St. Joseph and Elkhart Counties, Indiana**. Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1982. **A fisheries survey of the Pigeon River.** Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1986. **A fisheries survey of emma Creek and Bontrager ditch, LaGrange County, 1985.** Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1989a. **Pigeon River smallmouth bass, LaGrange and Steuben Counties.** Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1989b **St. Joseph River smallmouth bass, St. Joseph amd Elkhart Counties.** Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1990. **St. Joseph River fish population survey**. Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1991a. **Little Elkhart River, LaGrange and Elkhart Counties.** Indiana Department of Natural Resources, Indianapolis.

Ledet, N. 1991b. **Trout Creek, Elkhart County, 1990.** Indiana Department of Natural Resources, Indianapolis.

Leonard, P M. and D.J. Orth 1986. Application and testing of an Index of Biotic Integrity in small, cool water streams. ***Trans. Am. Fish. Soc.*** 115: 401-414.

Leopold, L.B., M.G. Woolman, and J.P. Miller. 1964. **Fluvial processes in geomorphology**. W.H. Freeman, San Francisco, CA.

Lyons, J. 1992. **Using the Index of Biotic Integrity (IBI) to measure environmental quality in warmwater streams of Wisconsin** U.S. Dept. Agriculture, Forest Service, General Technical Report NC-149.

Mayden, R.L. 1989. Phylogenetic studies of North American minnows, with emphasis on the genus Cyprinella (Teleostei: Cypriniformes). ***Misc. Publ. Univ. Kans. Mus. Nat. Hist. No. 80***. 189 pp.

McCormick, J.H., M.J. Ross, and D.B Siniff 1981. Where do yellow perch (Perca flavescens) go in winter when given the option between ice covered waters or a heated discharge. Can. Tech. Rept. Fish Aquat. Sci. 990: 33-45.

Mueller, W.P. 1959. The distribution of cladoceran remains in surficial sediments from three northern Indiana lakes ***Inv. Ind. Lakes & Streams*** 6: 1-63.

Ohio Environmental Protection Agency (OEPA). 1987. **Water Quality implementation manual**. QA Manual (3rd update). Fish. Ohio Environmental Protection Agency, Columbus.

Ohio Environmental Protection Agency (OEPA). 1987. **Biological criteria for the protection of aquatic life. Volume II. Users Manual for Biological field assessment of Ohio surface waters**. Ohio Environmental Protection Agency, Columbus.

Ohio Environmental Protection Agency (OEPA). 1989. **Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities.** Ohio Environmental Protection Awgncy, Columbus.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. ***Ann. Ass. Am. Geo.*** 77:118-125.

Omernik, J.M. and A.L. Gallant. 1988. **Ecoregions of the upper Midwest States.** USEPA, ERL, Corvallis, OR. EPA/600/3-88/037.

Page, L.M. 1983. **Handbook of Darters**. TFH Publications, Neptune, NJ.

Parks, C.E. 1949 The summer food of some game fishes in Winona Lake. ***Inv. Ind. Lakes & Streams*** 3: 235-245.

Pearson, J. 1981. **Elkhart River South Branch, 1981.** Indiana Department of Natural Resources, Indianapolis.

Pearson, J. 1986. **Dissolved oxygen content of the Elkhart River South Branch.** Indiana Department of Natural Resources, Indianapolis

Peterson, R.S. 1971. **Elkhart River basin stream survey report: Elkhart, Noble, LaGrange, and Kosciusko Counties.** Indiana Department of Natural Resources, Indianapolis.

Peterson, R.S. 1973. **Crooked Creek and Fawn River survey report, LaGrange and Steuben Counties.** Indiana Department of Natural Resources, Indianapolis

Peterson, R.S. **1974a.Crooked Creek and Fawn River survey report, LaGrange and Steuben Counties.** Indiana Department of Natural Resources, Indianapolis.

Peterson, R S. 1974b. **Little Elkhart River fisheries survey report, 1974.** Indiana Department of Natural Resources, Indianapolis.

Peterson, R.S. 1979. **A fisheries survey of baugo Creek, St. Joseph and Elkhart Counties, Indiana, 1978.** Indiana Department of Natural Resources, Indianapolis.

Peterson, R.S. and N. Ledet. 1982. **A fisheries survey of the Pigeon River.** Indiana Department of Natural Resources, Indianapolis.

Pflieger, W.L. 1975. **The Fishes of Missouri**. Mo. Dept. Conserv. Columbia 343 pp.

Phillips, G.L. and J.C. Underhill. 1971. Distribution and variation of the Catostomidae of Minnesota. ***Bell Mus. Nat. Hist. Univ. Minn., Occ. Pap. No. 10*** 45 pp.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989 **Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates** U.S. Environmental Protection Agency, Monitoring and Data Support Division, Washington, D C EPA 444/4-89-001.

Post, G. 1983. **Textbook of fish health.** TFH Publications, Neptune, NJ.

Raney, E.C. and B.W. Menzel. 1969. Heated effluents and effects on aquatic life with emphasis on fishes. Ichthyological Associates Bulletin 2., 468 pp.

Rankin, E.T. 1989. The use of the qualitative habitat evaluation index for use attainability studies in streams and rivers in Ohio. **Ohio Environmental Protection Agency, Division of Water Quality Planning and Assessments, Columbus, Ohio.**

Ricker, W.E. 1942a. The rate of growth of bluegill sunfish in lakes of northern Indiana. ***Inv. Ind. Lakes & Streams*** 2:161-214.

Ricker, W.E. 1942b. Creel census, population estimates, and rate of exploitation of game fish in Shoe Lake, Indiana. ***Inv. Ind. Lakes & Streams*** 2: 215-253.

Ricker, W.E. 1942c. Fish populations of two artificial lakes. ***Inv. Ind. Lakes & Streams*** 2:255-265.

Ricker, W.E. 1942d. Fish catches in three Indiana lakes. ***Inv. Ind. Lakes & Streams*** 2:325-344.

Ricker, W.E. 1942e. Abundance, exploitation, and mortality of the fishes in two lakes. ***Inv. Ind. Lakes & Streams*** 2: 345-448.

Ricker, W.E. 1955. Fish and fishing in Spear Lake, Indiana. ***Inv. Ind. Lakes & Streams*** 2: 4: 117-161.

Schneider, A F. 1966. Physiography, pp. 40-56, In A.A. Lindsey (ed). **Natural Features of Indiana.** Univ. Notre Dame Press Notre Dame, IN

Scott, W. 1931. The lakes of northeastern Indiana. ***Inv. Ind. Lakes & Streams*** 3: 59-145.

Scott, W., R.O. Hile, amd H.T. Spieth. 1928. A quantitative study of the bottom fauna of Lake Wawasee (Turkey Lake). ***Inv. Ind. Lakes & Streams*** 1: 5-25.

Scott, W., R.O. Hile, and H T Spieth. 1938. The bottom fauna of Tippecanoe Lake. ***Inv. Ind. Lakes & Streams*** 4: 3-16.

Seaber, P.R., S.P. Kapinost, and G.L. Knapp. 1984. State hydrologic unit maps. **U.S. Geol. Survey Open-file report. 84-708.** 198 pp.

Simon, T.P. 1989. Rationale for a family-level ichthyoplankton index for use in evaluating water quality. pp. 41-65 + appendix. In Davis, W.S. and T.P. Simon. **Proceedings of the 1989 Midwest Pollution Control Biologists Meeting, Chicago, Illinois, February 14-17, 1989.** U.S. Environmental Protection Agency, Chicago, IL. EPA 905/9-89-007.

Simon, T.P. 1991. **Development of Index of Biotic Integrity expectations for the ecoregions of Indiana. I. Central Corn Belt Plain.** U.S. Environmental Protection Agency, Region V, Chicago, IL. EPA 905/9-91/025.

Simon, T.P., L.L. Holst, and L.J. Shepard 1988. **Proceedings of the First National Workshop on Biological Criteria, Lincolnwood, Illinois, December 2-4, 1987** U.S. Environmental Protection Agency, Region V, Chicago. EPA 905/9-89/003

Simon, T P. and S.A. Newhouse. In preparation. Species richness estimates revisiting the River Continuum concept.

Smith, G.R., J.N. Taylor, and T.W. Grimshaw. 1981. Ecological survey of fishes in the Raisin River drainage, Michigan. ***Michigan Academician*** 13: 275-305.

Smith, P.W. 1979. **The Fishes of Illinois.** University of Illinois Press: Champaign, IL.

Smith, P.W. 1971. Illinois streams: a classification based on their fishes and an analysis of factors responsible for the disappearance of native species. ***Ill. Nat. Hist. Surv. Biol. Notes*** 76.

Stahl, J.B. 1959. The developmental history of the chironomid and *Chaoborus* faunas of Myers Lake. ***Inv. Ind. Lakes & Streams*** 5: 47-102.

Steedman, R.J. 1988. Modification and assessment of an Index of Biotic Integrity to quantify stream quality in southern Ontario. ***Canadian Journal of Fisheries and Aquatic Sciences*** 45: 492-501.

Stefanavage, T. 1987. **Food habits of Pigeon River smallmouth bass.** Indiana Department of Natural Resources, Indianapolis.

Stewart, J.A. 1983. **Low-flow characteristics of Indiana streams.** U S. Geological Survey Open File Report 82-1007

Trautman, M.B 1981. **The Fishes of Ohio.** The Ohio State University Press: Columbus, OH. 782 pp.

Underhill, J.C. 1986. The fish fauna of the laurentian Great Lakes, the St Lawrence lowlands, aNewfoundland and Labrador. p. 105-136 In C.H. Hocutt and E.O. Wiley (eds). **The Zoogeography of North American Freshwater Fishes** John Wiley & Sons, Interscience, New York.

U.S. Geological Survey (USGS). undated. **Indiana State 208 Water Quality Management Planning Maps.** Region 1B. U.S. Geological Survey, Indianapolis, IN.

U.S. Geological Survey (USGS) 1990 **National Water Summary.** U.S. Geological Survey, Resnick, VA.

U.S. Environmental Protection Agency (USEPA). 1980. **Spatial distribution and temperature selection of fish near the thermal outfall of a power plant during fall, winter, and spring.** USEPA, Env. Res. Lab.-Duluth, MN. EA 600/3-80/009.

U.S. Environmental Protection Agency (USEPA). 1988. **Standard Operating Procedures for conducting rapid assessment of ambient surface water quality using fish.** USEPA, Region V, Central Regional Laboratory, Chicago, IL.

