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RELATIONS OF STREAM FISH COMMUNITIES TO PHYSICAL AND CHEMICAL PARAMETERS AND LAND USE IN THE MISSISSIPPI ALLUVIAL PLAIN ECOREGION

Open-File Report 03-31

U.S. Department of the Interior
U.S. Geological Survey

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by Brian J. Caskey

U.S. GEOLOGICAL SURVEY
Open-File Report 03-31

National Water-Quality Assessment Program

Jackson, Mississippi
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U.S. DEPARTMENT OF THE INTERIOR

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http://wwwrvares.er.usgs.gov/nawqa_home.html.

FOREWORD

The U.S. Geological Survey (USGS) is committed to serve the Nation with accurate and timely scientific information that helps enhance and protect the overall quality of life, and facilitates effective management of water, biological, energy, and mineral resources. Information on the quality of the Nation's water resources is of critical interest to the USGS because it is so integrally linked to the long-term availability of water that is clean and safe for drinking and recreation and that is suitable for industry, irrigation, and habitat for fish and wildlife. Escalating population growth and increasing demands for the multiple water uses make water availability, now measured in terms of quantity *and* quality, even more critical to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) Program to support national, regional, and local information needs and decisions related to water-quality management and policy. Shaped by and coordinated with ongoing efforts of other Federal, State, and local agencies, the NAWQA Program is designed to answer: What is the condition of our Nation's streams and ground water? How are the conditions changing over time? How do natural features and human activities affect the quality of streams and ground water, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues. NAWQA results can contribute to informed decisions that result in practical and effective water-resource management and strategies that protect and restore water quality.

Since 1991, the NAWQA Program has implemented interdisciplinary assessments in more than 50 of the Nation's most important river basins and aquifers, referred to as Study Units. Collectively, these Study Units account for more than 60 percent of the overall water use and population served by public water supply, and are representative of the Nation's major hydrologic landscapes, priority ecological resources, and agricultural, urban, and natural sources of contamination.

Each assessment is guided by a nationally consistent study design and methods of sampling and analysis. The assessments thereby build local knowledge about water-quality issues and trends in a particular stream or aquifer while providing an understanding of how and why water quality varies regionally and nationally. The consistent, multi-scale approach helps to determine if certain types of water-quality issues are isolated or pervasive, and allows direct comparisons of how human activities and natural processes affect water quality and ecological health in the Nation's diverse geographic and environmental settings. Comprehensive assessments on pesticides, nutrients, volatile organic compounds, trace metals, and aquatic ecology are developed at the national scale through comparative analysis of the Study-Unit findings.

The USGS places high value on the communication and dissemination of credible, timely, and relevant science so that the most recent and available knowledge about water resources can be applied in management and policy decisions. We hope this NAWQA publication will provide you the needed insights and information to meet your needs, and thereby foster increased awareness and involvement in the protection and restoration of our Nation's waters.

The NAWQA Program recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for a fully integrated understanding of watersheds and for cost-effective management, regulation, and conservation of our Nation's water resources. The Program, therefore, depends extensively on the advice, cooperation, and information from other Federal, State, interstate, Tribal, and local agencies, non-government organizations, industry, academia, and other stakeholder groups. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch
Associate Director for Water

Preface

In 1994, the U.S. Geological Survey (USGS) began a study of the Mississippi Embayment Study Unit (MISE) as part of the National Water-Quality Assessment (NAWQA) Program. The NAWQA Program is designed to assess status and trends in the quality of the Nation's water resouces and to determine the natural and human factors affecting these resources. The Program will eventually integrate physical, chemical, and biological data from more than 50 study units across the Nation.

All of the data presented herein were collected in support of the MISE NAWQA Program and were collected according to the protocols set forth by the NAWQA Program. The author, Brian J. Caskey, collected much of the data as part of his duties as an employee of the USGS on the MISE NAWQA project. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the USGS.

This thesis was written in partial fulfillment of the requirements for the Degree of Master of Science in Environmental Science. The thesis is presented here in its entirety and was written, formatted, edited, compiled, and approved in accordance with the requirements of the Department of Environmental Science, Jackson State University, Jackson, Mississippi.

RELATIONS OF STREAM FISH COMMUNITIES TO PHYSICAL AND CHEMICAL PARAMETERS AND LAND USE IN THE MISSISSIPPI ALLUVIAL PLAIN ECOREGION

by

Brian J. Caskey

A Thesis

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PHYSICAL AND CHEMICAL PARAMETERS AND LAND USE
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Approved by:

Committee Chairperson

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Dean, Graduate School

May 2002

DEDICATION

In memory of my great aunt Bea Sherban, who first influenced my appreciation of nature.

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ACKNOWLEDGMENTS

I would like to thank the U.S. Geological Survey for funding this project. I would also like to thank my major professor Dr. Paulinus Chigbu for his instruction through this project and Dr.s' Barbara Kleiss and Charles Rhyne for serving as committee members; their advice and comments throughout my graduate studies are appreciated. The number of friends, colleagues, and peers who encouraged me throughout this project are too numerous to mention [everyone], but I would like to mention three colleagues who have made significant contribution to my career: Steve Filipek, Charles Gagen, and Humbert Zappia. Lastly, I would like to acknowledge my Lord and Savior for granting me the courage, strength, and perseverance to endure the trials and tribulations of graduate work. With God all things are possible.

ABSTRACT

Fish community, habitat, and basin assessments were conducted in the northern part of the Mississippi Alluvial Plain Ecoregion following protocols set by the U.S. Geological Survey. The information collected was used to assess the relations between stream fish communities and land use. Seventy-seven fish species and one hybrid sunfish from 16 families were recorded in this study, although, historically, 160 fish species from 24 families have been recorded in the study area. In this study, the fish community sampling used only two sampling methods, where as the historical collections followed a variety of sampling methods. The differences between historical fish collections and this study could be due, in part, to differences in sampling methods and types (sizes) of streams sampled.

Historically, wetlands accounted for more than 50 percent of the land use in the Mississippi Alluvial Plain Ecoregion. During this study, it was found that the dominant land use in the Mississippi Alluvial Plain Ecoregion was agriculture (about 82 percent), and about 6 percent of the wetlands remain.

Multivariate procedures were used to draw inferences between the fish communities and land use. A TWINSPAN was run first of the percent relative abundance fish community data, and it showed that, based on the fish community data that the sites differed following a northern versus southern break. Then a correspondence analysis of the arsine transformed fish community data was run after partialling out four

naturally occurring environmental parameters. The eigenvalue from this analysis was about 0.356; therefore, it was concluded that the sites were constrained to the first axis.

Next, a canonical correspondence analysis was run using the arsine transformed fish community data and 18 selected environmental parameters after partialling out four naturally occurring environmental parameters. The canonical correspondence analysis showed that the correspondence analysis site scores were related to the percent of corn (r^2 = -0.4769) and average channel width (r^2 = 0.4607) along the first axis and related to the percent rice (r^2 = -0.6720) and small grains (r^2 = 0.4902) along the second axis. The findings from this analysis suggest that land use in Mississippi Alluvial Plain Ecoregion differ in the northern versus southern portions of the study area.

Further analysis, Spearman rho correlations, showed that the percent of deciduous forest was correlated with Shannon diversity (r_s = 0.4694), small grains were correlated to the average standard length of black bass (r_s = 0.4515), and the percent corn was correlated to the number of intolerant taxa (r_s = 0.5382), to the number of minnow taxa (r_s = 0.4749), and to the relative abundance of insectivores (r_s = 0.6114). Findings from the Spearman analysis support the idea that land use is related to fish communities in the Mississippi Alluvial Plain Ecoregion.

The combination of the canonical correspondence analysis and Spearman rho correlations suggest that streams in the northern portion of the study area are typically small streams that are dominated by intolerant minnow species, while the land use is dominated by corn production. Streams are larger in the southern portion of the study area and dominated by a few tolerant species, and the land use is dominated by rice production.

INTRODUCTION

The Clean Water Act (CWA) of 1976 has greatly improved the quality of water Nationwide, in part, by regulating point source pollutants. Unfortunately, the CWA has fallen short of its original goal of making 80 percent of the Nation's fresh waters swimable and fishable by the early 1990s. The effects of point source pollution have been well documented, although less is known about the effects of non-point source pollution. However, some research has shown that non-point source pollution, such as alterations in land use which can result in the loss of in-stream habitat, is related to declining biodiversity in many aquatic ecosystems (Fausch et al. 1990; Wesche 1993; Anon 1994).

In 1991 the U.S. Congress established the National Water-Quality Assessment (NAWQA) Program and designated the U.S. Geological Survey (USGS) to conduct this program. The goals of the Program are to assess status and trends in the quality of the Nation's water resources and to determine the natural and human factors affecting these resources. The information obtained from this program can help managers and policy makers to better anticipate, prioritize, and manage water quality in different hydrologic and land-use settings. The Program will eventually integrate physical, chemical, and biological data from more than 50 study units across the Nation (Fuhrer 1999).

The NAWQA Program is not intended to assess the quality of the Nation's drinking water, but to assess the quality of the resource itself. Many other state programs monitor the quality of drinking water as they are assessed by National standards. The NAWQA Program has focused its studies on how alluvial ecosystems are affected by nutrients and pesticides. This concern is due, in part, to the fact that nutrients and pesticides are commonly used in the United States. These chemicals are often used to increase the productivity of crops and the aesthetic value of yards in urban areas (Fuhrer 1999). Increases in the concentrations of nitrogen and phosphorous can make many aquatic systems eutrophic. The eutrophication of aquatic systems has led to shifts in biological communities in many of our rivers and streams (Fuhrer 1999).

For many of the chemicals, it is too early to tell whether conditions are getting better or worse, because there is no long-term data for comparison. Despite this limitation, many trends are evident from monitoring nutrients and pesticides. The NAWQA program has shown that water quality is constantly changing, from season to season and from year to year. Some of the preliminary findings of the NAWQA Program showed that streams in basins with a significant agriculture or urban concentration almost always contain complex mixtures of nutrients and pesticides. These trends show that changes in water quality over time are often controlled by many factors, such as topography, climate, and land use, to name a few (Fuhrer 1999).

The objectives of this study are to (1) document stream fish communities within the Mississippi Alluvial Plain (MAP) Ecoregion using standardized sampling methods, (2) document land use within the MAP Ecoregion, and (3) assess the relations between physical, chemical and land-use parameters and stream fish communities in the MAP Ecoregion. This study will help scientists develop understandings of the fish communities by documenting the relations between fish communities and land use in the MAP Ecoregion. The insights gained from this study will help managers and policy makers to better anticipate, prioritize, and manage land-use issues in the MAP Ecoregion.

CHAPTER 1

REVIEW OF LITERATURE ON FISH COMMUNITY ASSESSMENTS AND LAND-USE STUDIES

The Environmental Protection Agency (EPA) has found that 87 percent of the wetlands drained each year are for agriculture. This has led the EPA to conclude that agricultural activities may be a source of non-point water pollution in many areas across the United States (Cox 1993). Such pollution can impact biotic integrity of streams. This has led to a growing interest in the use of biological methods to assess the biotic integrity of streams (Karr 1981; Allen and Flecker 1993; Fisher, Surmount, and Martin 1998). Biotic integrity can be summarized briefly as the ability of a stream to support a biological community and processes, typically of undisturbed and natural conditions (Karr 1981; Hallerman and Epifanio 1992; Allen and Zarull 1995). Many animal communities have been used to assess perturbation in streams, including benthic invertebrate and fish communities.

A fish community is a group of fish species that inhabits the same area and interacts with each other. The structure of a fish community is determined by the species present, their relative abundance, life stage and size distribution, and their distribution in space and time (Tate and Martin 1995). The life cycle of fish can be described in several stages: eggs, larvae, juveniles, and adults.

Fish communities can be influenced by many ecological conditions (Maret, Robinson, and Minshall 1997). The primary agents that stress fish communities, apart from natural environmental fluctuations, are anthropogenic disturbances (Ross, Matthews, and Echelles 1985). The effects of any given perturbation on a fish community can vary depending on the species present, their life stage, the type of disturbance, and duration of the disturbance (Orth and White 1993; Master, Flack, and Stein 1998).

In recent years there has been a growing interest in using fish to characterize water quality. One of the biggest advantages of using biological methods to assess perturbation of streams is that aquatic communities integrate the totality of environmental factors within a stream (Karr 1981; Larkin 1988; Matthews 1993). Consequently, they represent a powerful tool for quick, economical, and comprehensive assessment of stream health (Ross, Matthews, and Echelles 1985; Schlosser 1991; Ward 1998).

The most commonly used single measure to describe fish health is diversity. In general, diversity can be defined as a function of both the number of species present (richness) and the equitability of the distribution of individuals within these species (evenness). Typically, streams that have high fish diversity values are generally classified as relatively pristine. However, some recent findings have suggested that species diversity may increase in some degraded systems (Wang et al. 1997). This has led ecologists to believe that species diversity may not always be a measure of degraded systems, and consequently, single metric approaches may not be applicable in water-quality studies.

In 1981, Karr proposed the Index of Biotic Integrity (IBI) to assess degradation of streams. This method uses several measurable attributes of fish communities, also termed metrics, that can easily be calculated from a sample. This method, as developed by Karr (1981), was first implemented in Midwest streams that were impacted by agriculture. The initial IBI method consisted of twelve metrics in three categories: species composition, trophic composition, and fish abundance and health. The species composition category describes the overall species richness within major taxonomic groups and occurrence of tolerant and intolerant species. The trophic composition category describes the food habits of fish. Food habits can show linkages to trophic levels, which can describe diversity and productivity. The final category, fish abundance and health, reflects the productivity and habitat stability.

Individually, each metric receives a score ranging from worst (degraded) to best (pristine). The individual metric scores are summed, and the final score is used to assess the water quality of a given site. There is a growing interest in the use of this application, but a major drawback is that the applicable metrics vary from region to region. Consequently, metrics need to be developed for the fish distribution of each region. To develop metrics that are appropriate for any given region, biologists from each region must take an active interest in their development. Currently, no regional metrics have been developed for the MAP Ecoregion.

Watersheds typically dominated by agriculture generally have increased loads of sediment, nutrients, and pesticides (Fuhrer 1999). The primary impact from increased sediment loads on fish is the loss of feeding and spawning grounds (Fajen and Layzer 1993). Many fish require vegetation or coarse material for spawning. The majority of these fish are more desirable species, referred to as game fish. Those fish not affected typically tend to be open-water spawners, often termed as "non-game fish" (Berkman and Rabeni 1987).

In areas that have increased sediment loads, silt particles often coat fish eggs, which can result in high egg mortality. Sediment can completely bury spawning beds, causing little or no reproduction of native fish in affected reaches of streams. Some research has suggested that fish larvae are even less tolerant to siltation than eggs or adults. At a turbidity of 100 ppm or greater, the spawning success of many game fish is severely reduced or even non-existent (Fajen and Layzer 1993). Furthermore, increases in turbidity could also result in reduced predation of juvenile fish (Berkman and Rabeni 1987). Others have shown that juvenile and adult fish can experience reductions in growth rates due to increased turbidity (Ross, Matthews, and Echelles 1985; Fajen and Layzer 1993). In areas where there has not typically been a high amount of silt, increased siltation can drastically alter fish species composition. In such high turbidity conditions, non-game fish may flourish and, in some cases, there can be a decrease in species diversity.

An influx of nutrients, due in part to agricultural runoff, will likely affect the biotic community and energy cycles within a stream (Fuhrer 1999). Whether or not these influences have a negative or positive impact depends on the dynamics within each stream's watershed. For example, an increase in nutrients in a stream that has a closed canopy may not have a noticeable change in biotic communities, because these systems are often rich in nutrients because they are driven, in part, by allochthonous production. However, increases in the same nutrient in an area with an open canopy will likely result in an increase in primary production. This increase in primary production could lead to a shift in fish species composition, from one that is dominated by insectivores to one dominated by herbivores.

An underlying assumption in water-resource management is that altered streams will contain altered biological communities (Larimore 1981; Angermeier 1993; McGrady-Steed, Harris, and Morin 1997); thus, the physical and chemical environment within streams directly affect aquatic community composition and abundance (Karr and Schlosser 1978). Fish, being near the top of the aquatic food pyramid, probably best reflect the general ecological condition of the streams where they reside. Consequently, they are often used to assess environmental conditions, not only because of their position in the food pyramid, but because they represent an organism that the public can relate to, are relatively inexpensive to collect (Karr 1981; Maret, Robinson, and Minshall 1997), and can be easily identified with minimal training.

Using multivariate procedures, researchers have begun to develop a better understanding of how fish communities respond to anthropogenic influences. Various multivariate methods are often useful for exploring the structure of data sets and generating relevant ecological hypotheses. Analyses that use multivariate methods can reduce the dimensions of data sets from one that has many parameters that may appear to be unrelated, to a data set that can be plotted on two or three derived axes, which may clarify relationships among samples and provide ecological hypotheses to be tested.

Features of in-stream habitat such as stream hydrology, sedimentation, nutrient inputs, channel morphology, and riparian vegetation have long been considered when defining local aquatic community composition (Vannote et al. 1980; Junk, Bayley, and Sparks 1989; Schramm and Hubert 1996). Recently, studies that evaluated basin-wide parameters such as geology, land use, and climate have provided a better understanding of important linkages in aquatic community composition (Cuffney et al. 1990; Wang et al. 1997).

Several studies have revealed that riparian vegetation can directly influence aquatic communities by mediating the effects that agricultural activities have on local biological communities (Benfield, Jones, and Patterson 1977; Cobb and Kaufman 1993; Ebersole, Liss, and Frissell 1997). Riparian cover directly affects aquatic communities by influencing habitat, in-stream temperature, and primary production, particularly in mid- to small-size streams (Schlosser 1990; Filipek 1993; Gower et al. 1994).

Physical habitat in streams strongly influences fish community composition (Baker, Killgore, and Kasul 1991; Ebersole, Liss, and Frisell 1997). Some studies have suggested that woody riparian cover could be effective in maintaining and improving fish community composition in streams in basins with heavy agriculture land use (Winger 1981; Schlosser 1990; Stiassny 1996). Other studies have shown that in agricultural basins with high runoff potential due to artificial drainage, woody riparian cover could be important for protecting and maintaining healthy fish communities (Benfield, Jones, and Patterson 1977; Sullivan and Peterson 1997; Wang et al. 1997).

A study of 67 streams in the Maryland Coastal Plain supported the idea that altered habitats contain altered biological communities. The study showed that disturbed streams were characterized by low relative abundances or lack of desirable fish species and by increased relative abundance of several fish species known to be generalists. The relative abundance of the generalists was greater at sites disturbed by urban development and agriculture. The study demonstrated that differences exist in the fish assemblages of high and low quality streams and that measures of assemblage structure and function were useful in reflecting degraded stream and watershed conditions (Scott and Hall 1997).

A study in eastern Wisconsin looked at whether the fish communities were representative of fish communities in streams that were minimally affected by agriculture and found that fish were particularly effective indicators of the environmental quality of surface waters (Berkman and Rabeni 1987). The study also found that multivariate analysis could be very useful in studies of community ecology. It helped the ecologists discover structure in their data and provided objective summarization of data to facilitate interpretation and aid in communicating results. Furthermore, the study found that environmental degradation in warmwater streams often results in a decrease in the number of species present.

The concept of ecoregions has proven to be an effective aid for inventorying and assessing national and regional environmental resources, for setting resource-management goals, and for developing biological criteria and water-quality standards. From 1993 to 1995, Bilger and Brightbill (1998) studied fish communities and their relation to physical and chemical characteristics of streams in the Lower Susquehanna River Basin. Fish communities were sampled in agricultural areas to determine if the fish communities differed temporally and/or spatially within an ecoregion. Using a multivariate approach, the study found that non-game species appeared to be non-specific in their habitat requirements and were found in a wide variety of streams, whereas game fish appeared to have very specific environmental requirements.

A study in the South Platte River (Tate and Martin 1995) found that differences in fish communities at upstream and downstream sites also might be related to differences in water quality or in the types of habitat available. Results of the study showed that there was a wide distribution of suckers (*Catostomidae species*), common carp (*Cyprinus carpio*), fathead minnows (*Pimephales vigilax*), and creek chubs (*Semotilus atromaculatus*) at the disturbed sites. These species are considered to be tolerant; that is, they are relatively adaptable to streams degraded due to habitat alterations, siltation, organic pollution, channelization, or flow fluctuation.

Sullivan and Peterson (1997) found that streams in agricultural areas generally contained low fish species diversity. Fish communities from impacted and unimpacted streams were relatively similar to each other because a few tolerant species dominated each sample. Berkman and Rabeni (1987) found that differences exist in fish communities associated with riffle siltation, but this finding alone was not as useful as the IBI for detecting changes in water and habitat quality in three Missouri agricultural streams.

In the MAP Ecoregion, substantial changes have occurred in land use over the past 100 years. The Mississippi Alluvial Plain is located in the lower third of the Mississippi River drainage, which is the fifth largest freshwater drainage basin in the world and the largest freshwater drainage basin in North America, draining about 41 percent of the contiguous United States and a portion of Canada (Baker, Killgore, and Kasul 1991). The MAP Ecoregion (Omernik 1986) includes six states. The climate within the MAP Ecoregion is characterized as humid, subtropical to temperate, and the mean annual temperature ranges from approximately 14 °C in the northern portion of the area to approximately 18 °C in the southern portion. The annual precipitation ranges from approximately 122 cm in the northern portion to approximately 142 cm in the southern portion (United States Department of Commerce 1995). The streams in the MAP

Ecoregion generally flow towards the Mississippi River, and then head south towards the Gulf of Mexico.

Watersheds in the MAP Ecoregion have typically been altered from bottomland hardwoods and wetlands to row-crop agricultural fields and channelized streams (Baker, Killgore, and Kasul 1991; Fajen and Layzer 1993). From the arrival of the first European settlers until today, many people have altered the MAP Ecoregion without considering the possible environmental effects. Human alterations of the physical, chemical, or biological properties of alluvial ecosystems could result in a change of the distribution and structure of a fish community (Karr 1981; Maret, Robinson, and Minshall 1997).

During the early to mid 1900s, about 50 percent of the MAP Ecoregion consisted of bottomland hardwoods and wetlands; whereas only about 5 percent remains today (Baker, Killgore, and Kasul 1991). The conversion of these bottomland hardwoods and wetlands to row-crop agricultural fields and channelized streams over the past century probably has been the most dramatic change to the MAP Ecoregion. The land-use conversions that have occurred within the MAP Ecoregion have caused dramatic changes in available stream habitat, and some researchers have suggested that habitat loss is one of the leading causes of biodiversity loss within streams (Winter and Hughes 1997).

Fish communities have been documented within the MAP Ecoregion since the late 1800s (Hay 1882) using a variety of sampling methods that met the objectives of each specific study. Although historically 160 species representing 23 families have been documented within the MAP Ecoregion, no single state or federal agency has sampled fish communities following a single standardized sampling protocol, until this study began in 1994. The number of fish species that have historically been collected in the MAP Ecoregion (Table 1) ranges from 137 species in Louisiana (Douglas 1974) to 91 species in Kentucky (Burr and Warren 1986).

CHAPTER 2

METHODS AND MATERIALS

Study Area, Site, and Reach Selection

The study area (Figure 1) is located in the northern portion of the MAP Ecoregion (Omernik 1986). The area is approximately 150,000 km^2 and is within all or part of 107 counties within the states of Arkansas, Kentucky, Mississippi, Missouri, Tennessee, and 11 parishes in Louisiana. In 1997, thirty-six sites on thirty-four streams (Figure 1) were selected for fish community sampling planned for the summer of 1998 (Table 2). The first twenty-six sites were selected because they integrated most types of land use in the MAP Ecoregion or were representative of a specific land use in the Ecoregion; collectively the selected sites provided spatial coverage of the entire region. The remaining ten sites were chosen to represent a gradient of crop intensity for each of three major crops grown in the MAP Ecoregion--corn, rice, and cotton. County-level land-use information for 1995 and 1996 were used to determine crop intensities (U.S. Geological Survey 1990).

Stream reaches; lengths of the stream to be sampled were designated at each of the 36 sites before sampling. To designate reaches, a visual assessment of the stream was made, and lengths physically representative of the stream were measured and marked for sampling. Thirty-four of the 36 reaches were sampled as planned. At two of the sites

(LaGrue Bayou near Dewitt, Arkansas, and Second Creek near Palestine, Arkansas), fallen trees and beaver dams restricted access: consequently, a 250-m reach was sampled at these sites.

Habitat, Chemical, and Fish Community Assessment

After site selection, but prior to the fish community assessment, a quantitative habitat assessment was conducted. At three transects within the reach (top, center, and bottom) the thalweg, water depth, and wetted channel width were measured using a telescopic depth pole and hip chain. A discharge measurement was made following protocols set by the USGS (Meador et al. 1994). The average measurement of each physical parameter was then calculated.

From May to August 1998, fish communities were assessed at each of the 36 sites by seining (Appendix 1) and electrofishing (Appendix 2) during low-flow periods. In general, methods were consistent with the NAWQA Program fish sampling protocols (Meador, Cuffney, and Gurtz 1993). Chemical parameters were measured prior to the fish community assessment using a Hydro Lab (H20 Submersible Water Quality-Data Transmitter).

In streams having some wadeable areas, the seining was conducted by two people wading and pulling a 4-m x 2-m x 5-m seine with a mesh size of 0.5 cm through the water prior to electrofishing. In streams with areas that were non-wadeable, a near-shore method was used. This consisted of two people facing each other about 2 m apart at the edge of the water. Each person held the seine by the top of one of the seine-poles with the bottom of the poles resting on the bank about 1.5 m from the edge of water. On a signal, the seine was swung overhead with the lead line on the outer edge of the arc, and then into the water as far away from the bank as possible. After the lead line sank to the stream bottom, the seine was retrieved. After each seine haul, specimens were placed into a container containing 10-percent formalin. All fishes collected by seining were taken to a lab at the USGS office in Pearl, Mississippi, where they were identified to the lowest possible taxon (usually species), weighed, measured, and examined for anomalies.

Electrofishing was conducted with an electrofishing boat and a Smith-Root Model 5.0 GPP electrofishing pulsator and generator system. Two umbrella anodes were suspended from booms in the front of the boat, each having four droppers, 4.75 mm in diameter. Each bank was sampled independently. The fish were captured using a dip net, put into aerated live wells, and then taken to the stream bank for processing (Meador, Cuffney, and Gurtz 1993).