Watter, C.T. 1988. A survey of the freshwater mussels of the St. Joseph River system, with emphasis on the federally endangered white cat's paw pearly mussel. Indiana Department of Natural Resources, Indianapolis.

Whittier, T.R., D.P. Larsen, R.M. Hughes, C.M. Rohm, A.L. Gallant, and J.M. Omernik 1987. **The Ohio Stream Regionalization Project: A compendium of results.** USEPA, Environmental Research Laboratory, Corvallis, OR.

APPENDICES

A. Tolerance, trophic, and reproductive guilds classification for computing the Index of Biotic Integrity for Indiana taxa.

B. Site classification percentages based on individual metric attributes.

C. Fish nomenclature changes for the species of fish occurring within the political boundaries of Indiana.

APPENDIX A. Tolerance, trophic, and reproductive guild classifications for computing the Index of Biotic Integrity for Indiana taxa.

VOUCHERCD	GENUS	SPECIES	COMMON_NAM	FEED_GUILD	REPR_GUILD	TOLERANCE
1 00	Lampetra	aepyptera	LEAST BROOK LAMPREY	F	N	R
2 00	Lampetra	appendix	AMERICAN BROOK LAMPR	F	N	R
3 00	Petromyzon	marinus	SEA LAMPREY	P	N	-
4 00	Ichthyomyzon	bdellium	OHIO LAMPREY	P	N	S
5.00	Ichthyomyzon	castaneus	CHESTNUT LAMPREY	P	N	-
6 00	Ichthyomyzon	fossor	NORTHERN BROOK LAMP	F	N	S
7 00	Ichthyomyzon	unicuspis	SILVER LAMPREY	P	N	-
8 00	Acipenser	fulvescens	LAKE STURGEON	V	S	-
9 00	Scaphirhynchus	platorynchus	SHOVELNOSE STURGEON	I	S	-
10 00	Polyodon	spathula	PADDLEFISH	F	S	S
11 00	Lepisosteus	osseus	LONGNOSE GAR	P	M	-
12 00	Lepisosteus	oculatus	SPOTTED GAR	P	M	-
13 00	Lepisosteus	platostomus	SHORTNOSE GAR	P	M	-
14 00	Atractosteus	spatula	ALLIGATOR GAR	P	M	-
15 00	Amia	calva	BOWFIN	P	C	-
16 00	Anguilla	rostrata	AMERICAN EEL	C	-	T
17.00	Alosa	alabamae	ALABAMA SHAD	-	N	-
18 00	Alosa	pseudoharengus	ALEWIFE	F	M	-
19 00	Dorosoma	cepedianum	GIZZARD SHAD	O	M	-
20 00	Alosa	chrysochloris	SKIPJACK HERRING	P	M	-
21 00	Dorosoma	petenense	THREADFIN SHAD	O	M	-
22 00	Hiodon	alosoides	GOLDEYE	I	M	R
23 00	Hiodon	tergisus	MOONEYE	I	M	R
24 00	Coregonus	clupeaformis	LAKE WHITEFISH	V	M	-
25 00	Coregonus	artedi	CISCO OR LAKE HERRING	F	M	-
26 00	Coregonus	hoyi	BLOATER	-	M	-
27.00	Coregonus	nigripinnis	BLACKFIN CISCO	-	N	-
28 00	Coregonus	reighardi	SHORTNOSE CISCO	-	N	-
29 00	Coregonus	zenithicus	SHORTJAW CISCO	-	M	-
30 00	Oncorhynchus	kisutch	COHO SALMON	P	N	M
31 00	Oncorhynchus	tshawytscha	CHINOOK SALMON	P	N	M
32 00	Oncorhynchus	mykiss	RAINBOW TROUT	P	N	M
33 00	Salmo	salar	ATLANTIC SALMON	P	N	M
34 00	Salmo	trutta	BROWN TROUT	P	N	M
35 00	Salvelinus	namaycush	LAKE TROUT	P	N	M
36 00	Salvelinus	fontinalis	BROOK TROUT	P	N	M
37 00	Osmerus	mordax	RAINBOW SMELT	V	M	-
38 00	Esox	lucius	NORTHERN PIKE	P	M	-
39 00	Esox	americanus	GRASS PICKEREL	P	M	P
40 00	Esox	ohioensis	MUSKELLUNGE	P	M	-
41 00	Esox	masquinongy	GREAT LAKES MUSKELLU	P	M	-
42 00	Umbra	limi	CENTRAL MUDMINNOW	O	C	T
43 00	Cyprinus	carpio	CARP	O	M	T
44 00	Carassius	auratus	GOLDFISH	O	M	T
46 00	Hybognathus	nuchalis	MISSISSIPPI SILVERY MINN	O	S	-
47 00	Hybognathus	hankinsoni	BRASSY MINNOW	O	-	-
48 00	Hybognathus	hayi	CYPRESS MINNOW	O	M	-
49 00	Notemigonus	crysoleucus	GOLDEN SHINER	I	M	T
50 00	Clinostomus	elongatus	REDSIDE DACE	I	S	R
51 00	Semotilus	atromaculatus	CREEK CHUB	G	N	T

VOUCHERCD	GENUS	SPECIES	COMMON_NAM	FEED_GUILD	REPR_GUILD	TOLERANCE
52.00	Rhinichthys	atratulus	BLACKNOSE DACE	G	S	T
53 00	Rhinichthys	cataractae	LONGNOSE DACE	I	S	R
54 00	Nocomis	micropogon	RIVER CHUB	I	N	I
55 00	Nocomis	biguttatus	HORNYHEAD CHUB	I	N	I
56.00	Notropis	chalybaeus	IRONCOLOR SHINER	I	M	I
57.00	Notropis	hudsonius	SPOTTAIL SHINER	I	M	P
58 00	Notropis	rubellus	ROSYFACE SHINER	I	S	I
59 00	Notropis	atherinoides	EMERALD SHINER	I	M	-
60.00	Notropis	buchanani	GHOST SHINER	I	M	-
61.00	Notropis	shumardi	SILVERBAND SHINER	I	S	I
62 00	Notropis	ludibundus	SAND SHINER	I	M	M
63.00	Notropis	texanus	WEED SHINER	I	M	R
64.00	Notropis	volucellus	MIMIC SHINER	I	M	I
65 00	Notropis	anogenus	PUGNOSE SHINER	I	M	S
66.00	Notropis	ariommus	POPEYE SHINER	I	S	S
67.00	Notropis	blennius	RIVER SHINER	I	S	-
68.00	Notropis	boops	BIGEYE SHINER	I	S	I
69.00	Notropis	dorsalis	BIGMOUTH SHINER	I	M	-
70.00	Notropis	heterodon	BLACKCHIN SHINER	I	M	R
71 00	Notropis	heterolepis	BLACKNOSE SHINER	I	M	S
72 00	Notropis	photogenis	SILVER SHINER	I	S	R
73 00	Euricymba	buccata	SILVERJAW MINNOW	I	M	-
74.00	Hybopsis	amblops	BIGEYE CHUB	I	S	I
75 00	Hybopsis	amnis	PALLID SHINER	I	S	R
76 00	Phenacobius	mirabilis	SUCKERMOUTH MINNOW	I	S	-
77.00	Campostoma	anomalum	CENTRAL STONEROLLER	H	N	-
78.00	Campostoma	oligolepis	LARGESCALE STONEROLL	H	N	-
79 00	Pimephales	notatus	BLUNTNOSE MINNOW	O	C	T
80.00	Pimephales	promelas	FATHEAD MINNOW	O	C	T
81.00	Pimephales	vigilax	BULLHEAD MINNOW	O	C	-
82.00	Couesius	plumbeus	LAKE CHUB	I	S	-
83 00	Ctenopharyngodon	idella	GRASS CARP	O	M	T
84 00	Phoxinus	eythrogaster	SOUTHERN REDBELLY DA	H	S	-
85 00	Scardinius	erythrophthalmus	RUDD	O	M	T
86.00	Hypophthalmichthys	molitrix	SILVER CARP	O	M	T
87.00	Cyprinella	lutrensis	RED SHINER	I	N	T
88 00	Cyprinella	spiloptera	SPOTFIN SHINER	I	M	-
89 00	Cyprinella	whipplei	STEELCOLOR SHINER	I	M	-
90 00	Erimystax	dissimilis	STREAMLINE CHUB	I	S	R
91.00	Erimystax	x-punctatus	GRAVEL CHUB	I	S	M
92 00	Luxilus	chrysocephalus	STRIPED SHINER	I	S	-
93 00	Luxilus	cornutus	COMMON SHINER	I	S	-
94 00	Lythrurus	ardens	ROSEFIN SHINER	I	S	M
95.00	Lythrurus	fumeus	RIBBON SHINER	I	M	-
96 00	Lythrurus	umbratilis	REDFIN SHINER	I	N	-
97.00	Macrhybopsis	storeriana	SILVER CHUB	I	M	-
98 00	Opsopoeodus	emiliae	PUGNOSE MINNOW	I	M	R
99 00	Extrarius	aestivalis	SPECKLED CHUB	I	M	R
100 00	Catostomus	catostomus	LONGNOSE SUCKER	I	S	-
101 00	Catostomus	commersoni	WHITE SUCKER	O	S	T