All fish weighing more than 20 g and identified in the field were measured, weighed, and released. Individuals that could not be accurately weighed or identified were preserved in 10-percent formalin and returned to the lab for proper identification. When the number of fish in a species and in a sample exceeded 30 individuals, the lengths and weights of 30 individuals that represented all size classes were recorded. For the remaining individuals in that species and sample, the number of individuals and total biomass was recorded.

Standard quality-assurance and quality-control procedures were taken to ensure that the fish data were of high quality (Walsh and Meador 1998). Common and scientific names reported are listed as established by the American Fisheries Society's Committee on Names of Fishes (Robins et al. 1991). Although a trained biologist made most identifications, some individuals were of a size or species that made them challenging to identify. To ensure data quality, those specimens were also identified by curators of fish museums in Louisiana and Mississippi. Voucher specimens are stored in fish collections at two museums: The Museum of Natural Sciences in Jackson, Mississippi; and the Museum of Natural History (Zoology) at the University of Louisiana at Monroe in Monroe, Louisiana.

Basin Assessment

Basin assessments consisted of extracting the attributes of basin characteristics, such as, basin area mean precipitation, mean run off, population, land use (Table 3), and crop type. Using ArcView Geographical Information Systems (GIS) 3.1, each streams sampling station was located on a 15-minute series Quadrangle Topographic Map. The upstream portion of each site's watershed, or basin, was digitized as a closed polygon. These polygons were displayed as themes, and polygon over polygon, and polygon over grid analysis were used to generate the basin characteristic values.

The characteristic of each parameter was then used to describe each basin. The basin coverage values were then converted into the portion (i.e. percentage) that each particular parameter represented in each basin, thus allowing for comparisons among basins. This methodology normalized for the different number of acres within each basin. The attribute values for each basin were imported into a Microsoft Excel worksheet for further analysis.

Data Analysis

Cluster analysis (TWINSPAN), principal correspondence analysis (PCA), correspondence analysis (CA), and canonical correspondence analysis (CCA) have all been recommended for analyses of environmental data. The multivariate data analysis for this project consisted of manipulating two major data sets. Consequently, the quantitative values for chemical, physical, and land-use parameters were compiled into a single environmental parameters data set (Table 5). The environmental parameters were standardized to Z-scores, thus allowing for comparison of parameters that were originally recorded in different units. The second data set (fish community data) consisted of the percent relative abundance of fish, which was arsine transformed to standardize the data set for the CA and CCA. All data were entered and manipulated in an Excel worksheet.

TWINSPAN, a clustering technique, was used to describe the fish community data, based on the percentage relative abundance values. TWINSPAN constructs a two-way table by identification of differential species (Hill 1979). This technique is recommended because of its effectiveness and robustness as a polythetic hierarchical classification technique based on abundance data leading to less misclassification due to "noise" than typical monothetic techniques that are based on presence/absence data (Gauch 1982). There are three steps that are involved in the dichotomy of TWINSPAN. The first is reciprocal averaging, which makes a crude dichotomy, then a refined ordination derived from the reciprocal averaging by identification of differential species, and the final step shows the species indicators that were the basis of the refined ordination. Pseudospecies cut levels, representing abundance categories of a single taxon, were set at 0, 0.01, 0.02, 0.04, 0.08, 0.16, 0.32, and 0.64 (Gauch 1982).

From the fish community data set, 20 fish community metrics (Table 4) were calculated. Spearman rho correlations were then calculated for the fish community metrics, habitat parameters, chemical parameters, and land-use data so that the fish communities of the MAP Ecoregion could be discussed in more detail. The list of fish community metrics calculated in this study has not been approved for an IBI in the MAP Ecoregion; they are only intended to help describe the fish assemblages. To begin to understand how the environmental parameters and fish community metrics differed among sites, XY plots were created. Then a Shapiro-Wilk test was run, using SAS, to determine the normality of the environmental parameters. A PCA analysis was then run on the environmental data. By relaxing the normality assumptions of a PCA, this analysis can be a very beneficial analysis tool where by the PCA may show naturally occurring environmental parameters within the data set.

All the mentioned techniques then allowed us to develop an understanding of how the environmental parameters varied among the sites and identified naturally occurring parameters that could contribute to natural variations in the fish community data. The PCA and correlation analysis should show if any environmental parameters need to be partialed in the CA due to naturally occurring environmental parameters in the data set. Partialling for the naturally occurring environmental parameters can remove unwanted noise, or variations in the fish community data. Unlike the PCA and cluster analysis, which are linear procedures, the CA is based on a unimodal response of species to environmental gradients. The objective of this analysis is to determine site scores based on the species composition and relative abundance at each site.

Although the cluster analysis and PCA indicated which parameters of the environmental data set are most important in distinguishing sites, those parameters may not necessarily relate to the fish community. For example: average channel width, one of the physical parameters, may be quite important in distinguishing sites. However, fish community composition may not relate to average channel width, because fish may respond more to available habitat. Consequently, a third ordination procedure was used in the data analysis, a CCA. A CCA compares the fish community data with the environmental parameters and partials out the naturally occurring environmental parameters.

One major problem with a CCA is that the number of parameters must be one less than the number of samples. The manual forward selection procedure found in CANOCO 4 was used to aid in decreasing the number of environmental parameters. A list comparing an environmental parameter to all the parameters with p-values less than 0.05 and correlation greater than 0.5 was also used to further eliminate parameters.

The manual selection mode of CANOCO 4 determines (through mathematical calculations) which environmental parameter accounts for the majority of the variation within the data set. The parameters are then listed in order by the amount of variation they account for, from most to least. The first parameter was selected; CANOCO 4 then recalculated the variation that can be accounted for in the remaining parameters. If the parameter that accounted for the majority of the variation was not correlated with any selected parameters (from looking at our correlation table), it was retained; however, if the parameter was correlated to a selected parameter, I then looked to see if the second parameter was correlated to any selected parameters and so on, until the parameters were selected. Each time a parameter was selected, the process started over again. The representative environmental parameter from the environmental data was then combined into a single data set and used in the final analysis. The final CCA used the arsine fish community data, the set of standardized environmental parameters (determined from the forward selection), and the set of standardized naturally occurring environmental parameters, if needed.

CHAPTER 3

RESULTS

Habitat, Chemical, and Fish Community Assessments

The physical habitat of the 36 sites varied substantially. Table 6 lists the average habitat parameters calculated at each of the thirty-six sites in the MAP Ecoregion. The mean channel width ranged from 8.1 m to 115.8 m, while the mean thalweg depth ranged from 0.2 m to 6.2 m, and the mean water depth ranged from 0.1 m to 5.9 m. The discharge ranged from 0.00 m^3/s to 405 m^3/s, and the secchi depth ranged from 10 cm to 91 cm.

There was considerable variation among stream water chemistry parameters at the 36 sites during the fish sampling. Table 7 lists chemical parameters measured at each site prior to electrofishing. The water temperature ranged from 24.1 °C to 33.5 °C; the pH ranged from 5.8 to 8.1; the specific conductance ranged from 78 μS/cm to 1,087 μS/cm; and the dissolved oxygen ranged from 2.1 mg/L to 13.4 mg/L.

Table 8 shows, in phylogenetic order, fish species collected during this study. Seventy-seven species and 1 hybrid representing 16 families were collected from the 36 sites. Twenty-one (about 27 percent) of the fish species were considered rare and were collected at two or fewer of the sites. Eighteen (about 23 percent) of the species were considered very common and were collected at more than 18 sites. The majority of fish species collected (39) were common and these species were recorded at 3 to 17 of the sites. No single species was collected at all the sites; however, 2 species were collected from 35 sites, the mosquitofish (*Gambusia affinis)* and the freshwater drum (*Aplodinotus grunniens).* Only two species collected were introduced: grass carp (*Ctenopharyngodon idella)* and common carp (*Cyprinus carpio).*

Presented in table 9 is the percent relative abundance of all fish collected from the 36 sites. A total of 18,394 individual fish was collected during this study, and the most abundant and frequently collected species was the mosquitofish (*Gambusia affinis)* with 3,688 individuals from 35 sites. The table also shows that common carp (*Cyprinus carpio)* and spotted gar (*Lepisosteus oculatus)* were collected at 34 and 33 sites, respectively. Only one individual of the following 10 species was collected: an American eel *(Anguilla rostrata)* and quillback *(Carpiodes cyprinus)* were collected at the Little River Ditch no. 251 near Libourn, MO; a spotfin shiner *(Cyprinella spiloptera)* was collected at Spillway Ditch at Hwy 102 near East Prairie, MO; a silver chub *(Macrhybopsis storeriana)* was collected at Main Ditch at Hwy 153 near White Oak, MO; a ironcolor shiner *(Notropis chalybaeus)* was collected at Cockle Burr Slough Ditch near Monette, AR; a stripped bass *(Morone saxatilis)* was collected at Obion Creek near Hickman, KY; a dollar sunfish *(Lepomis marginatus)* was collected at Village Creek near Swifton, AR; a harlequin darter (*Etheostoma histrio)* was collected at St. Johns Ditch near Sikeston, MO; a logperch *(Percina caprodes)* was collected at Bayou Meto at Bayou

Meto, AR; and a freckled madtom (*Noturus nocturnus*) was collected at St. Francis River near Coldwater, AR.

Although no current fish community metrics have been adopted for the MAP Ecoregion, 20 fish community metrics that have been useful in other studies across the United States were calculated. Table 10 lists the results for ten species richness and composition metrics. The number of taxa collected ranged from 16 to 37, and the number of minnow taxa ranged from 0 to 9. The average standard length of *Lepomis species* ranged from 20.3 mm to 94.8 mm. The percent of individuals that were buffalo species, within a site, ranged from 0 to 23.2. The ratio of tolerant/intolerant taxa ranged from 1.0 to 12.0, whereas the number of tolerant taxa ranged from 7 to 15, and the number of intolerant taxa ranged from 1 to 10. The percent of individuals that were carp ranged from 0.0 to 22.2. The Shannon diversity scores ranged from 1.32 to 4.22, and the evenness scores ranged from 0.323 to 0.845.

Table 11 lists results of the three trophic composition and seven fish abundance and condition metrics. The trophic composition differed among the sites. The relative abundance of top carnivores ranged from 0.0177 to 0.2184, where as the relative abundance of omnivores ranged from 0.0000 to 0.3668, and the relative abundance of insectivores ranged from 0.0365 to 0.4269. As shown in table 11, the seven fish abundance metrics varied among sites. The abundance, or number of individuals, ranged from 131 to 1,908. The average standard length of all black bass ranged from 0.0 mm (because no black bass were recorded at two sites) to 263.6 mm, and the average standard length of all individuals ranged from 55.9 mm to 211.9. The total fish biomass ranged from 14.3 kg to 178.8 kg, where as the percent of total biomass that were buffalo species and carp ranged from 0.0 to 89.0 percent. The relative abundance of fish with anomalies ranged from 0.0042 to 0.1096. The percent contribution by dominant taxa ranged from 17.3 percent to 70.0 percent (Table 11).

Basin Assessment

As shown in table 12, the basin characteristics varied among 36 drainage basins. The area of the drainage basins ranged in size from 47.9 km^2 to 34,850.0 km^2. The elevation ranged from 12 meters above sea level to 94 meters above sea level. The segment gradient ranged from 0.001 to 1.720. The average annual runoff ranged from 41 cm to 53 cm, and the average annual precipitation ranged from 117 to 137 cm. Based on 1990 census data, the population within each basin ranged from 691 to 553,326 people, and the population per acre within the basins ranged from 0.1 to 93.

Table 13 lists the intensity, or percent, of several crops that occurred at the 36 drainage basins in the study. Overall, soybeans were the most common crop type and their intensity in the ecoregions ranged 4.0 to 44.0 percent of each basin. Cotton was the second most common crop type and its intensity ranged 0.0 to 32.6 percent of each basin. Rice intensity within the ecoregions, another crop planted, ranged from 0.0 to 26.1, while the intensity of corn ranged from 0.2 to 25.2 percent of each basin. The remaining crop types (oats, sorghum, and wheat) only accounted for 9.8 to 38.8 percent of the crop intensity for each basin.

As shown in Table 14, the study area has very little urban land use. Low intensity residential land use ranged from 0.0 to 2.8 percent, while high intensity residential land use ranged from 0.0 to 0.8 percent, and high intensity commercial land use ranged from 0.0 to 1.1 percent. The total urban land use within the drainage basins ranged from 0.0 to 4.6 percent.

With a couple of exceptions, most of the 36 drainage basins had very little forested areas (Table 15). Deciduous forest was the most common forest land-use type, and it ranged from 0.2 to 39.7 percent of the drainage basins. The percent of evergreen forest in each drainage basin intensity ranged from 0.0 to 6.8 percent, while the percent of mixed forest ranged from 0.1 to 9.5 percent. The percent of total forest land use ranged from 0.3 to 50.5 percent of each basin

Agriculture was the dominant land use in the MAP Ecoregion. The percent of agriculture land-use types varied significantly among basins (Table 16). The percent of row crops agriculture in the study area ranged from 26.6 to 89.8 percent. Pasture/hay land use ranged from 1.2 to 45.2 percent of the drainage basins, while small grains ranged from 0.0 to 14.7 percent of the drainage basins, and other grasses ranged from 1.0 percent or less of the drainage basins. The total agriculture within the drainage basins ranged from 42.8 to 97.7 percent.

As shown in Table 17, there is little of the once dominant wetlands land-use type remain in the study area. Our analysis showed that the percent woody wetlands ranged from 0.1 to 16 percent of the drainage basins, and herbaceous woody wetland ranged from 0.0 to 1.5 percent of the drainage basins. Of the total land use within the streams in the drainage basins of the study area only 0.2 to 16.2 percent of area were wetlands.

Table 18 lists miscellaneous land uses within the study area. It shows that bare rock/sand/clay land use ranged from 0.00 to 0.03 percent of the basins, where as quarries/strip mines/gravel pits ranged from 0.00 to 0.08 percent of the basins, and transitional areas ranged from 0.00 to 0.43 percent of the basins.

Multivariate Analysis

It was determined from the XY plots and PCA that six of the sites (Table 12) were large enough that the naturally occurring environmental variation allowed for significant differences in fish communities. These assumptions follow the ecological theories of the River Continuum Concept (Vannote et al 1990). Consequently, sites with drainage areas greater than 2,500 km^2 (Table 12) were dropped from the analysis. These data modifications help to decrease the noise, or variation, in the data and allow for the interpretation of how the fish communities differ among sites.

The percent relative abundance of fish from 30 sites was input into the TWINSPAN analysis. The first break divided the 30 sites into two groups of 19 and 11 sites (Figure 2). The iteration was one, and the eigenvalue was 0.272. These sites were divided based on the presence of white crappie (*Pomoxis annularis)* in the negative group and presence of longear sunfish (*Lepomis megalotis*), bowfin (*Amia calva*), and blackspotted topminnow (*Fundulus olivaceus*) in the positive group (Figure 2).

The second break divided the negative group of the first break of 19 sites into a group of 7 and 12. The iteration was three, and the eigenvalue was 0.218. These sites were divided based on the presence of bigmouth buffalo (*Ictiobus cyprinellus*) and white crappie (*Pomoxis annularis*) in the negative group. The third break divided the positive group from the first break of 11 sites into groups of 4 and 7 sites. These sites were divided based on the presence of spotted bass (*Micropterus punctulatus*) in the positive group. The divisions seem to follow a pattern of northern versus southern sites (Figure 2), suggesting that the fish communities differ in the northern and southern portions of the study area.

Since the TWINSPAN analysis showed that the fish communities differ in the northern versus the southern portions of the study area, it was realized that the CA would have to partial for some naturally occurring environmental variation in the data set. It was then determined from the XY plots, Spearman rho correlations, and PCA that four of the physical environmental parameters (elevation, latitude, average precipitation, and drainage area) would need to be partialed in the CA. Partialing for these variables help to decrease the remaining noise, or variation, in the data and allow for the interpretation of how fish communities respond to land use in the MAP Ecoregion.

Presented in table 19 is the significant Spearman rho correlations between elevation and a list of physical environmental parameters (Table 5). Only elevation was selected to be presented in this table because elevation was correlated to all of the partialed environmental parameters, and elevation was correlated to 50 percent of the physical environmental parameters. Elevation was positively correlated to latitude (r_s= 0.9684), and secchi depth (r_s= 0.3874), while elevation was found to be negatively correlated to longitude, (r_s= -0.6586), average channel width (r_s= -0.4302), average channel width (r_s= -0.5707), average water depth (r_s= -0.5543), average precipitation (r_s= -0.8797), and drainage area (r_s= -0.3747).

Because elevation played an important role in the environmental parameters, presented in table 20 are the significant Spearman rho correlations between elevation and list of fish community metrics (Table 4). Elevation was positively correlated to total number of taxa (r_s= 0.5312), number of minnow taxa (r_s= 0.4440), average standard length of *Lepomis* species (r_s= 0.4297), number of intolerant taxa (r_s= 0.6132), Shannon diversity (r_s= 0.3959), relative abundance of insectivores (r_s= 0.4806), and average standard length of black bass (r_s= 0.5234), where as elevation was found to be negatively correlated to ratio of tolerant/intolerant taxa (r_s= -0.6281) and percent contribution by dominant taxa (r_s= -0.3569).

A CA was then used to determine if variations in the data due to the physical and chemical parameters were removed. In this analysis the, arsine transformed fish community data from 30 sites were analyzed. This analysis was completed while partialing for four naturally occurring environmental parameters. The first axis had an eigenvalue of 0.356, and the eigenvalue was 0.299 for the second axis; these two axes explained 24.6 of the variance at the sites according to the fish species (Table 21). Of the total variance at the sites, 43.0 percent was explained by the differences in the fish communities at each site (Table 21). With the exception of Cockle Burr Slough Ditch near Monette, MO, and Bayou Macon near Halley, AR, all of the 30 sites were constrained to the first axis (Figure 3) suggesting that the sites constrained to the first axis were similar. The first axis explained 13.3 percent of the 43.0 percent total variance (Table 21) that differentiates the sites based only on fish communities.

In the TWINSPAN (Figure 2) there was a northern versus southern split in the sites. I hypothesized that this was due, in part, to naturally occurring variation in the data. Consequently, this finding influenced my decision to partial the four naturally occurring parameters (Table 19) in the CA, so that "noise" in our community data could be reduced. This will aid in the ability to draw inferences from the relations between the community and land-use data. As shown in Figure 3, partialing for the four naturally occurring parameters constrained the sites to the first CA axis.

Because Cockle Burr Slough Ditch near Monette, AR, differed from the remainder of the sites, a second CA was run using arsine transformed fish community data from 29 sites, and partialed for the four naturally occurring parameters. The second CA helped to constrain the data to the axis and should aid in interpretation. The first axis had an eigenvalue of 0.353, and the second axis had an eigenvalue of 0.268 on the second axis (Table 22). Of the total variance at the sites, 44.8 percent was explained by the differences in the fish communities at each site. These sites are listed from the most to least correlated along the first axis. The first axis explained 14.5 percent of the 44.8 percent total variance (Table 22) that differentiates the sites based only on fish communities. As expected, removing Cockle Burr Slough Ditch near Monette, AR, increased the explained variance on the first axis from 13.3 to 14.5, and the total variance increased from 43.0 percent to 44.8 percent (Tables 22 and 23); all the sites were further constrained to the second axis.

Relation of Environmental Parameters to Fish Communities

The original list of forty-one environmental parameters (Table 5) was too large to be interpreted by CCA. Surrogate parameters were chosen using the manual forward selection process in CANOCO 4 to regress against the CA site scores for the first axis. A total of eighteen environmental parameters were correlated with the site scores (Table 23). The CCA arranges sites along the CCA axis according to the fish communities and their related environmental parameters. As a site gets closer to a particular axis, the analysis suggests which parameters may be the driving force in that site's fish communities. The selected environmental parameters act together to show a relation between the fish communities and the environmental parameters.

A first CCA was run using arsine transformed fish community data, 18 standardized environmental parameters, and four partialed naturally occurring parameters at 30 sites. The first axis had an eigenvalue of 0.329, and the species-environment correlation was 0.918 (Table 24). The second axis had an eigenvalue of 0.302, and species-environment correlation was 0.967 (Table 24). The first two axes explained 28.1 percent of the variance at the sites according to the species-environmental relations. Of the total variance at the sites, the species-environmental relation could explain 49.9 percent of the variation.

Table 25 shows the correlations on the first four axes and indicates that the first axis was dominated by the environmental parameters of percent corn (r^2= 0.4769) and average channel width (r^2= 0.4607), which accounts for 14.7 percent of the species-environmental relation (Table 24). The combination of these parameters from Table 25 and Figure 5 suggest that the sites are significantly similar along the first axis. Table 25 also shows that the second axis was dominated by the environmental parameters of percent rice (r^2= -0.6720) and percent small grains (r^2= 0.4902). These two axes accounted for 28.1 percent of the species-environmental relation (Table 24). The parameters from the second axis and eigenvalue from Table 24 (0.302) suggest that all of the sites are significantly similar along this axis.

As with the CA, there was justification to run a second CCA using the same data set that was used in the first CCA; however, one site was dropped. Table 26 shows that the first axis had an eigenvalue of 0.329, and the species-environment correlation was 0.973. The second axis had an eigenvalue of 0.256, and species-environment correlation was 0.981 (Table 26). The first two axes explained 27.7 percent of the species-environmental relation of the total variance at the sites; the species-environmental relation could explain 49.4 percent (Table 26).

Table 27 lists correlations on the first four axes and shows that the first axis was dominated by the environmental parameters of percent rice (r^2= -0.7138) and percent small grains (r^2= 0.4922), which accounts for 15.6 percent of the total variance (Table 26). The combination of these parameters from Table 27 and the eigenvalue from Table 26 (0.329) suggests that the sites are significantly similar along the first axis (Figure 6). The correlation from Table 27 shows that the second axis was dominated by the environmental parameters of discharge (r^2= 0.7184) and percent total agriculture (r^2 = 0.4592). The combination of the environmental parameters on the first and second axes account for 27.7 percent of the species-environmental relation with an eigenvalue of 0.256 (Table 26) and the combination of the parameters from Table 27 suggests that the sites are significantly similar along the two axes.

Table 28 lists the significant relations between 20 fish community metrics and the 18 environmental parameters that were used in the CCA. In Table 28 you can see that the secchi depth was correlated to the average standard length of *Lepomis* (r_s = 0.4631) and percent of biomass that was buffalo species and carp (r_s = -0.4903). The percent of quarries, strip mines, and gravel mines within the basins was correlated with the average standard length of all individuals (r_s = 0.4623), the average standard length of black bass (r_s = 0.4989), and the relative abundance of omnivores (r_s = 0.5437). The percent of deciduous forest within the basins was correlated with Shannon diversity (r_s = 0.4694).

The percent of small grains within a basin was correlated with the average standard length of black bass ($r_s = -0.4515$). The percent of corn within the basins was correlated with the number of intolerant taxa ($r_s = 0.5382$), the number of minnow taxa ($r_s = 0.4749$), and the relative abundance of insectivores ($r_s = 0.6114$). The population per acre within the basins was correlated with the total fish biomass ($r_s = 0.5727$).

CHAPTER 4

DISCUSSION

Fish communities have been documented within the MAP Ecoregion since the late 1800s (Hay 1882) using a variety of sampling methods that meet the objectives of each specific study. Historically, 160 species representing 24 families have been documented following numerous study sampling methods (Douglas 1974; Pflierger 1975; Burr and Warren 1986; Robison and Buchannan 1998; Ross and Brennerman 1991; Etnier and Starnes 1993). This study documented a total of 77 fish species and 1 hybrid sunfish representing 16 families from 36 sites. All of the species collected during this study had been historically collected in the MAP Ecoregion.

Although the number of fish species and families collected during this study may appear to be substantially lower than historical collections, it is important to note that this is one of the first studies to look at the northern portion of the MAP Ecoregion, while following a standardized sampling protocol that used only two sampling methods. This study did not sample major rivers or intermittent streams, which could potentially have several unique fish species. The list of fish species historically collected in the MAP Ecoregion includes samples that were collected using every known sampling method, and these collections occurred over the past hundred years. It is also important to note that this study did not find any exotic fish species that were not previously recorded, nor did the study find any extirpated fish species.

The exploratory statistics showed several patterns in the environmental parameters and fish community data. One of the environmental parameters stood out from the others: elevation. Elevation, one of the environmental parameters that was partialed in the multivariate analysis, was correlated to 35 (about 57 percent) of the fish community metrics and environmental parameters. The average water depth, average channel width, and average precipitation were found to decrease as the elevation increased. The number of minnow taxa, number of intolerant taxa, Shannon Diversity, and relative abundance of insectivores were found to increase as the elevation increased and the ratio of tolerant/intolerant taxa and percent contribution by dominant taxa decreased as the elevation increased. These findings suggest that the streams in the northern portion of the study area are not as wide or deep, meaning streams in the northern portion of the study area are typically smaller than the streams in the southern portion. Also the fish communities in the northern portion of the study area typically have more intolerant minnow species (many of which are known to be insectivores) than the southern portion, and streams in the southern portion of the study area generally are dominated by a few tolerant species.

Several studies have concluded that, historically, streams in the MAP Ecoregion have typically been altered from bottomland hardwoods and wetlands to channelized streams and row-crop agricultural fields (Baker, Killgore, and Kasul 1991; Fajen and

Layzer 1993). This study also documented that, on average, about 82 percent of each basin was used for agricultural activities. During the early to mid 1900s, about 50 percent of the MAP Ecoregion consisted of bottomland hardwoods and wetlands (Baker, Killgore, and Kasul 1991); this study revealed that, on average, about 6 percent of each drainage basin was comprised of wetlands. The conversion of these bottomland hardwood and wetlands to row-crop agriculture fields and channelized streams over the past century probably has been the most dramatic change to the MAP Ecoregion.

Studies have concluded that there is a relation between fish diversity and intensity of agriculture in a drainage basin (Schlosser 1990; Sullivan and Peterson 1997; Wang et al 1997). Relations between fish community diversity and the intensity of agriculture land-use activities are very complex; however, the threshold level where fish community shifts can be documented has been generally considered to be around 50 percent of agriculture (Wang et al 1997). Wang et al (1997) noted that when the intensity of agriculture reached about 80 percent, the fish communities actually become stable.