APPENDIX A. **Continued**

VOUCHERCD	GENUS	SPECIES	COMMON NAM	FEED GUILD	REPR GUILD	TOLERANCE
102.00	Carpiodes	cyprinus	QUILLBACK	O	M	-
103 00	Carpiodes	carpio	RIVER CARPSUCKER	O	M	-
104.00	Carpiodes	velifer	HIGHFIN CARPSUCKER	O	M	S
105 00	Erimyzon	sucetta	LAKE CHUBSUCKER	I	M	-
106.00	Erimyzon	oblongus	CREEK CHUBSUCKER	I	M	-
107.00	Moxostoma	macrolepidotum	SHORTHEAD REDHORSE	I	S	M
108 00	Moxostoma	anisurum	SILVER REDHORSE	I	S	M
109.00	Moxostoma	carinatum	RIVER REDHORSE	I	S	R
110.00	Moxostoma	duquesnei	BLACK REDHORSE	I	S	R
111 00	Moxostoma	erythrurum	GOLDEN REDHORSE	I	S	M
112 00	Moxostoma	valenciennesi	GREATER REDHORSE	I	S	R
113 00	Hypentilium	nigricans	NORTHERN HOGSUCKER	I	S	M
114 00	Cycleptus	elongatus	BLUE SUCKER	I	S	R
115.00	Ictiobus	bubalus	SMALLMOUTH BUFFALO	I	M	-
116.00	Ictiobus	cyprinellus	BIGMOUTH BUFFALO	I	M	-
117 00	Ictiobus	niger	BLACK BUFFALO	I	M	-
118.00	Minytrema	melanops	SPOTTED SUCKER	I	S	-
119.00	Lagochila	lacera	HARELIP SUCKER	-	-	S
120.00	Ictalurus	furcatus	BLUE CATFISH	C	C	-
121 00	Ictalurus	punctatus	CHANNEL CATFISH	C	C	-
122 00	Noturus	gyrinus	TADPOLE MADTOM	I	C	-
123 00	Noturus	nocturnus	FRECKLED MADTOM	I	C	R
124.00	Noturus	eleutherus	MOUNTAIN MADTOM	I	C	R
125 00	Noturus	exilis	SLENDER MADTOM	I	C	R
126 00	Noturus	flavus	STONECAT	I	C	I
127 00	Noturus	miurus	BRINDLED MADTOM	I	C	R
128 00	Noturus	stigmosus	NORTHERN MADTOM	I	C	R
129 00	Pylodictus	olivaris	FLATHEAD CATFISH	P	C	-
130 00	Ameiurus	catus	WHITE CATFISH	-	C	-
131 00	Ameiurus	melas	BLACK BULLHEAD	I	C	T
132 00	Ameiurus	natalis	YELLOW BULLHEAD	I	C	P
133 00	Ameiurus	nebulosus	BROWN BULLHEAD	I	C	P
134 00	Amblyopsis	spelaea	NORTHERN CAVEFISH	G	C	S
135 00	Typhlichthys	subterraneus	SOUTHERN CAVEFISH	G	C	S
136 00	Aphredoderus	sayanus	PIRATE PERCH	I	M	-
137 00	Percopsis	omniscomaycus	TROUT-PERCH	I	M	-
138 00	Lota	lota	BURBOT	-	S	-
139 00	Fundulus	diaphanus	BANDED KILLIFISH	I	M	-
140.00	Fundulus	olivaceus	BLACKSPOTTED TOPMINN	I	M	-
141.00	Fundulus	catenatus	NORTHERN STUDFISH	I	M	R
142 00	Fundulus	notatus	BLACKSTRIPE TOPMINNO	I	M	-
143.00	Fundulus	dispar	STARHEAD TOPMINNOW	I	M	R
144 00	Gambusia	affinis	WESTERN MOSQUITOFISH	I	N	-
145.00	Labidesthes	sicculus	BROOK SILVERSIDE	I	M	M
146.00	Pungitius	pungitius	NINESPINE STICKLEBACK	I	C	-
147 00	Culaea	inconstans	BROOK STICKLEBACK	I	C	-
148.00	Cottus	cognatus	SLIMY SCULPIN	-	C	-
149 00	Cottus	bairdi	MOTTLED SCULPIN	I	C	-
150 00	Cottus	carolinae	BANDED SCULPIN	I	C	-
151 00	Cottus	ricei	SPOONHEAD SCULPIN	I	C	-

APPENDIX A. **Continued**

VOUCHERCD	GENUS	SPECIES	COMMON NAM	FEED GUILD	REPR GUILD	TOLERANCE
152 00	Myoxocephalus	thompsoni	DEEPWATER SCULPIN	-	C	-
153 00	Morone	saxatilis	STRIPED BASS	P	M	-
154 00	Morone	chrysops	WHITE BASS	P	M	-
155.00	Morone	mississippiensis	YELLOW BASS	P	M	-
156 00	Ambloplites	rupestris	ROCK BASS	C	C	M
157 00	Centrarchus	macropterus	FLIER	I	C	-
158.00	Lepomis	cyanellus	GREEN SUNFISH	I	C	T
159 00	Lepomis	gulosus	WARMOUTH	C	C	-
160 00	Lepomis	macrochirus	BLUEGILL	I	C	P
161.00	Lepomis	gibbosus	PUMPKINSEED	I	C	P
162 00	Lepomis	humilis	ORANGESPOTTED SUNFIS	I	C	-
163.00	Lepomis	megalotis	LONGEAR SUNFISH	I	C	M
164 00	Lepomis	microlophus	REDEAR SUNFISH	I	C	-
165.00	Lepomis	punctatus	SPOTTED SUNFISH	I	C	-
166.00	Lepomis	symmetricus	BANTAM SUNFISH	I	C	-
167.00	Micropterus	dolomieu	SMALLMOUTH BASS	C	C	M
168.00	Micropterus	salmoides	LARGEMOUTH BASS	C	C	-
169 00	Micropterus	punctulatus	SPOTTED BASS	C	C	-
170 00	Pomoxis	annularis	WHITE CRAPPIE	-	C	-
171 00	Pomoxis	nigromaculatus	BLACK CRAPPIE	-	C	-
172 00	Etheostoma	chlorosomum	BLUNTNOSE DARTER	I	M	-
173 00	Etheostoma	gracile	SLOUGH DARTER	I	N	-
174.00	Etheostoma	spectabile	ORANGETHROAT DARTER	I	S	-
175.00	Etheostoma	nigrum	JOHNNY DARTER	I	C	-
176 00	Etheostoma	asprigene	MUD DARTER	I	M	-
177.00	Etheostoma	blennioides	GREENSIDE DARTER	I	M	M
178 00	Etheostoma	caeruleum	RAINBOW DARTER	I	S	M
179 00	Etheostoma	camurum	BLUEBREAST DARTER	I	S	R
180.00	Etheostoma	exile	IOWA DARTER	I	M	-
181 00	Etheostoma	flabellare	FANTAIL DARTER	I	C	-
= 182 00	Etheostoma	histrio	HARLEQUIN DARTER	I	M	S
184 00	Etheostoma	maculatum	SPOTTED DARTER	I	S	R
185 00	Etheostoma	microperca	LEAST DARTER	I	N	-
186.00	Etheostoma	squamiceps	SPOTTAIL DARTER	I	C	-
187.00	Etheostoma	tippecanoe	TIPPECANOE DARTER	I	S	R
188.00	Etheostoma	variatum	VARIEGATE DARTER	I	S	R
189.00	Etheostoma	zonale	BANDED DARTER	I	M	M
190.00	Perca	flavescens	YELLOW PERCH	-	M	-
191.00	Percina	caprodes	LOGPERCH	I	S	M
192 00	Percina	sciera	DUSKY DARTER	I	S	M
193.00	Percina	evides	GILT DARTER	I	S	R
194.00	Percina	maculata	BLACKSIDE DARTER	I	S	-
195.00	Percina	phoxocephala	SLENDERHEAD DARTER	I	S	I
196.00	Percina	shumardi	RIVER DARTER	I	S	-
197 00	Percina	uranidea	STARGAZING DARTER	I	S	S
198.00	Percina	vigil	SADDLEBACK DARTER	I	S	M
199 00	Stizostedion	vitreum	WALLEYE	P	S	-
200.00	Stizostedion	canadense	SAUGER	P	S	-
201 00	Percina	copelandi	CHANNEL DARTER	I	S	S
202 00	Ammocrypta	clara	WESTERN SAND DARTER	I	S	R

APPENDIX A. **Continued**

VOUCHERCD	GENUS	SPECIES	COMMON NAM	FEED GUILD	REPR GUILD	TOLERANCE
203.00	Ammocrypta	pellucida	EASTERN SAND DARTER	I	S	R
204.00	Crystallaria	asprella	CRYSTAL DARTER	I	S	S
205.00	Aplodinotus	grunniens	FRESHWATER DRUM	-	M	P
206.00	Elassoma	zonatum	BANDED PYGMY SUNFISH	I	C	-
207.00	Notropis	wickliffi	CHANNEL SHINER	I	M	I
208.00	Esox	lucius x maspuinongy	TIGER MUSKIE	P	M	-
209.00	Morone	chrysops x saxatilis	WIPER	P	M	-
210.00	Stizostedion	canadense x vitreum	SAUGEYE	P	S	M
211.00	Lepomis	x-hybrid	SUNFISH HYBRID			
212.00	Gymnocephalus	cernuus	RUFFE	C	S	-
213.00	Mylopharyngodon	piceus	BLACK CARP	O	M	T
214.00	Hypophthalmichthys	noblis	BIGHEAD CARP	H	M	T
215.00	Neogobius	malanostomus	ROUND GOBY	I	C	M
216.00	Proterorhinus	marmoratus	TUBE NOSE GOBY			
217.00	Morone	americana	WHITE PERCH	P	M	-
218.00	Moxostoma	m. breviceps	OHIO REDHORSE	I	S	M
219.00	Menidia	beryllina	INLAND SILVERSIDE	I	M	P
220.00	Gasterosteus	aculeatus	THREESPINE STICKLEBAC	I	C	-

Feeding Guild: C = carnivore; F = filter feeder; G = generalist feeder; H = herbivore; I = insectivore; O = omnivore; P = piscivore; Pa = Parasite; V = invertivore; – = feeding guild behaviorally plastic.

Reproductive Guild: C = complex with parental care; M = simple, miscellaneous; N = complex, no parental care; S = simple lithophil.

Tolerance/Sensitivity: I = common intolerant; M = moderately intolerant; P = moderately tolerant; R = rare intolerant; S = special intolerant; T = highly tolerant; – = tolerance classification moderate.

APPENDIX B. Site classification percentages based on individual metric attributes.

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	90,103.00
County	MARSHALL
Drainage Area	257.00

IBI METRICS

1. Total Number of Fish Species	17
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	4
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	73.30
7. Proportion of Omnivores	13.30
8. Proportion of Insectivores	77.30
9. Proportion of Pioneer Species	62.00
Proportion of Carnivores	5.30
10. Number of Individuals in Sample	150 00
11. Proportion Simple Lithophils	16.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	90,104.00
County	MARSHALL
Drainage Area	274.00

IBI METRICS

1. Total Number of Fish Species	21
2. Number of Darter Species	3
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	2.20
Number of Sunfish Species	4
4. Number of Minnow Species	7
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	5
6. Percent Tolerant Species	42 20
7. Proportion of Omnivores	30.00
8. Proportion of Insectivores	53.30
9. Proportion of Pioneer Species	30.00
Proportion of Carnivores	10.00
10. Number of Individuals in Sample	90.00
11. Proportion Simple Lithophils	38.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	90,195.00
County	PORTER
Drainage Area	330.00

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	5
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	89.10
7. Proportion of Omnivores	87.00
8. Proportion of Insectivores	13.00
9. Proportion of Pioneer Species	22.80
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	92.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	90,196.00
County	PORTER
Drainage Area	177.00

IBI METRICS

1. Total Number of Fish Species	18
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	6
Number of Sucker Species	2
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	0.60
5. Number of Sentive Species	0
6. Percent Tolerant Species	81.00
7. Proportion of Omnivores	80.20
8. Proportion of Insectivores	15.50
9. Proportion of Pioneer Species	59.50
Proportion of Carnivores	1.00
10. Number of Individuals in Sample	489.00
11. Proportion Simple Lithophils	3 30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	90,198.00
County	PORTER
Drainage Area	66.20

IBI METRICS

1. Total Number of Fish Species	22
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.80
Number of Sunfish Species	5
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	4.20
5. Number of Sentive Species	2
6. Percent Tolerant Species	70.60
7. Proportion of Omnivores	36.10
8. Proportion of Insectivores	44.50
9. Proportion of Pioneer Species	55.50
Proportion of Carnivores	9.20
10. Number of Individuals in Sample	119.00
11. Proportion Simple Lithophils	5.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,001.00
County	LAPORTE
Drainage Area	54.10

IBI METRICS

1. Total Number of Fish Species	5
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	70.00
Number of Sunfish Species	1
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	24.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	4.00
7. Proportion of Omnivores	4.00
8. Proportion of Insectivores	72.00
9. Proportion of Pioneer Species	0.00
Proportion of Carnivores	24.00
10. Number of Individuals in Sample	50.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,002.00
County	LAPORTE
Drainage Area	3.20

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	2.40
Number of Sunfish Species	4
4. Number of Minnow Species	2
Number of Sucker Species	0
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	7.20
5. Number of Sentive Species	0
6. Percent Tolerant Species	32.50
7. Proportion of Omnivores	9.60
8. Proportion of Insectivores	77.10
9. Proportion of Pioneer Species	19.30
Proportion of Carnivores	7.20
10. Number of Individuals in Sample	83.00
11. Proportion Simple Lithophils	2.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,003.00
County	LAPORTE
Drainage Area	2.00

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	5.00
Number of Sunfish Species	1
4. Number of Minnow Species	3
Number of Sucker Species	0
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	20.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	70.00
7. Proportion of Omnivores	0.00
8. Proportion of Insectivores	15.00
9. Proportion of Pioneer Species	70.00
Proportion of Carnivores	15.00
10. Number of Individuals in Sample	20 00
11. Proportion Simple Lithophils	5.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,004.00
County	LAPORTE
Drainage Area	49.70

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	37.90
Number of Sunfish Species	2
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	24.10
5. Number of Sentive Species	0
6. Percent Tolerant Species	24.10
7. Proportion of Omnivores	3.40
8. Proportion of Insectivores	72.40
9. Proportion of Pioneer Species	31.00
Proportion of Carnivores	24.10
10. Number of Individuals in Sample	29 00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,005.00
County	LAPORTE
Drainage Area	20.90

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	26.00
Number of Sunfish Species	2
4. Number of Minnow Species	1
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	62.00
7. Proportion of Omnivores	24.00
8. Proportion of Insectivores	52.00
9. Proportion of Pioneer Species	44.00
Proportion of Carnivores	2.00
10. Number of Individuals in Sample	50 00
11. Proportion Simple Lithophils	8 00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,006.00
County	LAPORTE
Drainage Area	17.20

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	2
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	68.20
7. Proportion of Omnivores	18.20
8. Proportion of Insectivores	34.10
9. Proportion of Pioneer Species	68.20
Proportion of Carnivores	4.50
10. Number of Individuals in Sample	44 00
11. Proportion Simple Lithophils	36.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,007.00
County	LAPORTE
Drainage Area	3.30

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	1
4. Number of Minnow Species	1
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	63.60
7. Proportion of Omnivores	13.60
8. Proportion of Insectivores	18.20
9. Proportion of Pioneer Species	59.10
Proportion of Carnivores	18.20
10. Number of Individuals in Sample	22.00
11. Proportion Simple Lithophils	18 20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,008.00
County	LAPORTE
Drainage Area	5.40

IBI METRICS

1. Total Number of Fish Species	4
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	50.80
Number of Sunfish Species	1
4. Number of Minnow Species	1
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	49.20
7. Proportion of Omnivores	29.00
8. Proportion of Insectivores	58.10
9. Proportion of Pioneer Species	20.20
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	124.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,009.00
County	LAPORTE
Drainage Area	14.60

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	16.10
Number of Sunfish Species	1
4. Number of Minnow Species	1
Number of Sucker Species	0
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	1.80
5. Number of Sentive Species	0
6. Percent Tolerant Species	76.80
7. Proportion of Omnivores	69.60
8. Proportion of Insectivores	26.80
9. Proportion of Pioneer Species	10.70
Proportion of Carnivores	1.80
10. Number of Individuals in Sample	56.00
11. Proportion Simple Lithophils	1 80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,010.00
County	LAPORTE
Drainage Area	17.90

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	37.50
Number of Sunfish Species	2
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	46.90
7. Proportion of Omnivores	6.20
8. Proportion of Insectivores	87.50
9. Proportion of Pioneer Species	46.90
Proportion of Carnivores	6.20
10. Number of Individuals in Sample	32.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,025.00
County	STEUBEN
Drainage Area	103.00

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.40
Number of Sunfish Species	4
4. Number of Minnow Species	1
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	25.30
7. Proportion of Omnivores	6.50
8. Proportion of Insectivores	82.90
9. Proportion of Pioneer Species	21.20
Proportion of Carnivores	10.60
10. Number of Individuals in Sample	245.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,026.00
County	STEUBEN
Drainage Area	7.10

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	53.10
Number of Sunfish Species	0
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	53.10
5. Number of Sentive Species	1
6. Percent Tolerant Species	84.60
7. Proportion of Omnivores	9.80
8. Proportion of Insectivores	11.90
9. Proportion of Pioneer Species	36.40
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	143.00
11 Proportion Simple Lithophils	72.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,027.00
County	STEUBEN
Drainage Area	19.50

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	62.80
7. Proportion of Omnivores	57.70
8. Proportion of Insectivores	35.90
9. Proportion of Pioneer Species	65.40
Proportion of Carnivores	6.40
10. Number of Individuals in Sample	78 00
11. Proportion Simple Lithophils	2.60
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,032.00
County	STEUBEN
Drainage Area	111.00

IBI METRICS

1. Total Number of Fish Species	13
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	50.00
Number of Sunfish Species	2
4. Number of Minnow Species	3
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	4
6. Percent Tolerant Species	24.10
7. Proportion of Omnivores	16.70
8. Proportion of Insectivores	75.90
9. Proportion of Pioneer Species	24.10
Proportion of Carnivores	3.70
10. Number of Individuals in Sample	54.00
11. Proportion Simple Lithophils	5.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,033.00
County	STEUBEN
Drainage Area	121.00

IBI METRICS

1. Total Number of Fish Species	17
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	9.00
Number of Sunfish Species	4
4. Number of Minnow Species	1
Number of Sucker Species	2
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	0.90
5. Number of Sentive Species	2
6. Percent Tolerant Species	72.60
7. Proportion of Omnivores	3.30
8. Proportion of Insectivores	89.20
9. Proportion of Pioneer Species	70.30
Proportion of Carnivores	7 50
10. Number of Individuals in Sample	212 00
11. Proportion Simple Lithophils	3.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,034.00
County	STEUBEN
Drainage Area	57.50

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	2
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	22.60
7. Proportion of Omnivores	3.20
8. Proportion of Insectivores	80.60
9. Proportion of Pioneer Species	3.20
Proportion of Carnivores	16.10
10. Number of Individuals in Sample	31.00
11. Proportion Simple Lithophils	6.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,036.00
County	LAGRANGE
Drainage Area	213.00

IBI METRICS

1. Total Number of Fish Species	19
2. Number of Darter Species	4
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.60
Number of Sunfish Species	2
4. Number of Minnow Species	8
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	9
6. Percent Tolerant Species	11.70
7 Proportion of Omnivores	9 80
8. Proportion of Insectivores	83.40
9. Proportion of Pioneer Species	59.50
Proportion of Carnivores	6.10
10. Number of Individuals in Sample	163.00
11. Proportion Simple Lithophils	80.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,037.00
County	LAGRANGE
Drainage Area	127.00

IBI METRICS

1. Total Number of Fish Species	14
2. Number of Darter Species	3
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	2.00
Number of Sunfish Species	1
4. Number of Minnow Species	3
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	31.40
7. Proportion of Omnivores	23.50
8. Proportion of Insectivores	58.80
9. Proportion of Pioneer Species	37.30
Proportion of Carnivores	17.60
10. Number of Individuals in Sample	51.00
11. Proportion Simple Lithophils	29.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,038.00
County	LAGRANGE
Drainage Area	62.30

IBI METRICS

1. Total Number of Fish Species	16
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	6.70
Number of Sunfish Species	3
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	33.30
7. Proportion of Omnivores	26.70
8. Proportion of Insectivores	53.30
9. Proportion of Pioneer Species	22.20
Proportion of Carnivores	20.00
10. Number of Individuals in Sample	45.00
11. Proportion Simple Lithophils	42.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,039.00
County	LAGRANGE
Drainage Area	57.50

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	4
4. Number of Minnow Species	0
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	42.30
7. Proportion of Omnivores	7.70
8. Proportion of Insectivores	53.80
9. Proportion of Pioneer Species	26.90
Proportion of Carnivores	38.50
10. Number of Individuals in Sample	26.00
11. Proportion Simple Lithophils	11.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,047.00
County	LAGRANGE
Drainage Area	173.00

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	2
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	8
6. Percent Tolerant Species	0.00
7. Proportion of Omnivores	0.00
8. Proportion of Insectivores	70.40
9. Proportion of Pioneer Species	0.00
Proportion of Carnivores	29.60
10. Number of Individuals in Sample	27.00
11. Proportion Simple Lithophils	33.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,048.00
County	LAGRANGE
Drainage Area	192.00

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	1
4. Number of Minnow Species	6
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	5
6. Percent Tolerant Species	12.80
7. Proportion of Omnivores	7.70
8. Proportion of Insectivores	76.90
9. Proportion of Pioneer Species	7.70
Proportion of Carnivores	15.40
10. Number of Individuals in Sample	39.00
11. Proportion Simple Lithophils	43.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,049.00
County	LAGRANGE
Drainage Area	9.70