In this study the CCA showed, along the first axis, that the CA site scores in the MAP Ecoregion were correlated to the percent corn (r^2 = -0.4769) and average channel width (r^2 = 0.4607) within the drainage basins (Table 25). This finding suggests that the percent of percent corn within a drainage basin has inverse relations to fish communities in the MAP Ecoregion. This analysis also showed that the CA site scores correlated to the percent of rice (r^2 = -0.6720) and percent small grains (r^2 = 0.4902) along the second axis (Table 25). The CCA shows that three of the agricultural land-use categories are having strong influences on fish communities in the MAP Ecoregion.

Spearman rho analysis of the 20 environmental parameters showed us that 6 of the environmental parameters were correlated to 14 of the fish community metrics (Table 28). These findings have helped in developing our understanding of the fish communities of the MAP Ecoregion. The secchi depth, a measurement made prior to fish community assessments, was correlated to the average standard length of *Lepomis species* ($r_s = 0.4631$) and percent of biomass that was buffalo species and carp ($r_s = -0.4903$). Managers often look at the length of fish when they determine the health of a fish population because, generally, stunted fish populations can indicate unhealthy population. The correlation between secchi depth and the average standard length of *Lepomis species* would suggest that larger *Lepomis species* would be more typical of clearer, less turbid waters. The secchi depth was negatively correlated to the percent of the biomass that was buffalo species and carp. Buffalo species and carp are all large fish, which are typical of highly turbid streams. Studies have shown that as turbidity increases within a stream, many of the small minnows and shiners, fish with low biomass, are replaced by large tolerant undesirable species, such as buffalo species (*Ictiobus species)* and common carp (*Cyprinus carpio*) (Tate and Martin 1995).

Four of the land-use parameters were correlated to the fish community metrics. The percent of quarries, strip mines, and gravel mines within the basins was correlated with the relative abundance of omnivores ($r_s = 0.5437$), average standard length of black bass ($r_s = 0.4989$), the average standard length of all individuals ($r^2 = 0.4623$), Shannon Diversity ($r_s = 0.3790$), and total fish biomass ($r_s = 0.3983$). In the MAP Ecoregion, this finding may be a false artifact due, in part, to the analysis used, because there are few quarries and mines present in the MAP Ecoregion. The Spearman rho procedure calculates correlations by ranking the parameter values, and then calculates correlation based on the rankings.

The percent of deciduous forest within a basin was one of the most interesting correlations. The percent deciduous forest was a surrogate parameter for six other land-use parameters -- mixed forest, total forest, evergreen forest, transitional, herbaceous wetlands, and cotton -- that were used in the CCA. The correlation for the percent of deciduous forest and Shannon diversity was $r_s = 0.4694$. Since diversity is a measure of both the function and number of species present (richness) and the equitability of the distribution of individuals within these species (eveness), the association between deciduous forest and diversity can be explained as follows: As the percentage of forested areas within a drainage basin increases, typically more trees and tree branches fall into streams, which in turn increases the quality of fish habitat, resulting in more diverse fish communities.

Of the six surrogate parameters for deciduous forest (Table 25), all but two can be explained by increasing available habitat. The percent of transitional area was another outlier in the data, due in part, to the limitations in our analysis. Values recorded for transitional areas were quite low and did not represent any gradient. The other parameter was percent of cotton, which was negatively correlated (Table 25) to percent of deciduous forest. This parameter would have the opposite effect on fish diversity. As more cotton is planted in a drainage basin, the available fish habitat would decrease, resulting in a decrease in the Shannon diversity.

The percent of small grains within a drainage basin was found to correlate with the average standard length of black bass ($r_s = -0.4515$). Black bass species require some degree of low turbidity in their environments. Researchers have shown that in areas that are used intensively for the production of small grains, there typically is an increase in sedimentation and loss of in-stream habitat (Berkman and Rabeni 1987; Fajen and Layzer 1993). Both of these factors can cause a decrease in food available to bass, thereby reducing fish growth rates.

The percent of corn within the basins was correlated with the average standard length of black bass ($r_s = 0.3651$), the number of intolerant taxa ($r_s = 0.0.5382$), the number of minnow taxa ($r_s = 0.4749$), the number of intolerant taxa ($r_s = 0.5382$), and the relative abundance of insectivores ($r_s = 0.6114$). As with the case of percent of small grains, as the intensity of crop production increases there tends to be less habitat available for fish communities and a decrease in allochthonous production. The loss of available habitat and trophic change will result in the minnow taxa increasing from one that is comprised of tolerant herbivore species to one comprised largely of intolerant insectivores. The increase of intolerant insectivore taxa is due, in part, to shift in invertebrate communities. When aquatic systems are driven more by allochthonous production invertebrate communities tend to become dominated by *Chironomid species.*

From this study and others, scientists have learned that human alterations of the physical, chemical, or biological properties of alluvial ecosystems will result in a change of the distribution and structure of a fish community. Consequently, fish can reflect the general ecological condition of the streams where they reside. Understandings developed from multivariate analysis can help managers and policy makers to better anticipate, prioritize, and manage water quality in different hydrologic and land-use settings.

In this study it was learned that designs for gradient analysis studies need to establish strong controls for the natural occurring variability among sites, when possible. For example, when selecting sites it is important that the size of the stream basins be similar. This is very important because, as you would expect, streams with drainage basins that differ significantly in size should have different fish communities; therefore, if a researcher wanted to develop an understanding of how fish communities relate to a specific parameter they would need to minimize naturally occurring variation among sites. This study also demonstrated the need to develop strong controls for natural conditions. In some study areas such as the MAP Ecoregion, the majority of the streams may have been altered to a point where it is difficult to elucidate strong relations between land use and fish communities; however, some patterns were documented. In this study it was found that both land use and fish communities may be a result of natural variation such as elevation.

Table 1. Historical species list of fish collected in Mississippi Alluvial Plain Ecoregion [AR,indicates Arkansas; KY, indicates Kentucky; LA, indicates Lousiana; MS, indicates Mississippi; TN, indicates Tennessee; and MAP, indicates Mississippi Alluvial Plain] (Douglas 1974; Pflierger 1975; Burr and Warren 1986; Robison and Buchanan 1988; Ross and Brennerman 1991; Etnier and Starnes 1993).

Scientific Name	Common Name	AR	KY	LA	MS	MO	TN	MAP
Petromyzontidae - lampreys								
Ichthyomyzon castaneus Girard, 1858	chestnut lamprey	X		X	X	X	X	X
Icthyomyzon gagei Hubbs & Trautman, 1937	southern brook lamprey	X		X				X
Lampetra aepyptera (Abbott, 1860)	least brook lamprey	X					X	X
Acipenseridae - sturgeons								
Acipenser fulvescens Rafinesque, 1817	lake sturgeon						X	X
Scaphirhynchus albus (Forbes & Richardson, 1905)	pallid sturgeon			X				X
Scaphirhynchus platorynchus (Rafinesque, 1820)	shovelnose sturgeon	X		X		X	X	X
Polyodontidae - paddlefishes								
Polyodon spathula (Walbaum, 1792)	paddlefish	X	X	X	X	X	X	X
Lepisosteisae - gars								
Lepisosteus oculatus (Winchell, 1864)	spotted gar	X	X	X	X	X	X	X
Lepisosteus osseus (Linnaeus, 1758)	longnose gar	X	X	X	X	X	X	X
Lepisosteus platostomus Rafinesque, 1820	shortnose gar	X	X	X	X	X	X	X
Lepisosteus spatula Lacepede, 1803	alligator gar	X	X	X	X	X	X	X
Amiidae - bowfins								
Amia calva Linnaeus, 1766	bowfin	X	X	X	X	X	X	X
Hiodontidae - monneyes								
Hiodon alosoides (Rafinesque, 1819)	goldeye	X	X	X	X	X	X	X
Hiodon tergisus Lesueur, 1818	mooneye	X			X	X	X	X
Anguillidae - freshwater eels								
Anguilla rostrata (Lesueur, 1817)	american eel	X	X	X	X	X	X	X
Clupeidae - herrings								
Alosa chrysochloris (Rafinesque, 1820)	skipjack herring	X		X	X	X	X	X
Dorosoma cepedianum (Lesueur, 1818)	gizzard shad	X	X	X	X	X	X	X
Dorosoma petenense (Gunther, 1867)	threadfin shad	X		X	X	X	X	X
Cyprinidae - carps and minnows								
Campostoma anomalum (Rafinesque, 1820)	central stoneroller	X	X	X	X		X	X
Campostoma oligolepis Hubbs & Greene, 1935	largescale stoneroller					X		X
Carassius auratus (Linnaeus, 1758)	goldfish	X	X	X				X
Ctenopharyngodon idella (Valenciennes, 1844)	grass carp	X	X			X	X	X
Cyprinella camura (Jordan & Meek, 1884)	bluntface shiner		X	X				X
Cyprinella lutrensis (Baird & Girard, 1853)	red shiner	X	X	X	X	X	X	X
Cyprinella spiloptera (Cope, 1868)	spotfin shiner					X		X
Cyprinella venusta Girard, 1856	blacktail shiner	X	X	X	X	X	X	X
Cyprinella whipplei Girard, 1856	steelcolor shiner		X	X				X
Cyprinus carpio Linnaeus, 1758	common carp	X	X	X	X	X	X	X
Hybognathus hayi Jordan, 1885	cypress minnow	X	X	X	X		X	X
Hybognathus nuchalis Agassiz, 1855	Mississippi silvery minnow	X	X	X	X	X	X	X
Hybognathus placitus Girard, 1856	plains minnow						X	X
Hypophthalmichthys nobilis (Richardson, 1845)	bighead carp	X					X	X
Lythrurus fumeus (Evermann, 1892)	ribbon shiner	X	X	X	X	X	X	X
Lythrurus umbratilis (Girard, 1856)	redfin shiner	X	X	X	X	X	X	X
Macrhybopsis aestivalis (Girard, 1856)	speckled chub	X		X	X	X	X	X

Table 1. Continued.

Scientific Name	**Common Name**	**AR**	**KY**	**LA**	**MS**	**MO**	**TN**	**MAP**
Macrhybopsis gelida (Girard, 1856)	sturgeon chub						X	X
Macrhybopsis storeriana (Kirtland, 1847)	silver chub	X	X	X	X	X	X	X
Notemigonus crysoleucas (Mitchill, 1814)	golden shiner	X	X	X	X		X	X
Notropis ammophilus Suttkus & Boschung, 1990	orangefin shiner	X				X		X
Notropis amnis Hubbs & Greene, 1951	pallid shiner	X		X	X	X	X	X
Notropis atherinoides Rafinesque, 1818	emerald shiner	X	X	X	X	X	X	X
Notropis blennius (Girard, 1856)	river shiner	X	X	X	X	X	X	X
Notropis boops Gilbert, 1884	bigeye shiner			X				X
Notropis buchanani Meek, 1896	ghost shiner	X		X	X			X
Notropis chalybaeus (Cope, 1869)	ironcolor shiner	X		X		X		X
Notropis cummingsae (Myers, 1925)	dusky shiner					X		X
Notropis dorsalis (Agassiz, 1854)	bigmouth shiner						X	X
Notropis maculatus (Hay, 1881)	taillight shiner	X	X	X	X		X	X
Notropis sabinae Jordan & Gilbert, 1886	Sabine shiner	X						X
Notropis shumardi (Girard, 1856)	silverband shiner		X	X	X	X	X	X
Notropis stramineus (Cope, 1865)	sand shiner		X				X	X
Notropis texanus (Girard, 1856)	weed shiner	X		X	X	X	X	X
Notropis volucellus (Cope, 1865)	mimic shiner	X	X	X	X	X	X	X
Notropis wickliffi (Mitchill, 1818)	channel shiner						X	X
Opsopoeodus emiliae Hay, 1881	pugnose minnow	X	X	X	X	X	X	X
Phenacobius mirabilis (Girard, 1856)	suckermouth minnow	X	X	X		X	X	X
Phoxinus erythrogaster (Rafinesque, 1820)	southern redbelly dace	X			X		X	X
Pimephales notatus (Rafinesque, 1820)	bluntnose minnow	X			X	X	X	X
Pimephales promelas Rafinesque, 1820	fathead minnow	X	X	X	X		X	X
Pimephales vigilax (Baird & Girard, 1853)	bullhead minnow	X	X	X	X	X	X	X
Platygobio gracilis (Richardson, 1836)	flathead chub			X		X	X	X
Rhinichthys atratulus (Hermann, 1804)	blacknose dace						X	X
Semotilus atromaculatus Jordan, 1877	creek chub	X	X	X	X	X	X	X
Catostomidae - suckers								
Carpiodes carpio (Rafinesque, 1820)	river carpsucker	X	X	X	X	X	X	X
Carpiodes cyprinus (Lesueur, 1817)	quillback	X					X	X
Carpiodes velifer (Rafinesque, 1820)	highfin carpsucker	X			X			X
Catostomus commersoni (Lacepede, 1803)	white sucker		X				X	X
Cycleptus elongatus (Lesueur, 1817)	blue sucker	X			X	X	X	X
Erimyzon oblongus (Mitchill, 1814)	creek chubsucker	X	X	X	X		X	X
Erimyzon sucetta (Lacepede, 1803)	lake chubsucker	X	X	X	X	X	X	X
Hypentelium nigricans (Lesueur, 1817)	northern hog sucker						X	X
Ictiobus bubalus (Rafinesque, 1818)	smallmouth buffalo	X	X	X	X	X	X	X
Ictiobus cyprinellus (Valenciennes, 1844)	bigmouth buffalo	X	X	X	X	X	X	X
Ictiobus niger (Rafinesque, 1819)	black buffalo	X	X	X	X	X	X	X
Lagochila lacera Jordan & Brayton, 1877	harelip sucker						X	X
Minytrema melanops (Rafinesque, 1820)	spotted sucker	X	X	X		X	X	X
Moxostoma anisurum (Rafinesque 1820)	silver redhorse	X						X
Moxostoma carinatum (Cope, 1870)	river redhorse					X	X	X
Moxostoma erythrurum (Rafinesque, 1818)	golden redhorse	X	X				X	X
Moxostoma macrolepidotum (Lesueur, 1817)	shorthead redhorse	X				X		X
Moxostoma poecilurum (Jordan, 1877)	blacktail redhorse			X			X	X
Ictaluridae - bullhead catfishes								
Ameiurus catus (Linnaeus, 1758)	white catfish	X						X
Ameiurus melas (Rafinesque, 1820)	black bullhead	X	X	X	X	X	X	X
Ameiurus natalis (Lesueur, 1819)	yellow bullhead	X	X	X	X	X	X	X
Ameiurus nebulosus (Lesueur, 1819)	brown bullhead	X	X	X	X		X	X
Ictalurus furcatus (Lesueur, 1840)	blue catfish	X	X	X	X	X	X	X

Table 1. Continued.

Scientific Name	Common Name	AR	KY	LA	MS	MO	TN	MAP
Ictalurus punctatus (Rafinesque, 1818)	channel catfish	X	X	X	X	X	X	X
Noturus eleutherus Jordan, 1877	mountain madtom	X					X	X
Noturus exilis Nelson, 1876	slender madtom	X						X
Noturus flavus Rafinesque, 1818	stonecat	X					X	X
Noturus gyrinus (Mitchill, 1817)	tadpole madtom	X	X	X	X	X	X	X
Noturus hildebrandi (Bailey & Taylor, 1950)	least madtom		X				X	X
Noturus miurus Jordan, 1877	brindled madtom	X	X	X		X	X	X
Noturus nocturnus Jordan & Gilbert, 1886	freckled madtom	X	X	X		X		X
Noturus phaeus Taylor, 1969	brown madtom			X			X	X
Noturus stigmosus Taylor, 1969	northern madtom						X	X
Pylodictis olivaris (Rafinesque, 1818)	flathead catfish	X	X	X	X	X	X	X
Esocidae - pikes								
Esox americanus vermiculatus Lesueur, 1846	grass pickerel			X	X	X	X	X
Esox niger Lesueur, 1818	chain pickerel	X	X	X	X		X	X
Umbridae - mudminnows								
Umbra limi (Kirtland, 1840)	central mudminnow	X						X
Osmeridae - smelts								
Osmerus mordax (Mitchill, 1814)	rainbow smelt	X					X	X
Salmonidae - trouts								
Oncorhynchus mykiss (Walbaum, 1792)	rainbow trout	X						X
Aphredoderidae - pirate perches								
Aphredoderus sayanus (Gilliams, 1824)	pirate perch	X	X	X	X	X	X	X
Cyprinodontidae - killifishes								
Fundulus chrysotus (Gunther, 1866)	golden topminnow	X		X	X		X	X
Fundulus dispar (Agassiz, 1854)	starhead topminnow	X					X	X
Fundulus notatus (Rafinesque, 1820)	blackstriped topminnow	X	X	X	X	X	X	X
Fundulus notti (Agassiz, 1854)	bayou topminnow			X		X		X
Fundulus olivaceus (Storer, 1845)	blackspotted topminnow	X	X	X	X	X	X	X
Poeciliidae - liverbearers								
Gambusia affinis (Baird & Girard, 1853)	western mosquitofish	X	X	X	X	X	X	X
Atherinidae - silversides								
Labidesthes sicculus (Cope, 1865)	brook silverside	X	X	X	X	X	X	X
Menidia beryllina (Cope, 1866)	inland silverside	X			X	X	X	X
Percichthyidae - temperate basses								
Morone chrysops (Rafinesque, 1820)	white bass	X	X	X	X	X	X	X
Morone mississippiensis Jordan & Eigenmann, 1887	yellow bass	X	X	X	X	X	X	X
Morone saxatilis (Walbaum, 1792)	striped bass	X		X			X	X
Centrarchidae - sunfishes								
Ambloplites ariommus Viosca, 1936	shadow bass	X						X
Ambloplites rupestris (Rafinesque, 1817)	rock bass					X		X
Centrarchus macropterus (Lacepede, 1801)	flier	X	X	X	X	X	X	X
Elassoma zonatum Jordan, 1877	banded pygmy sunfish	X	X	X	X	X	X	X
Lepomis cyanellus Rafinesque, 1819	green sunfish	X	X	X	X	X	X	X
Lepomis gulosus (Covier, 1829)	warmouth	X	X	X	X	X	X	X
Lepomis humilis (Girard, 1858)	orangespotted sunfish	X	X	X	X	X	X	X

Table 1. Continued.

Scientific Name	Common Name	AR	KY	LA	MS	MO	TN	MAP
Lepomis microlophus (Gunther, 1859)	redear sunfish	X	X	X	X		X	X
Lepomis punctatus (Valenciennes, 1831)	spotted sunfish	X	X	X	X	X	X	X
Lepomis symmetricus Forbes, 1883	bantam sunfish	X	X	X			X	X
Micropterus punctulatus (Rafinesque, 1819)	spotted bass	X	X	X	X	X	X	X
Micropterus salmoides (Lacepede, 1802)	largemouth bass	X	X	X	X	X		X
Pomoxis annularis Rafinesque, 1818	white crappie	X	X	X	X	X	X	X
Pomoxis nigromaculatus (Lesueur, 1829)	black crappie	X	X	X	X	X		X
Percidae - perches								
Ammocrypta asprella (Jordan, 1878)	crystal darter	X		X		X		X
Ammocrypta beani Jordan, 1877	naked sand darter							
Ammocrypta clara Jordan & Meek, 1885	western sand darter	X				X	X	X
Ammocrypta vivax Hay, 1882	scaly sand darter	X		X	X	X	X	X
Etheostoma asprigene (Forbes, 1878)	mud darter	X	X	X	X	X	X	X
Etheostoma blennioides Rafinesque, 1819	greenside darter	X						X
Etheostoma caeruleum Storer, 1845	rainbow darter	X			X			X
Etheostoma chlorosomum (Hay, 1881)	bluntnose darter	X	X	X	X	X	X	X
Etheostoma collettei Birdsong & Knapp, 1969	creole darter			X				X
Etheostoma crossopterum Braasch & Mayden, 1985	fringed darter						X	X
Etheostoma fusiforme (Girard, 1854)	swamp darter	X		X	X		X	X
Etheostoma gracile (Girard, 1859)	slough darter	X	X	X	X	X	X	X
Etheostoma histrio Jordan & Gilbert, 1887	harlequin darter	X	X	X		X	X	X
Etheostoma lynceum Hay, 1885	brighteye darter		X				X	X
Etheostoma nigrum Rafinesque, 1820	johnny darter	X	X				X	X
Etheostoma parvipinne Gilbert & Swain, 1887	goldstripe darter	X					X	X
Etheostoma proeliare (Hay, 1881)	cypress darter	X	X	X		X	X	X
Etheostoma spectabile (Agassiz, 1854)	orangethroat darter		X				X	X
Etheostoma stigmaeum (Jordan, 1877)	speckled darter	X		X		X	X	X
Etheostoma whipplei (Girard, 1859)	redfin darter			X	X			X
Percina caprodes (Rafinesque, 1818)	logperch	X	X	X	X	X	X	X
Percina maculata (Girard, 1859)	blackside darter	X				X	X	X
Percina phoxocephala (Nelson, 1876)	slenderhead darter		X					X
Percina sciera (Swain, 1883)	dusky darter	X	X	X		X	X	X
Percina shumardi (Girard, 1859)	river darter	X	X	X	X	X	X	X
Percina uranidea (Jordan & Gilbert, 1887)	stargazing darter					X		X
Percina vigil (Hay, 1882)	saddleback darter	X	X				X	X
Stizostedion canadense (Smith, 1834)	sauger	X	X	X	X	X	X	X
Stizostedion vitreum (Mitchill, 1818)	walleye	X			X		X	X
Sciaenidae - drums								
Aplodinotus grunniens Rafinesque, 1819	freshwater drum	X	X	X	X	X	X	X
	Number Family	23	18	20	19	20	21	23
	Number Taxa	126	91	106	90	97	127	160

Table 2. Location of the thirty-six fish community sampling sites, May to August 1998.

USGS ID	Site name	County/Parish	Latitude	Longitude
07043300	St. Johns Ditch near Sikeston, MO	Scottt	365608	893302
07043500	Little River Ditch no. 1 near Morehouse, MO	Stoddard	365003	894348
07024160	Spillway Ditch at Hwy 102 near East Prairie, MO	Mississippi	364454	892119
07042500	Little River Ditch no. 251 near Lilbourn, MO	New Madrid	363320	894012
07023800	Obion Creek near Hickman, KY	Hickman	364454	892119
07041120	Main Ditch at Hwy. 153 near White Oak, MO	Pemiscot	361927	900020
07027050	Running Reelfoot Bayou at Hwy 103, TN	Dyer	360944	893036
07046515	Elk Chute near Gobler, MO	Pemiscot	361018	895734
07040496	Cockle Burr Slough Ditch near Monette, AR	Craighead	355139	901949
07040450	St. Francis River at Lake City, AR	Craighead	354916	902556
07077380	Cache River at Egypt, AR	Craighead	355128	905600
07074660	Village Creek near Swifton, AR	Jackson	354910	910505
07047700	Tyronza River near Twist, AR	Crittenden	352229	902805
07047520	St. Francis River near Coldwater, AR	Cross	352152	903436
07077700	Bayou DeView at Morton, AR	Woodruff	351507	910637
07047947	Second Creek near Palestine, AR	St. Francis	350221	905440
07047950	L'Anguille River near Palestine, AR	St. Francis	345820	905310
07077555	Cache River near Cotton Plant, AR	Woodruff	350207	911919
07077950	Big Creek at Poplar Grove, AR	Phillips	343320	905044
07078040	LaGrue Bayou near Dewitt, AR	Arkansas	341900	911657
07279950	Coldwater River at Marks, MS	Quitman	341522	901557
07265099	Bayou Meto near Bayou Meto, AR	Arkansas	341205	913145
07280900	Cassidy Bayou at Webb, MS	Tallahatchie	335659	902028
07288570	Quiver River near Doddsville, MS	Leflore	333825	902405
07288500	Big Sunflower River at Sunflower, MS	Sunflower	333250	903235
07288650	Bogue Phalia near Leland, MS	Washington	332347	905047
073676595	Bayou Macon near Halley, AR	Desha	333216	911736
07288770	Deer Creek near Hollandale, MS	Washington	330859	905047
07367700	Boeuf River near Arkansas/LA State Line, LA	West Carrol	325825	912625
07288700	Big Sunflower River near Anguilla, MS	Sharky	325818	904640
07288870	Steele Bayou East Prong near Rolling Fork, MS	Issaquena	325441	905710
0728872008	Silver Creek near Bayland, MS	Yazoo	325208	904145
07288955	Yazoo River below Steele Bayou near Long Lake, MS	Issaquena	322640	905400
07369500	Tensas River at Tendal, LA	Madison	322555	912200
07370000	Bayou Macon near Delhi, LA	Richland	322725	912830
07368580	Big Creek near Sligo, LA	Richland	321220	914911

Table 3. Description of land-use parameters that were calculated for thirty-six drainage basins within Mississippi Alluvial Plain Ecoregion, 1998.

1.) Open Water - all areas of open water, generally with less the 25% cover of vegetation/land cover.

2.) Low Intensity Residential - land includes areas with a mixture of constructed materials and vegetation or other cover. Constructed materials account for 30-80 percent of the total area. These areas most commonly include single-family housing areas, especially suburban neighborhoods. Generally, population density values in this class will be lower than in high intensity residential areas.

3.) High Intensity Residential - includes heavy build-up urban centers where people reside. Examples include apartment complexes and row houses. Vegetation occupies less than 20 percent of the landscape. Construction materials account for 80-100 percent of the total area. Typically, population densities will be quite high in these areas.

4.) High Intensity Commercial - includes highways and roads and all highly developed lands not classified as High Intensity Residential.

5.) Total Urban - sum of Low Intensity Residential, High Intensity Residential, and High Intensity Commercial.

6.) Bare Rock/Sand/Clay - includes areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, and other accumulation of rock without vegetative cover.

7.) Quarries/Strip Mines/Gravel Pits - areas of extractive mining activities with significant surface expression.

8.) Transitional - areas dynamically changing from one land cover to another, often because of land use activities. Examples include forest lands cleared areas as well as areas in the earliest stages of forest regrowth.

9.) Deciduous Forest - areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to an unfavorable season.

10.) Evergreen Forest - areas dominated by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.

11.) Mixed Forest - areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Table 3. Continued.

12.) Total Forest - sum of Deciduous Forest, Evergreen Forest, and Mixed Forest.

13.) Pasture/Hay - grasses, legume, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

14.) Row Crops - all areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

15.) Small Grains - all areas used for the production of graminoid crops such as wheat and rice.

16.) Other Grasses - vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

17.) Total Agriculture - sum of Pasture/Hay, Row Crops, Small Grains, and Other Grasses.