IBI METRICS

1. Total Number of Fish Species	5
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	66.70
7. Proportion of Omnivores	57.10
8. Proportion of Insectivores	35.70
9. Proportion of Pioneer Species	9.50
Proportion of Carnivores	2 40
10. Number of Individuals in Sample	42.00
11. Proportion Simple Lithophils	88.10
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,050.00
County	LAGRANGE
Drainage Area	5.90

IBI METRICS

1. Total Number of Fish Species	14
2. Number of Darter Species	3
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	4
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	5
6. Percent Tolerant Species	45.10
7. Proportion of Omnivores	35.30
8. Proportion of Insectivores	54.90
9. Proportion of Pioneer Species	27.50
Proportion of Carnivores	9.80
10. Number of Individuals in Sample	51 00
11. Proportion Simple Lithophils	25.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,051.00
County	LAGRANGE
Drainage Area	340.00

IBI METRICS

1. Total Number of Fish Species	20
2. Number of Darter Species	4
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	1
4. Number of Minnow Species	8
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	10
6. Percent Tolerant Species	29 40
7. Proportion of Omnivores	26.70
8. Proportion of Insectivores	43.30
9. Proportion of Pioneer Species	40.60
Proportion of Carnivores	18.70
10. Number of Individuals in Sample	187.00
11. Proportion Simple Lithophils	15.00
12. Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,052.00
County	LAGRANGE
Drainage Area	240.00

IBI METRICS

1. Total Number of Fish Species	24
2. Number of Darter Species	4
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	4
4. Number of Minnow Species	7
Number of Sucker Species	4
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	10
6. Percent Tolerant Species	14.90
7. Proportion of Omnivores	11.10
8. Proportion of Insectivores	79.10
9. Proportion of Pioneer Species	19.60
Proportion of Carnivores	8.50
10 Number of Individuals in Sample	235.00
11. Proportion Simple Lithophils	26.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,053.00
County	LAGRANGE
Drainage Area	12.20

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	62.30
Number of Sunfish Species	2
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	36.40
5. Number of Sentive Species	0
6. Percent Tolerant Species	66.20
7. Proportion of Omnivores	15.20
8. Proportion of Insectivores	33.10
9. Proportion of Pioneer Species	21.90
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	151.00
11. Proportion Simple Lithophils	49.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,054.00
County	LAGRANGE
Drainage Area	17.10

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	11.30
Number of Sunfish Species	1
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	41.90
7. Proportion of Omnivores	25.80
8. Proportion of Insectivores	67.70
9. Proportion of Pioneer Species	16.10
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	62.00
11. Proportion Simple Lithophils	53.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,055.00
County	LAGRANGE
Drainage Area	1.00

IBI METRICS

1. Total Number of Fish Species	5
2. Number of Darter Species	1
.Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	38.10
Number of Sunfish Species	0
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	38.10
5. Number of Sentive Species	0
6. Percent Tolerant Species	95.20
7. Proportion of Omnivores	42.90
8. Proportion of Insectivores	4.80
9. Proportion of Pioneer Species	23.80
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	42.00
11. Proportion Simple Lithophils	76 20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,056.00
County	LAGRANGE
Drainage Area	53.80

IBI METRICS

1. Total Number of Fish Species	13
2. Number of Darter Species	3
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	48.30
Number of Sunfish Species	1
4. Number of Minnow Species	6
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	32.20
5. Number of Sentive Species	4
6. Percent Tolerant Species	36.00
7. Proportion of Omnivores	1.50
8. Proportion of Insectivores	49.40
9. Proportion of Pioneer Species	18.00
Proportion of Carnivores	0.80
10. Number of Individuals in Sample	261.00
11. Proportion Simple Lithophils	50.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,057.00
County	LAGRANGE
Drainage Area	28.10

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	0
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	86.90
Number of Sunfish Species	0
4. Number of Minnow Species	3
Number of Sucker Species	2
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	87.90
5. Number of Sentive Species	1
6. Percent Tolerant Species	90.70
7. Proportion of Omnivores	2.80
8. Proportion of Insectivores	2.80
9. Proportion of Pioneer Species	6.50
Proportion of Carnivores	2.80
10. Number of Individuals in Sample	107.00
11. Proportion Simple Lithophils	88.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,058.00
County	LAGRANGE
Drainage Area	16.50

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.80
Number of Sunfish Species	2
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.80
5. Number of Sentive Species	2
6. Percent Tolerant Species	22.60
7. Proportion of Omnivores	0.80
8. Proportion of Insectivores	71.40
9. Proportion of Pioneer Species	26.30
Proportion of Carnivores	0.80
10. Number of Individuals in Sample	133 00
11. Proportion Simple Lithophils	50.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,059.00
County	LAGRANGE
Drainage Area	57.40

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	2
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	51.20
7. Proportion of Omnivores	17.10
8. Proportion of Insectivores	65.90
9. Proportion of Pioneer Species	31.70
Proportion of Carnivores	17.10
10. Number of Individuals in Sample	41.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,085.00
County	NOBLE
Drainage Area	35.30

IBI METRICS

1. Total Number of Fish Species	17
2. Number of Darter Species	4
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	4
4. Number of Minnow Species	2
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	17.80
7. Proportion of Omnivores	11.90
8. Proportion of Insectivores	62.40
9. Proportion of Pioneer Species	13.90
Proportion of Carnivores	17.80
10. Number of Individuals in Sample	101.00
11. Proportion Simple Lithophils	16.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,086.00
County	NOBLE
Drainage Area	15.80

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	3.80
Number of Sunfish Species	2
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	3.80
5. Number of Sentive Species	0
6. Percent Tolerant Species	88.60
7. Proportion of Omnivores	15.20
8. Proportion of Insectivores	11.40
9. Proportion of Pioneer Species	69.60
Proportion of Carnivores	2.50
10. Number of Individuals in Sample	79 00
11. Proportion Simple Lithophils	17.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,087.00
County	NOBLE
Drainage Area	7.60

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	16.70
7. Proportion of Omnivores	2.60
8. Proportion of Insectivores	93.00
9. Proportion of Pioneer Species	13.20
Proportion of Carnivores	1.80
10. Number of Individuals in Sample	114.00
11. Proportion Simple Lithophils	1.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,088.00
County	NOBLE
Drainage Area	78.50

IBI METRICS

1. Total Number of Fish Species	23
2. Number of Darter Species	2
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	7
4. Number of Minnow Species	2
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	4
6. Percent Tolerant Species	16.20
7. Proportion of Omnivores	0.80
8. Proportion of Insectivores	67.90
9. Proportion of Pioneer Species	11.70
Proportion of Carnivores	29 60
10. Number of Individuals in Sample	240 00
11. Proportion Simple Lithophils	1 20
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,089.00
County	NOBLE
Drainage Area	14.50

IBI METRICS

1. Total Number of Fish Species	16
2. Number of Darter Species	2
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	5
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	57.00
7. Proportion of Omnivores	17.60
8. Proportion of Insectivores	28.90
9. Proportion of Pioneer Species	57.70
Proportion of Carnivores	19.70
10. Number of Individuals in Sample	142.00
11. Proportion Simple Lithophils	6.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,090.00
County	NOBLE
Drainage Area	10.80

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	6
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	83.90
7. Proportion of Omnivores	64.30
8. Proportion of Insectivores	10.70
9. Proportion of Pioneer Species	35.70
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	56.00
11. Proportion Simple Lithophils	53.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,091.00
County	NOBLE
Drainage Area	10.40

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	34.30
Number of Sunfish Species	0
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	34.30
5. Number of Sentive Species	1
6. Percent Tolerant Species	53.50
7. Proportion of Omnivores	11.40
8. Proportion of Insectivores	13.50
9. Proportion of Pioneer Species	57.20
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	297.00
11. Proportion Simple Lithophils	36.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,093.00
County	NOBLE
Drainage Area	103.00

IBI METRICS

1. Total Number of Fish Species	15
2. Number of Darter Species	0
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	1
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	28.60
7. Proportion of Omnivores	24.70
8. Proportion of Insectivores	41.60
9. Proportion of Pioneer Species	2.60
Proportion of Carnivores	33.80
10. Number of Individuals in Sample	77 00
11. Proportion Simple Lithophils	2.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,094.00
County	NOBLE
Drainage Area	162.00

IBI METRICS

1. Total Number of Fish Species	19
2. Number of Darter Species	1
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	4
4. Number of Minnow Species	6
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	8
6. Percent Tolerant Species	25.60
7. Proportion of Omnivores	15.40
8. Proportion of Insectivores	64.10
9. Proportion of Pioneer Species	20.50
Proportion of Carnivores	20.50
10. Number of Individuals in Sample	78.00
11. Proportion Simple Lithophils	28.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,095.00
County	NOBLE
Drainage Area	2.60

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	3
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	26.30
Number of Sunfish Species	0
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	26.30
5. Number of Sentive Species	1
6. Percent Tolerant Species	83.90
7. Proportion of Omnivores	9.50
8. Proportion of Insectivores	14.60
9. Proportion of Pioneer Species	62.00
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	137.00
11. Proportion Simple Lithophils	41.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,096.00
County	NOBLE
Drainage Area	1.00

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	48.10
7. Proportion of Omnivores	29.60
8. Proportion of Insectivores	37.00
9. Proportion of Pioneer Species	59.30
Proportion of Carnivores	14.80
10. Number of Individuals in Sample	27.00
11 Proportion Simple Lithophils	3.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,097.00
County	NOBLE
Drainage Area	18.00

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	4
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	1
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	7.70
7. Proportion of Omnivores	3 80
8. Proportion of Insectivores	53.80
9. Proportion of Pioneer Species	23.10
Proportion of Carnivores	42.30
10. Number of Individuals in Sample	26 00
11. Proportion Simple Lithophils	26.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,098.00
County	NOBLE
Drainage Area	6.70

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	3
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	2
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	15.30
7. Proportion of Omnivores	5.10
8. Proportion of Insectivores	64.40
9. Proportion of Pioneer Species	69.50
Proportion of Carnivores	6.80
10. Number of Individuals in Sample	59.00
11. Proportion Simple Lithophils	20.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,099.00
County	NOBLE
Drainage Area	1.00