18.) Woody Wetlands - areas of forested or shrubland vegetation where the soil of substrate is periodically saturated with or covered with water as defined by Cowardin et al 1979.

19.) Herbaceous Wetland - non-woody vascular perennial vegetation where the soil or substrate is periodically saturated with or covered with water as defined by Cowardin et al 1979.

20.) Total Wetland - sum of Woody Wetlands and Herbaceous Wetland.

Table 4. Twenty fish community metrics to be calculated using the fish community data from thirty-six sites in the Mississippi Alluvial Plain Ecoregion.

Species Richness & Composition	
	1 Total taxa
	2 Total number of minnow taxa (excluding common carp and grass carp)
	3 Average standard length of all *Lepomis*
	4 Percent of buffalo
	5 Ratio of tolerant/intolerant (assumes all sites have 1 intolerant taxa)
	6 Number of tolerant taxa
	7 Number of intolerant taxa
	8 Percent of carp
	9 Shannon Diversity
	10 Evenness
Trophic Composition	
	11 Relative abundance of top carnivores
	12 Relative abundance of omnivores
	13 Relative abundance of insectivores
Fish Abundance & Condition	
	14 Abundance
	15 Average standard length of all bass
	16 Average standard length of all individuals
	17 Total biomass
	18 Percent of biomass which is buffalo and carp
	19 Relative abundance of anomalies
	20 Percent contribution by the dominant taxa

Table 5. Environmental parameter groups, subgroups, specific parameters, and unit of measure.

Environmental parameter group	Environmental parameter subgroup	Specific environmental parameter	Unit of measure
Chemical	reach	pH	standard units
Chemical	reach	specific conductance	microsiemens per centimeter
Chemical	reach	water temperature	celsius
Land Use	basin	percent corn	percent
Land Use	basin	percent cotton	percent
Land Use	basin	percent deciduous forest	percent
Land Use	basin	percent evergreen forest	percent
Land Use	basin	percent hay and pasture	percent
Land Use	basin	percent herbaceous wetlands	percent
Land Use	basin	percent high intensive commercial	percent
Land Use	basin	percent high intensive residential	percent
Land Use	basin	percent low intensive residential	percent
Land Use	basin	percent mixed forest	percent
Land Use	basin	percent oats, sorghum, and wheat	percent
Land Use	basin	percent open water	percent
Land Use	basin	percent other grasses	percent
Land Use	basin	percent quarries, strip mines, and gravel pits	percent
Land Use	basin	percent rice	percent
Land Use	basin	percent row crops	percent
Land Use	basin	percent small grains	percent
Land Use	basin	percent soybeans	percent
Land Use	basin	percent total agriculture	percent
Land Use	basin	percent total forest	percent
Land Use	basin	percent total urban	percent
Land Use	basin	percent total wetlands	percent
Land Use	basin	percent transitional	percent
Land Use	basin	percent woody wetlands	percent
Physical	basin	drainage area	square kilometer
Physical	basin	elevation	meter
Physical	basin	latitude	none
Physical	basin	longitude	none
Physical	basin	average precipitation	centimeters
Physical	basin	average runoff	centimeters
Physical	basin	population	none
Physical	basin	populations per acre	none
Physical	basin	segment gradient	kilometers
Physical	reach	average channel width	meter
Physical	reach	average water depth	meter
Physical	reach	discharge	cubic meters per second
Physical	reach	secchi	centimeters
Physical	reach	average thalweg depth	meter

Table 6. Average habitat parameters calculated at each of the thirty-six sampling sites within the Mississippi Alluvial Plain Ecoregion, 1998.

Site Name	Average channel width (m)	Average thalweg depth (m)	Average water depth (m)	Discharge (Q m3/s)	Secchi depth (cm)
Bayou DeView at Morton, AR	28.8	3.2	2.6	4.61	18
Bayou Macon near Delhi, LA	55.4	2.3	2.0	6.80	38
Bayou Macon near Halley, AR	14.6	1.4	1.2	9.80	61
Bayou Meto near Bayou Meto, AR	25.5	4.0	3.5	0.00	25
Big Creek at Poplar Grove, AR	17.8	2.4	2.2	6.33	23
Big Creek near Sligo, LA	48.4	2.3	1.8	1.56	48
Big Sunflower River at Sunflower, MS	23.2	2.6	2.2	15.0	18
Big Sunflower River near Anguilla, MS	89.8	4.3	4.0	46.0	20
Boeuf River near Arkansas/LA State Line, LA	45.0	3.0	2.3	6.17	56
Bogue Phalia near Leland, MS	37.7	1.6	1.3	5.35	25
Cache River at Egypt, AR	21.7	2.8	2.3	8.84	41
Cache River near Cotton Plant, AR	35.0	2.2	2.0	14.6	18
Cassidy Bayou at Webb, MS	62.2	0.9	0.9	2.41	10
Cockle Burr Slough Ditch near Monette, AR	53.1	1.2	1.1	3.31	18
Coldwater River at Marks, MS	37.5	4.9	4.6	90.7	15
Deer Creek near Hollandale, MS	19.2	1.8	1.7	0.00	33
Elk Chute near Gobler, MO	11.7	0.3	0.2	0.70	25
LaGrue Bayou near Dewitt, AR	8.1	0.8	0.6	0.00	25
L'Anguille River near Palestine, AR	24.6	2.5	2.1	8.69	43
Little River Ditch no. 1 near Morehouse, MO	33.7	0.6	0.4	2.96	43
Little River Ditch no. 251 near Lilbourn, MO	22.4	0.8	0.7	3.60	36
Main Ditch at Hwy. 153 near White Oak, MO	19.9	0.4	0.3	2.20	64
Obion Creek near Hickman, KY	12.5	1.0	0.8	1.22	25
Quiver River near Doddsville, MS	16.3	1.8	1.7	5.77	23
Running Reelfoot Bayou at Hwy 103, TN	13.9	0.2	0.2	0.68	43
Second Creek near Palestine, AR	15.1	0.9	0.7	2.52	61
Silver Creek near Bayland, MS	20.4	0.2	0.1	0.00	25
Spillway Ditch at Hwy 102 near East Prairie, MO	10.5	0.5	0.4	0.93	71
St. Francis River at Lake City, AR	24.6	3.1	2.9	11.0	25
St. Francis River near Coldwater, AR	58.9	1.4	1.3	36.1	30
St. Johns Ditch near Sikeston, MO	10.9	0.5	0.5	2.22	61
Steele Bayou East Prong near Rolling Fork, MS	49.6	2.3	2.0	2.88	18
Tensas River at Tendal, LA	19.3	1.5	1.3	2.35	20
Tyronza River near Twist, AR	19.0	1.1	0.8	4.59	28
Village Creek near Swifton, AR	115.8	1.0	0.7	4.71	91
Yazoo River below Steele Bayou near Long Lake, MS	91.4	6.2	5.9	405	20
MIN	8.1	0.2	0.1	0.00	10
MAX	115.8	6.2	5.9	405.0	91
MEAN	33.7	1.9	1.6	20.0	35
MEDIAN	23.9	1.5	1.3	4.09	25
ST. DEVI	25.1	1.4	1.3	68.1	19

Table 7. Chemical parameters recorded, prior to electrofishing at each of the thirty-six sites within the Mississippi Alluvial Plain Ecoregion, 1998.

Site Name	Water temperature (°C)	pH	Specific conductance (µS	Dissolved oxygen (mg/L)
Bayou DeView at Morton, AR	27.5	6.4	455	7.4
Bayou Macon near Delhi, LA	31.2	8.1	236	7.8
Bayou Macon near Halley, AR	33.4	7.6	502	9.7
Bayou Meto near Bayou Meto, AR	29.8	7.5	450	8.7
Big Creek at Poplar Grove, AR	29.6	7.3	305	5.4
Big Creek near Sligo, LA	30.3	7.0	1087	4.8
Big Sunflower River at Sunflower, MS	31.0	7.7	338	8.5
Big Sunflower River near Anguilla, MS	31.7	6.8	280	10.1
Boeuf River near Arkansas/LA State Line, LA	31.2	6.4	354	10.0
Bogue Phalia near Leland, MS	27.2	6.6	371	8.3
Cache River at Egypt, AR	31.4	7.9	422	13.4
Cache River near Cotton Plant, AR	30.8	6.5	230	7.3
Cassidy Bayou at Webb, MS	30.5	6.9	132	8.0
Cockle Burr Slough Ditch near Monette, AR	28.9	6.0	213	4.4
Coldwater River at Marks, MS	27.7	6.2	78	8.1
Deer Creek near Hollandale, MS	29.4	6.4	154	3.0
Elk Chute near Gobler, MO	30.4	7.9	240	6.9
LaGrue Bayou near Dewitt, AR	26.9	6.5	290	4.2
L'Anguille River near Palestine, AR	33.5	7.1	452	6.1
Little River Ditch no. 1 near Morehouse, MO	27.5	7.5	580	6.0
Little River Ditch no. 251 near Lilbourn, MO	26.5	7.3	362	6.3
Main Ditch at Hwy. 153 near White Oak, MO	27.6	7.7	359	9.4
Obion Creek near Hickman, KY	27.1	6.5	155	4.1
Quiver River near Doddsville, MS	31.6	7.1	273	5.8
Running Reelfoot Bayou at Hwy 103, TN	27.2	7.3	327	4.6
Second Creek near Palestine, AR	28.1	6.3	453	3.8
Silver Creek near Bayland, MS	24.1	5.8	79	3.5
Spillway Ditch at Hwy 102 near East Prairie, MO	27.5	7.6	328	6.7
St. Francis River at Lake City, AR	29.9	7.1	285	6.5
St. Francis River near Coldwater, AR	32.5	6.7	401	7.9
St. Johns Ditch near Sikeston, MO	24.7	7.4	246	6.4
Steele Bayou East Prong near Rolling Fork, MS	26.7	6.3	180	6.7
Tensas River at Tendal, LA	27.6	7.0	269	5.1
Tyronza River near Twist, AR	31.4	6.3	456	8.1
Village Creek near Swifton, AR	26.5	6.7	275	2.1
Yazoo River below Steele Bayou near Long Lake, MS	30.7	6.8	125	5.6
MIN	24.1	5.8	78	2.1
MAX	33.5	8.1	1087	13.4
MEAN	29.2	6.9	326	6.7
MEDIAN	29.5	6.9	298	6.6
ST. DEVI.	2.4	0.6	178	2.3

Table 8. Scientific and common names of fishes collected from thirty-six sites within the Mississippi Alluvial Plain Ecoregion, 1998, listed in phylogenetic order [r = Rare and occurs at 2 or less (approximately 5 percent) of the sites sampled; c = common occurs at between 3 and 17 sites; vc = very common, occurs at 18 or more (50 percent) of the sites sampled; *, indicates species was introduced; (n), indicates the number of sites where the species was collected]

Scientific Name	**Common Name**	**Status**
Lepisosteidae - gars		
Lepisosteus oculatus (Winchell, 1864)	spotted gar	vc (33)
Lepisosteus osseus (Linnaeus, 1758)	longnose gar	c (11)
Lepisosteus platostomus Rafinesque, 1820	shortnose gar	vc (28)
Amiidae - bowfins		
Amia calva Linnaeus, 1766	bowfin	c (13)
Anguillidae - freshwater eels		
Anguilla rostrata (Lesueur, 1817)	American eel	r (1)
Clupeidae - herrings		
Dorosoma cepedianum (Lesueur, 1818)	gizzard shad	vc (32)
Dorosoma petenense (Gunther, 1867)	threadfin shad	c (6)
Cyprinidae - carps and minnows		
Ctenopharyngodon idella (Valenciennes, 1844) *	grass carp	c (3)
Cyprinella camura (Jordan and Meek, 1884)	bluntface shiner	c (3)
Cyprinella lutrensis (Baird and Girard, 1853)	red shiner	c (4)
Cyprinella spiloptera (Cope, 1868)	spotfin shiner	r (1)
Cyprinella venusta Girard, 1856	blacktail shiner	vc (21)
Cyprinus carpio Linnaeus, 1758 *	common carp	vc (34)
Hybognathus hayi Jordan, 1885	cypress minnow	c (5)
Hybognathus nuchalis Agassiz, 1855	Mississippi silvery minnow	r (2)
Lythrurus fumeus (Evermann, 1892)	ribbon shiner	c (9)
Macrhybopsis aestivalis (Girard, 1856)	speckled chub	r (2)
Macrhybopsis storeriana (Kirtland, 1847)	silver chub	r (1)
Notemigonus crysoleucas (Mitchill, 1814)	golden shiner	c (12)
Notropis atherinoides Rafinesque, 1818	emerald shiner	c (16)
Notropis buchanani Meek, 1896	ghost shiner	c (7)
Notropis chalybaeus (Cope, 1869)	ironcolor shiner	r (1)
Notropis maculatus (Hay, 1881)	taillight shiner	r (2)
Notropis texanus (Girard, 1856)	weed shiner	r (2)
Notropis volucellus (Cope, 1865)	mimic shiner	c (10)
Opsopoeodus emiliae Hay, 1881	pugnose minnow	c (8)
Pimephales notatus (Rafinesque, 1820)	bluntnose minnow	c (5)
Pimephales vigilax (Baird and Girard, 1853)	bullhead minnow	vc (23)
Catostomidae - suckers		
Carpiodes carpio (Rafinesque, 1820)	river carpsucker	c (12)
Carpiodes cyprinus (Lesueur, 1817)	quillback	r (1)
Ictiobus bubalus (Rafinesque, 1818)	smallmouth buffalo	vc (29)
Ictiobus cyprinellus (Valenciennes, 1844)	bigmouth buffalo	c (17)
Ictiobus niger (Rafinesque, 1819)	black buffalo	vc (23)
Minytrema melanops (Rafinesque, 1820)	spotted sucker	r (2)
Moxostoma macrolepidotum (Lesueur, 1817)	shorthead redhorse	r (2)
Ictaluridae - bullhead catfishes		
Ameiurus melas (Rafinesque, 1820)	black bullhead	c (3)
Ameiurus natalis (Lesueur, 1819)	yellow bullhead	c (6)
Ictalurus furcatus (Lesueur, 1840)	blue catfish	c (13)
Ictalurus punctatus (Rafinesque, 1818)	channel catfish	vc (29)
Noturus gyrinus (Mitchill, 1817)	tadpole madtom	c (8)
Noturus nocturnus Jordan and Gilbert, 1886	freckled madtom	r (1)