IBI METRICS

1. Total Number of Fish Species	4
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	16.90
Number of Sunfish Species	0
4. Number of Minnow Species	3
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	16.90
5. Number of Sentive Species	0
6. Percent Tolerant Species	71.90
7. Proportion of Omnivores	28.10
8. Proportion of Insectivores	0.00
9. Proportion of Pioneer Species	55.10
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	89.00
11. Proportion Simple Lithophils	16.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,141.00
County	ELKHART
Drainage Area	33.00

IBI METRICS

1. Total Number of Fish Species	16
2. Number of Darter Species	2
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	1.20
Number of Sunfish Species	0
4. Number of Minnow Species	9
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	1.50
5. Number of Sentive Species	5
6. Percent Tolerant Species	64.40
7. Proportion of Omnivores	44.30
8. Proportion of Insectivores	29.30
9. Proportion of Pioneer Species	50.00
Proportion of Carnivores	0.60
10. Number of Individuals in Sample	334.00
11. Proportion Simple Lithophils	37.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,142.00
County	ELKHART
Drainage Area	26.90

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	14.30
Number of Sunfish Species	2
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	5.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	87.10
7. Proportion of Omnivores	72.10
8. Proportion of Insectivores	13.60
9. Proportion of Pioneer Species	12.10
Proportion of Carnivores	0.70
10. Number of Individuals in Sample	140.00
11. Proportion Simple Lithophils	17.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,143.00
County	ELKHART
Drainage Area	13.60

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	5.40
Number of Sunfish Species	0
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	75.70
5. Number of Sentive Species	0
6. Percent Tolerant Species	29.70
7. Proportion of Omnivores	21.60
8. Proportion of Insectivores	0.00
9. Proportion of Pioneer Species	2.70
Proportion of Carnivores	70.30
10. Number of Individuals in Sample	37.00
11. Proportion Simple Lithophils	24.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,144.00
County	ELKHART
Drainage Area	14.80

IBI METRICS

1. Total Number of Fish Species	8
2. Number of Darter Species	4
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	1
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	2
6. Percent Tolerant Species	19.70
7. Proportion of Omnivores	7.70
8. Proportion of Insectivores	77 80
9. Proportion of Pioneer Species	53.80
Proportion of Carnivores	2.60
10 Number of Individuals in Sample	117.00
11. Proportion Simple Lithophils	48.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,145.00
County	ELKHART
Drainage Area	125.00

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.70
Number of Sunfish Species	1
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	5
6. Percent Tolerant Species	6.30
7. Proportion of Omnivores	0.00
8. Proportion of Insectivores	72.70
9. Proportion of Pioneer Species	2.80
Proportion of Carnivores	26.60
10. Number of Individuals in Sample	143.00
11.. Proportion Simple Lithophils	14.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,148.00
County	ST. JOSEPH
Drainage Area	0.00

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	18.70
Number of Sunfish Species	1
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	18.70
5. Number of Sentive Species	0
6. Percent Tolerant Species	77.70
7. Proportion of Omnivores	12.40
8. Proportion of Insectivores	17.50
9. Proportion of Pioneer Species	65 70
Proportion of Carnivores	0.40
10. Number of Individuals in Sample	251.00
11. Proportion Simple Lithophils	27.10
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,149.00
County	ELKHART
Drainage Area	23.20

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	21.80
Number of Sunfish Species	0
4. Number of Minnow Species	7
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	21.80
5. Number of Sentive Species	0
6. Percent Tolerant Species	82.90
7. Proportion of Omnivores	52.70
8. Proportion of Insectivores	15.70
9. Proportion of Pioneer Species	72.20
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	510.00
11. Proportion Simple Lithophils	24.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,150.00
County	ELKHART
Drainage Area	8.20

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	46.30
Number of Sunfish Species	0
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	46.30
5. Number of Sentive Species	0
6. Percent Tolerant Species	92.60
7. Proportion of Omnivores	3.70
8. Proportion of Insectivores	6 90
9. Proportion of Pioneer Species	50.50
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	188.00
11. Proportion Simple Lithophils	49.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,151.00
County	ELKHART
Drainage Area	10.00

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	1.70
Number of Sunfish Species	1
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	1.70
5. Number of Sentive Species	0
6. Percent Tolerant Species	96.90
7. Proportion of Omnivores	75.80
8. Proportion of Insectivores	4.60
9. Proportion of Pioneer Species	93.70
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	831.00
11. Proportion Simple Lithophils	5.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,152.00
County	ELKHART
Drainage Area	74.20

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	6.70
Number of Sunfish Species	1
4. Number of Minnow Species	6
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	10.00
5. Number of Sentive Species	3
6. Percent Tolerant Species	71.80
7. Proportion of Omnivores	64.20
8. Proportion of Insectivores	18.00
9. Proportion of Pioneer Species	83.40
Proportion of Carnivores	0.90
10. Number of Individuals in Sample	682 00
11. Proportion Simple Lithophils	15.00
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,154.00
County	ST. JOSEPH
Drainage Area	29.00

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	35.80
Number of Sunfish Species	4
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	1.80
5. Number of Sentive Species	1
6. Percent Tolerant Species	47.70
7. Proportion of Omnivores	2.80
8. Proportion of Insectivores	50.50
9. Proportion of Pioneer Species	56.90
Proportion of Carnivores	3.70
10. Number of Individuals in Sample	218.00
11. Proportion Simple Lithophils	4.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,155.00
County	ST. JOSEPH
Drainage Area	37.70

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	18.70
Number of Sunfish Species	2
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	12.10
5. Number of Sentive Species	2
6. Percent Tolerant Species	73.60
7. Proportion of Omnivores	4.40
8. Proportion of Insectivores	22.00
9. Proportion of Pioneer Species	63.70
Proportion of Carnivores	13.20
10 Number of Individuals in Sample	91 00
11. Proportion Simple Lithophils	15.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,156.00
County	ELKHART
Drainage Area	17.50

IBI METRICS

1. Total Number of Fish Species	10
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	37.40
Number of Sunfish Species	1
4. Number of Minnow Species	8
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	38.10
5. Number of Sentive Species	2
6. Percent Tolerant Species	68.10
7. Proportion of Omnivores	13.60
8. Proportion of Insectivores	29.20
9. Proportion of Pioneer Species	48.60
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	257.00
11. Proportion Simple Lithophils	50.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,157.00
County	ELKHART
Drainage Area	7 50

IBI METRICS

1. Total Number of Fish Species	14
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	4.80
Number of Sunfish Species	2
4. Number of Minnow Species	6
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	4.80
5. Number of Sentive Species	1
6. Percent Tolerant Species	81.30
7. Proportion of Omnivores	18.20
8. Proportion of Insectivores	22.50
9. Proportion of Pioneer Species	58.40
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	209.00
11. Proportion Simple Lithophils	34.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,158.00
County	ELKHART
Drainage Area	9.00

IBI METRICS

1. Total Number of Fish Species	4
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	1
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	57.60
7. Proportion of Omnivores	27.30
8. Proportion of Insectivores	0.00
9. Proportion of Pioneer Species	30.30
Proportion of Carnivores	42.40
10. Number of Individuals in Sample	33.00
11. Proportion Simple Lithophils	0.00
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,159.00
County	ELKHART
Drainage Area	153.00

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	1
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	26.30
7. Proportion of Omnivores	18.40
8. Proportion of Insectivores	65.80
9. Proportion of Pioneer Species	42.10
Proportion of Carnivores	15.80
10. Number of Individuals in Sample	38.00
11. Proportion Simple Lithophils	28.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,160.00
County	ELKHART
Drainage Area	136.00

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	86.10
7. Proportion of Omnivores	43.40
8. Proportion of Insectivores	5.50
9. Proportion of Pioneer Species	63.40
Proportion of Carnivores	3.20
10. Number of Individuals in Sample	309 00
11. Proportion Simple Lithophils	33.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,161.00
County	ELKHART
Drainage Area	17.70

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	17.70
Number of Sunfish Species	1
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	17.70
5. Number of Sentive Species	0
6. Percent Tolerant Species	88.50
7. Proportion of Omnivores	31.20
8. Proportion of Insectivores	14.60
9. Proportion of Pioneer Species	51.00
Proportion of Carnivores	0.00
10 Number of Individuals in Sample	96 00
11. Proportion Simple Lithophils	30.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,162.00
County	ELKHART
Drainage Area	129.00

IBI METRICS

1. Total Number of Fish Species	24
2. Number of Darter Species	4
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	21.10
Number of Sunfish Species	4
4. Number of Minnow Species	8
Number of Sucker Species	3
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	0.40
5. Number of Sentive Species	10
6. Percent Tolerant Species	11.80
7. Proportion of Omnivores	1.80
8. Proportion of Insectivores	93.40
9. Proportion of Pioneer Species	13.20
Proportion of Carnivores	1.30
10. Number of Individuals in Sample	228.00
11. Proportion Simple Lithophils	52.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,163.00
County	ELKHART
Drainage Area	110.00

IBI METRICS

1. Total Number of Fish Species	13
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	44.10
Number of Sunfish Species	2
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	1.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	14.70
7. Proportion of Omnivores	5 90
8. Proportion of Insectivores	86.30
9. Proportion of Pioneer Species	38.20
Proportion of Carnivores	3.90
10. Number of Individuals in Sample	102.00
11. Proportion Simple Lithophils	12.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,164.00
County	ELKHART
Drainage Area	63.10

IBI METRICS

1. Total Number of Fish Species	18
2. Number of Darter Species	2
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	53.50
Number of Sunfish Species	1
4. Number of Minnow Species	7
Number of Sucker Species	2
Number of Salmonid Species	2
Proportion Cool/Cold Water Species	14.90
5. Number of Sentive Species	5
6. Percent Tolerant Species	25.80
7. Proportion of Omnivores	4.00
8. Proportion of Insectivores	69.00
9. Proportion of Pioneer Species	14.60
Proportion of Carnivores	0.90
10. Number of Individuals in Sample	329.00
11. Proportion Simple Lithophils	36.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,165.00
County	ELKHART
Drainage Area	8.30

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	45.20
Number of Sunfish Species	0
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	45.20
5. Number of Sentive Species	1
6. Percent Tolerant Species	77 20
7. Proportion of Omnivores	28.10
8. Proportion of Insectivores	19.40
9. Proportion of Pioneer Species	26.20
Proportion of Carnivores	0 00
10. Number of Individuals in Sample	263.00
11. Proportion Simple Lithophils	73.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,166.00
County	ELKHART
Drainage Area	44.60

IBI METRICS

1. Total Number of Fish Species	16
2. Number of Darter Species	3
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	26.10
Number of Sunfish Species	2
4. Number of Minnow Species	7
Number of Sucker Species	3
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	27.50
5. Number of Sentive Species	3
6. Percent Tolerant Species	73.20
7. Proportion of Omnivores	37.30
8. Proportion of Insectivores	23.90
9. Proportion of Pioneer Species	22.50
Proportion of Carnivores	1.40
10. Number of Individuals in Sample	142.00
11. Proportion Simple Lithophils	78.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,167.00
County	ELKHART
Drainage Area	330.00

IBI METRICS

1. Total Number of Fish Species	26
2. Number of Darter Species	4
Number of Round-Bodied Suckers	4
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	3
4. Number of Minnow Species	8
Number of Sucker Species	5
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	11
6. Percent Tolerant Species	24.50
7. Proportion of Omnivores	19.50
8. Proportion of Insectivores	73.70
9. Proportion of Pioneer Species	11.50
Proportion of Carnivores	5.70
10. Number of Individuals in Sample	384.00
11. Proportion Simple Lithophils	67.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,168.00
County	ELKHART
Drainage Area	699.00

IBI METRICS

1. Total Number of Fish Species	35
2. Number of Darter Species	4
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	16
Number of Sucker Species	4
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	1.90
5. Number of Sentive Species	17
6. Percent Tolerant Species	3.60
7. Proportion of Omnivores	0.80
8. Proportion of Insectivores	77.30
9. Proportion of Pioneer Species	3.00
Proportion of Carnivores	21.20
10. Number of Individuals in Sample	638.00
11 Proportion Simple Lithophils	60.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,169.00
County	ELKHART
Drainage Area	32.00

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	77.60
Number of Sunfish Species	0
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	3
Proportion Cool/Cold Water Species	81.60
5. Number of Sentive Species	0
6. Percent Tolerant Species	96.00
7. Proportion of Omnivores	6.30
8. Proportion of Insectivores	0.00
9. Proportion of Pioneer Species	12.10
Proportion of Carnivores	4 00
10. Number of Individuals in Sample	174 00
11. Proportion Simple Lithophils	83.30
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,170.00
County	KOSCIUSKO
Drainage Area	2.70

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.90
Number of Sunfish Species	2
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.90
5. Number of Sentive Species	0
6. Percent Tolerant Species	55.20
7. Proportion of Omnivores	23.30
8. Proportion of Insectivores	49.10
9. Proportion of Pioneer Species	23.30
Proportion of Carnivores	22.40
10. Number of Individuals in Sample	116.00
11. Proportion Simple Lithophils	21.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,171.00
County	KOSCIUSKO
Drainage Area	9.50

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	95.60
7. Proportion of Omnivores	72.50
8. Proportion of Insectivores	15 40
9. Proportion of Pioneer Species	29.70
Proportion of Carnivores	1 10
10. Number of Individuals in Sample	91 00
11. Proportion Simple Lithophils	42.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,172.00
County	KOSCIUSKO
Drainage Area	11.50

IBI METRICS

1. Total Number of Fish Species	21
2. Number of Darter Species	4
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	13.30
Number of Sunfish Species	4
4. Number of Minnow Species	7
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	13.30
5. Number of Sentive Species	5
6. Percent Tolerant Species	35.00
7. Proportion of Omnivores	10.80
8. Proportion of Insectivores	50.00
9. Proportion of Pioneer Species	31.70
Proportion of Carnivores	15.80
10. Number of Individuals in Sample	120.00
11. Proportion Simple Lithophils	25.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,173.00
County	KOSCIUSKO
Drainage Area	47.80

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	2
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	2
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	1
6. Percent Tolerant Species	20.00
7. Proportion of Omnivores	0.00
8. Proportion of Insectivores	56.70
9. Proportion of Pioneer Species	43.30
Proportion of Carnivores	26.70
10. Number of Individuals in Sample	30.00
11. Proportion Simple Lithophils	13.30
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,174.00
County	ELKHART
Drainage Area	12.60

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	39.40
Number of Sunfish Species	0
4. Number of Minnow Species	7
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	39.40
5. Number of Sentive Species	0
6. Percent Tolerant Species	93.10
7. Proportion of Omnivores	44.00
8. Proportion of Insectivores	5.20
9. Proportion of Pioneer Species	57.20
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	734.00
11. Proportion Simple Lithophils	42.80
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,175 00
County	NOBLE
Drainage Area	282.00

IBI METRICS

1. Total Number of Fish Species	26
2. Number of Darter Species	4
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	6
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	9
6. Percent Tolerant Species	16.20
7. Proportion of Omnivores	8.80
8. Proportion of Insectivores	71.20
9. Proportion of Pioneer Species	15.60
Proportion of Carnivores	20.00
10. Number of Individuals in Sample	160.00
11. Proportion Simple Lithophils	39.40
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,176.00
County	NOBLE
Drainage Area	291.00

IBI METRICS

1. Total Number of Fish Species	24
2. Number of Darter Species	3
Number of Round-Bodied Suckers	4
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	3
Number of Sucker Species	4
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	7.20
5. Number of Sentive Species	7
6. Percent Tolerant Species	18.10
7. Proportion of Omnivores	11.10
8. Proportion of Insectivores	63.10
9. Proportion of Pioneer Species	18.60
Proportion of Carnivores	18.60
10. Number of Individuals in Sample	431 00
11. Proportion Simple Lithophils	38.70
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,177.00
County	ELKHART
Drainage Area	20.30

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	24.20
Number of Sunfish Species	1
4. Number of Minnow Species	7
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	24.20
5. Number of Sentive Species	1
6. Percent Tolerant Species	69.70
7. Proportion of Omnivores	30.30
8. Proportion of Insectivores	28.80
9. Proportion of Pioneer Species	38.60
Proportion of Carnivores	0 00
10. Number of Individuals in Sample	132.00
11. Proportion Simple Lithophils	43 20
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,178.00
County	ELKHART
Drainage Area	4.10

IBI METRICS

1. Total Number of Fish Species	9
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	68.60
Number of Sunfish Species	1
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	68.60
5. Number of Sentive Species	0
6. Percent Tolerant Species	77.90
7. Proportion of Omnivores	7.50
8. Proportion of Insectivores	23.60
9. Proportion of Pioneer Species	23.10
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	385.00
11. Proportion Simple Lithophils	64.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,179.00
County	ELKHART
Drainage Area	2,447.00

IBI METRICS

1. Total Number of Fish Species	35
2. Number of Darter Species	5
Number of Round-Bodied Suckers	5
3. Proportion of Headwater Species	1.10
Number of Sunfish Species	6
4. Number of Minnow Species	5
Number of Sucker Species	6
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.70
5. Number of Sentive Species	13
6. Percent Tolerant Species	6.20
7. Proportion of Omnivores	3.50
8. Proportion of Insectivores	72.20
9. Proportion of Pioneer Species	9.10
Proportion of Carnivores	22.80
10. Number of Individuals in Sample	569.00
11. Proportion Simple Lithophils	57.10
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,180.00
County	ELKHART
Drainage Area	593.00

IBI METRICS

1. Total Number of Fish Species	19
2. Number of Darter Species	2
Number of Round-Bodied Suckers	2
3. Proportion of Headwater Species	0.60
Number of Sunfish Species	5
4. Number of Minnow Species	3
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.60
5. Number of Sentive Species	7
6. Percent Tolerant Species	9.10
7. Proportion of Omnivores	0.60
8. Proportion of Insectivores	67.30
9. Proportion of Pioneer Species	21.20
Proportion of Carnivores	31.50
10. Number of Individuals in Sample	165.00
11. Proportion Simple Lithophils	18.20
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,181 00
County	ELKHART
Drainage Area	2,472.00

IBI METRICS

1. Total Number of Fish Species	26
2. Number of Darter Species	4
Number of Round-Bodied Suckers	7
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	6
4. Number of Minnow Species	5
Number of Sucker Species	7
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	14
6. Percent Tolerant Species	27.00
7. Proportion of Omnivores	26.00
8. Proportion of Insectivores	58.30
9. Proportion of Pioneer Species	30.70
Proportion of Carnivores	15.50
10. Number of Individuals in Sample	511 00
11. Proportion Simple Lithophils	42.10
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,182.00
County	ELKHART
Drainage Area	3,375.00

IBI METRICS

1. Total Number of Fish Species	30
2. Number of Darter Species	4
Number of Round-Bodied Suckers	7
3. Proportion of Headwater Species	0.10
Number of Sunfish Species	6
4. Number of Minnow Species	7
Number of Sucker Species	8
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.10
5. Number of Sentive Species	17
6. Percent Tolerant Species	2.70
7. Proportion of Omnivores	1.30
8. Proportion of Insectivores	78.00
9. Proportion of Pioneer Species	4.30
Proportion of Carnivores	19.90
10. Number of Individuals in Sample	700.00
11. Proportion Simple Lithophils	52.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,183.00
County	ST. JOSEPH
Drainage Area	3,531.00

IBI METRICS

1. Total Number of Fish Species	26
2. Number of Darter Species	3
Number of Round-Bodied Suckers	4
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	6
4. Number of Minnow Species	7
Number of Sucker Species	5
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	7
6. Percent Tolerant Species	15.80
7. Proportion of Omnivores	7.70
8. Proportion of Insectivores	65.30
9. Proportion of Pioneer Species	16.90
Proportion of Carnivores	25.70
10. Number of Individuals in Sample	467 00
11. Proportion Simple Lithophils	12.20
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,184.00
County	ST JOSEPH
Drainage Area	3,580.00

IBI METRICS

1. Total Number of Fish Species	15
2. Number of Darter Species	3
Number of Round-Bodied Suckers	3
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	1
Number of Sucker Species	3
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	7
6. Percent Tolerant Species	14.50
7. Proportion of Omnivores	12.80
8. Proportion of Insectivores	19.00
9. Proportion of Pioneer Species	15.10
Proportion of Carnivores	68.20
10. Number of Individuals in Sample	179.00
11. Proportion Simple Lithophils	4.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,185.00
County	ST JOSEPH
Drainage Area	3,659.00

IBI METRICS

1. Total Number of Fish Species	12
2. Number of Darter Species	1
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	5
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	4
6. Percent Tolerant Species	8.00
7. Proportion of Omnivores	4.50
8. Proportion of Insectivores	69.60
9. Proportion of Pioneer Species	3.60
Proportion of Carnivores	25.90
10. Number of Individuals in Sample	112.00
11. Proportion Simple Lithophils	0.90
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,186.00
County	ST. JOSEPH
Drainage Area	6.60