Table 8. Continued

Scientific Name	Common Name	Status
Pylodictis olivaris (Rafinesque, 1818)	flathead catfish	c (16)
Esocidae - pikes		
Esox americanus vermiculatus Lesueur, 1846	grass pickerel	c (7)
Aphredoderidae - pirate perches		
Aphredoderus sayanus (Gilliams, 1824)	pirate perch	c (15)
Cyprinodontidae - killifishes		
Fundulus chrysotus (Gunther, 1866)	golden topminnow	r (2)
Fundulus notatus (Rafinesque, 1820)	blackstripe topminnow	c (3)
Fundulus olivaceus (Storer, 1845)	blackspotted topminnow	c (15)
Poeciliidae - livebearers		
Gambusia affinis (Baird and Girard, 1853)	western mosquitofish	vc (35)
Atherinidae - silversides		
Labidesthes sicculus (Cope, 1865)	brook silverside	c (9)
Menidia beryllina (Cope, 1866)	inland silverside	r (2)
Percichthyidae - temperate basses		
Morone chrysops (Rafinesque, 1820)	white bass	c (6)
Morone mississippiensis Jordan and Eigenmann, 1887	yellow bass	c (3)
Morone saxatilis (Walbaum, 1792)	striped bass	r (1)
Centrarchidae - sunfishes		
Ambloplites ariommus Viosca, 1936	shadow bass	c (6)
Elassoma zonatum Jordan, 1877	banded pygmy sunfish	r (2)
Lepomis cyanellus Rafinesque, 1819	green sunfish	vc (25)
Lepomis gulosus (Cuvier, 1829)	warmouth	vc (27)
Lepomis humilis (Girard, 1858)	orangespotted sunfish	vc (27)
Lepomis macrochirus Rafinesque, 1819	bluegill	vc (31)
Lepomis marginatus (Holbrook, 1855)	dollar sunfish	r (1)
Lepomis megalotis (Rafinesque, 1820)	longear sunfish	vc (30)
Lepomis microlophus (Gunther, 1859)	redear sunfish	c (9)
Lepomis miniatus Evermann, 1899	redspotted sunfish	c (11)
Lepomis hybrid	hybrid sunfish	r (2)
Micropterus punctulatus (Rafinesque, 1819)	spotted bass	c (13)
Micropterus salmoides (Lacepede, 1802)	largemouth bass	vc (32)
Pomoxis annularis Rafinesque, 1818	white crappie	vc (31)
Pomoxis nigromaculatus (Lesueur, 1829)	black crappie	c (21)
Percidae - perches		
Ammocrypta vivax Hay, 1882	scaly sand darter	r (2)
Etheostoma asprigene (Forbes, 1878)	mud darter	c (4)
Etheostoma chlorosomum (Hay, 1881)	bluntnose darter	c (10)
Etheostoma gracile (Girard, 1859)	slough darter	c (5)
Etheostoma histrio Jordan and Gilbert, 1887	harlequin darter	r (1)
Etheostoma proeliare (Hay, 1881)	cypress darter	c (6)
Percina caprodes (Rafinesque, 1818)	logperch	r (1)
Percina maculata (Girard, 1859)	blackside darter	c (3)
Percina sciera (Swain, 1883)	dusky darter	c (4)
Sciaenidae - drums		
Aplodinotus grunniens Rafinesque, 1819	freshwater drum	vc (35)

Table 9. Percent relative abundance of fishes collected at thirty-six sites within the Mississippi Alluvial Plain Ecogregion, 1998 [--, no individuals collected; 0, value less than 0.5 percent].

SCIENTIFIC NAME	Bayou Deview at Morton, AR	Bayou Macon near Delhi, LA	Bayou Macon near Halley, AR	Bayou Meto near Bayou Meto, AR	Big Creek at Poplar Grove, AR	Big Creek near Sligo, LA	Big Sunflower near Anguilla, MS
Lepisosteidae - gars							
Lepisosteus oculatus (Winchell, 1864)	2	--	0	2	3	3	2
Lepisosteus osseus (Linnaeus, 1758)	0	--	--	1	--	--	--
Lepisosteus platostomus Rafinesque, 1820	0	--	1	1	1	1	6
Lepisosteus species	--	0	--	--	--	--	--
Amiidae - bowfins							
Amia calva Linnaeus, 1766	--	--	--	--	0	--	0
Anguillidae - freshwater eels							
Anguilla rostrata (Lesueur, 1817)	--	--	--	--	--	--	--
Clupeidae - herrings							
Dorosoma cepedianum (Lesueur, 1818)	2	3	4	6	8	8	2
Dorosoma petenense (Gunther, 1867)	--	--	2	--	--	--	--
Dorosoma species	2	--	2	39	--	--	--
Cyprinidae - carps and minnows							
Ctenopharyngodon idella (Valenciennes, 1844)	--	--	0	0	--	--	--
Cyprinella camura (Jordan and Meek, 1884)	--	--	--	--	--	--	--
Cyprinella lutrensis (Baird and Girard, 1853)	--	8	48	--	--	1	--
Cyprinella spiloptera (Cope, 1868)	--	--	--	--	--	--	--
Cyprinella venusta Girard, 1856	--	--	--	--	6	1	--
Cyprinus carpio Linnaeus, 1758	4	1	3	4	4	3	2
Cyprinidae species	0	1	2	--	--	--	--
Hybognathus hayi Jordan, 1885	--	--	--	2	--	--	--
Hybognathus nuchalis Agassiz, 1855	--	--	--	--	--	--	--
Lythrurus fumeus (Evermann, 1892)	2	--	--	--	1	--	--
Macrhybopsis aestivalis (Girard, 1856)	--	--	--	--	--	--	--
Macrhybopsis storeriana (Kirtland, 1847)	--	--	--	--	--	--	--
Notemigonus crysoleucas (Mitchill, 1814)	--	--	--	4	--	--	--
Notropis atherinoides Rafinesque, 1818	0	--	0	--	1	--	--
Notropis buchanani Meek, 1896	--	--	0	--	--	--	--
Notropis chalybaeus (Cope, 1869)	--	--	--	--	--	--	--
Notropis maculatus (Hay, 1881)	--	--	--	--	--	--	--
Notropis texanus (Girard, 1856)	--	--	--	--	--	--	--
Notropis volucellus (Cope, 1865)	2	--	--	--	--	--	--
Notropis species	--	--	--	--	--	--	--
Opsopoeodus emiliae Hay, 1881	--	--	--	0	--	--	--
Pimephales notatus (Rafinesque, 1820)	--	--	--	--	--	--	--
Pimephales vigilax (Baird and Girard, 1853)	0	10	5	--	6	9	--
Catostomidae - suckers							
Carpiodes carpio (Rafinesque, 1820)	--	--	1	0	0	--	--
Carpiodes cyprinus Lesueur, 1817	--	--	--	--	--	--	--
Ictiobus bubalus (Rafinesque, 1818)	4	--	7	6	10	0	4
Ictiobus cyprinellus (Valenciennes, 1844)	1	--	0	1	--	--	3
Ictiobus niger (Rafinesque, 1819)	0	--	1	--	1	0	0
Ictiobus species	--	--	--	0	--	--	35
Minytrema melanops (Rafinesque, 1820)	--	--	--	--	--	--	--
Moxostoma macrolepidotum (Lesueur, 1817)	--	--	--	--	--	--	--
Moxostoma species	--	--	--	--	--	--	--
Ictaluridae - bullhead catfishes							
Ameiurus melas (Rafinesque, 1820)	--	--	--	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	--	--	0	--	--	--	--
Ictalurus furcatus (Lesueur, 1840)	--	1	--	--	--	0	--
Ictalurus punctatus (Rafinesque, 1818)	--	--	1	0	0	--	--
Noturus gyrinus (Mitchill, 1817)	0	--	--	--	--	--	--
Noturus nocturnus Jordan and Gilbert, 1886	--	--	--	--	--	--	--
Pylodictis olivaris (Rafinesque, 1818)	1	--	--	0	1	--	0

Table 9. Continued

SCIENTIFIC NAME	Bayou Deview at Morton, AR	Bayou Macon near Delhi, LA	Bayou Macon near Halley, AR	Bayou Meto near Bayou Meto, AR	Big Creek at Poplar Grove, AR	Big Creek near Sligo, LA	Big Sunflower near Anguilla, MS
Esocidae - pikes							
Esox americanus vermiculatus Lesueur, 1846	--	--	--	--	0	0	--
Aphredoderidae - pirate perches							
Aphredoderus sayanus (Gilliams, 1824)	0	--	--	--	--	--	--
Cyprinodontidae - killifishes							
Fundulus chrysotus (Gunther, 1866)	--	--	--	--	--	--	--
Fundulus notatus (Rafinesque, 1820)	--	--	--	--	--	--	--
Fundulus olivaceus (Storer, 1845)	1	--	--	--	1	--	--
Fundulus species	--	--	--	0	--	--	--
Poeciliidae - livebearers							
Gambusia affinis (Baird and Girard, 1853)	6	26	12	7	28	54	16
Atherinidae - silversides							
Labidesthes sicculus (Cope, 1865)	--	3	--	--	--	0	--
Menidia beryllina (Cope, 1866)	--	--	--	--	--	--	--
Percichthyidae - temperate basses							
Morone chrysops (Rafinesque, 1820)	--	--	--	--	--	--	--
Morone mississippiensis Jordan and Eigenmann, 1887	--	--	--	0	--	--	--
Morone saxatilis (Walbaum, 1792)	--	--	--	--	--	--	--
Centrarchidae - sunfishes							
Ambloplites ariommus Viosca, 1936	--	--	--	--	--	--	--
Elassoma zonatum Jordan, 1877	--	--	--	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	--	2	1	0	0	--	1
Lepomis gulosus (Cuvier, 1829)	5	1	0	1	3	0	1
Lepomis humilis (Girard, 1858)	3	3	0	3	0	1	3
Lepomis macrochirus Rafinesque, 1819	19	1	--	5	6	1	3
Lepomis marginatus (Holbrook, 1855)	--	--	--	--	--	--	--
Lepomis megalotis (Rafinesque, 1820)	--	9	3	2	5	3	--
Lepomis microlophus (Gunther, 1859)	--	--	--	--	0	--	0
Lepomis miniatus Evermann, 1899	--	--	--	1	--	--	--
Lepomis hybrid	--	--	--	--	--	--	--
Lepomis species	22	26	3	--	--	1	14
Micropterus punctulatus (Rafinesque, 1819)	--	--	--	--	--	2	--
Micropterus salmoides (Lacepede, 1802)	1	2	0	2	2	4	0
Micropterus species	--	--	--	--	--	--	--
Pomoxis annularis Rafinesque, 1818	10	3	0	7	5	4	2
Pomoxis nigromaculatus (Lesueur, 1829)	1	--	--	1	--	0	0
Percidae - perches							
Ammocrypta vivax Hay, 1882	--	--	--	--	--	--	--
Etheostoma asprigene (Forbes, 1878)	--	--	--	--	--	--	--
Etheostoma chlorosomum (Hay, 1881)	3	--	--	1	3	--	--
Etheostoma gracile (Girard, 1859)	0	--	--	0	--	--	--
Etheostoma histrio Jordan and Gilbert, 1887	--	--	--	--	--	--	--
Etheostoma proeliare (Hay, 1881)	--	--	--	--	1	--	--
Percina caprodes (Rafinesque, 1818)	--	--	--	0	--	--	--
Percina maculata (Girard, 1859)	--	--	--	--	0	--	--
Percina sciera (Swain, 1883)	--	--	--	--	--	--	--
Sciaenidae - drums							
Aplodinotus grunniens Rafinesque, 1819	4	2	3	2	3	0	3
Unclassified fishes							
Unknown fry	--	--	--	--	--	0	--
Number of individuals	657	310	616	504	269	408	482
Number of taxa	26	16	24	32	29	23	19

Table 9. Continued

SCIENTIFIC NAME	Big Sunflower River at Sunflower, MS	Boeuf River near Arkansas/LA State Line, LA	Bogue Phalia near Leland, MS	Cache River at Egypt, AR	Cache River near Cotton Plant, AR	Cassidy Bayou at Webb, MS	Cockle Burr Slough Ditch near Monette, AR
Lepisosteidae - gars							
Lepisosteus oculatus (Winchell, 1864)	1	4	1	1	1	0	0
Lepisosteus osseus (Linnaeus, 1758)	--	--	--