IBI METRICS

1. Total Number of Fish Species	3
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	93.50
Number of Sunfish Species	1
4. Number of Minnow Species	2
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	93.50
5. Number of Sentive Species	0
6. Percent Tolerant Species	100.00
7. Proportion of Omnivores	0.00
8. Proportion of Insectivores	4.10
9. Proportion of Pioneer Species	6.50
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	123.00
11. Proportion Simple Lithophils	93.50
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,188.00
County	LAGRANGE
Drainage Area	30.20

IBI METRICS

1. Total Number of Fish Species	6
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	68.60
Number of Sunfish Species	0
4. Number of Minnow Species	3
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	48.80
5. Number of Sentive Species	0
6. Percent Tolerant Species	74.90
7. Proportion of Omnivores	18.40
8. Proportion of Insectivores	24.60
9. Proportion of Pioneer Species	13.00
Proportion of Carnivores	0.00
10 Number of Individuals in Sample	207.00
11. Proportion Simple Lithophils	67.10
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,189.00
County	ELKHART
Drainage Area	9.30

IBI METRICS

1. Total Number of Fish Species	0
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	
Number of Sunfish Species	0
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	
7. Proportion of Omnivores	
8. Proportion of Insectivores	
9. Proportion of Pioneer Species	
Proportion of Carnivores	
10. Number of Individuals in Sample	0.00
11. Proportion Simple Lithophils	
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,190.00
County	ELKHART
Drainage Area	4.00

IBI METRICS

1. Total Number of Fish Species	5
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	87.90
Number of Sunfish Species	0
4. Number of Minnow Species	2
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	87.90
5. Number of Sentive Species	0
6. Percent Tolerant Species	96.40
7. Proportion of Omnivores	6.30
8. Proportion of Insectivores	3.60
9. Proportion of Pioneer Species	5.80
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	223 00
11. Proportion Simple Lithophils	91.50
12 Proportion Delt	0 00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,191.00
County	ELKHART
Drainage Area	33.20

IBI METRICS

1. Total Number of Fish Species	11
2. Number of Darter Species	3
Number of Round-Bodied Suckers	1
3. Proportion of Headwater Species	51.60
Number of Sunfish Species	0
4. Number of Minnow Species	4
Number of Sucker Species	2
Number of Salmonid Species	1
Proportion Cool/Cold Water Species	52.80
5. Number of Sentive Species	2
6. Percent Tolerant Species	66.40
7. Proportion of Omnivores	9.20
8. Proportion of Insectivores	26.80
9. Proportion of Pioneer Species	30.40
Proportion of Carnivores	2.00
10. Number of Individuals in Sample	250.00
11. Proportion Simple Lithophils	67.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,192.00
County	ELKHART
Drainage Area	11.20

IBI METRICS

1.	Total Number of Fish Species	9
2.	Number of Darter Species	1
	Number of Round-Bodied Suckers	0
3.	Proportion of Headwater Species	0.60
	Number of Sunfish Species	0
4.	Number of Minnow Species	6
	Number of Sucker Species	1
	Number of Salmonid Species	0
	Proportion Cool/Cold Water Species	0.60
5.	Number of Sentive Species	0
6.	Percent Tolerant Species	94.70
7.	Proportion of Omnivores	80.60
8.	Proportion of Insectivores	4.20
9.	Proportion of Pioneer Species	54.70
	Proportion of Carnivores	0.80
10.	Number of Individuals in Sample	360.00
11.	Proportion Simple Lithophils	44.40
12	Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,193.00
County	ELKHART
Drainage Area	3.00

IBI METRICS

1. Total Number of Fish Species	0
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	
7. Proportion of Omnivores	
8. Proportion of Insectivores	
9. Proportion of Pioneer Species	
Proportion of Carnivores	
10. Number of Individuals in Sample	0.00
11. Proportion Simple Lithophils	
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,194.00
County	ELKHART
Drainage Area	2.30

IBI METRICS

1. Total Number of Fish Species	0
2. Number of Darter Species	0
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	0.00
Number of Sunfish Species	0
4. Number of Minnow Species	0
Number of Sucker Species	0
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	0.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	
7. Proportion of Omnivores	
8. Proportion of Insectivores	
9. Proportion of Pioneer Species	
Proportion of Carnivores	
10. Number of Individuals in Sample	0.00
11. Proportion Simple Lithophils	
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,195.00
County	ELKHART
Drainage Area	8.50

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	19.60
Number of Sunfish Species	0
4. Number of Minnow Species	5
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	19.60
5. Number of Sentive Species	0
6. Percent Tolerant Species	89.90
7. Proportion of Omnivores	32.70
8. Proportion of Insectivores	10.10
9. Proportion of Pioneer Species	78.40
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	199.00
11. Proportion Simple Lithophils	21.60
12 Proportion Delt	0.00

Indiana Department of Environmental Management
OWM - Biological Studies Section
Development of the Index of Biotic Integrity
SMNITP

SITE INFORMATION:

Site Number	91,196.00
County	ST. JOSEPH
Drainage Area	4.50

IBI METRICS

1. Total Number of Fish Species	7
2. Number of Darter Species	1
Number of Round-Bodied Suckers	0
3. Proportion of Headwater Species	40.00
Number of Sunfish Species	0
4. Number of Minnow Species	4
Number of Sucker Species	1
Number of Salmonid Species	0
Proportion Cool/Cold Water Species	40.00
5. Number of Sentive Species	0
6. Percent Tolerant Species	97.60
7. Proportion of Omnivores	52.00
8. Proportion of Insectivores	2.40
9. Proportion of Pioneer Species	56.00
Proportion of Carnivores	0.00
10. Number of Individuals in Sample	125.00
11 Proportion Simple Lithophils	41.60
12 Proportion Delt	0.00

APPENDIX C. Fish nomenclature changes for the species of fish occurring within the political boundaries of Indiana.

	Previous Nomenclature
Petromyzontiformes - lampreys	
Petromyzontidae - lamprey	
Lampetra appendix (DeKay), American brook lamprey	*Lampetra lamottei*
Lepisosteiformes - gars	
Lepisosteidae - gars	
Atractosteus spatula (Lacepede), alligator gar	*Lepisosteus spatula*
Salmoniformes - trout, salmon, whitefish	
Salmonidae - trout, salmon, whitefish	
Oncorhynchus mykiss Walbaum, rainbow trout	*Salmo gairdneri*
Cypriniformes - carps and minnows	
Cyprinidae -carps and minnows	
Campostoma oligolepis Hubbs and Greene, largescale stoneroller	previously considered *Campostoma anomalum pullum*
Cyprinella lutrensis (Baird and Girard), red shiner	*Notropis lutrensis*
Cyprinella spiloptera Cope, spotfin shiner	*Notropis spiloptera*
Cyprinella whipplei (Girard), steelcolor shiner	*Notropis whipplei*
Erimystax dissimilis Kirtland, streamline chub	*Hybopsis dissimilis*
Erimystax x-punctata Hubbs and Crowe, gravel chub	*Hybopsis x-punctata*
Extrarius aestivalis Girard, speckled chub	*Hybopsis aestivalis*
Hybopsis amnis Hubbs and Greene, pallid shiner	*Notropis amnis*
Luxilus chrysocephalus (Rafinesque), striped shiner	*Notropis chrysocephalus*
Luxilus cornutus (Mitchell), common shiner	*Notropis cornutus*
Lythrurus ardens (Cope), rosefin shiner	*Notropis ardens*
Lythrurus fumeus Evermann, ribbon shiner	*Notropis fumeus*
Lythrurus umbratilis (Girard), redfin shiner	*Notropis umbratilis*
Macrhybopsis storeriana (Kirkland), silver chub	*Hybopsis storeriana*
Notropis ludibuundus Cope, sand shiner	*Notropis stramineus*
Opsopoeodus emiliae Hay, pugnose minnow	*Notropis emiliae*
Siluriformes - bullhead and catfish	
Ictaluridae - bullhead and catfish	
Ameiurus catus (Linnaeus), white catfish	*Ictalurus catus*
Ameiurus melas (Rafinesque), black bullhead	*Ictalurus melas*
Ameiurus natalis (Lesueur), yellow bullhead	*Ictalurus natalis*
Ameiurus nebulosus (Lesueur), brown bullhead	*Ictalurus nebulosus*
Atheriniformes - topminnows, silversides	
Fundulidae - topminnows	previously Cyprinodontidae
Perciformes - basses, sunfish, perch, darters	previously Percichthyidae
Moronidae - temperate basses	
Morone chrysops (Rafinesque), white bass	
Morone mississippiensis Jordan and Eigenmann, yellow bass	
Morone saxatilis (Walbaum), striped bass	
Elassomatidae - pygmy sunfish	previously Centrarchidae
Elassoma zonatum Jordan, banded pygmy sunfish	
Percidae - perches and darters	
Crystallaria asprella Jordan, crystal darter	*Ammocrypta asprella*

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1997	Final

4. TITLE AND SUBTITLE
Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana. III. Northern Indiana Till Plain

5. FUNDING NUMBERS

6. AUTHOR(S)
Thomas P. Simon

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Environmental Protection Agency
Water Division
Watershed and Non-Point Source Branch
77 West Jackson Boulevard, WW-16J
Chicago, Illinois 60604

8. PERFORMING ORGANIZATION REPORT NUMBER
EPA 905-R-96-002

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
same as #7

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Prepared in cooperation with the Indiana Department of Environmental Management, Assessment Branch

12a. DISTRIBUTION/AVAILABILITY STATEMENT
UNLIMITED

12b. DISTRIBUTION CODE
UNLIMITED

13. ABSTRACT (Maximum 200 words)

The St. Joseph River was investigated during 1992 to determine water resource expectations for headwater and wadable streams. A total of 104 sites were sampled within four watersheds to develop and calibrate an Index of Biotic Integrity for use in the Indiana portion of the watershed. Maximum species richness lines were developed for streams less than 2000 mi^2 drainage area. The St. Joseph Piver drainage had very good biotic integrity approaching a normal curve in integrity classes. Site specific data including an evaluation of fish community trends, tolerance classification, trophic and reproductive guilds are included.

14. SUBJECT TERMS
St. Joseph River, biological criteria, IBI, fish community structure, Indiana

15. NUMBER OF PAGES
67 + appendices

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR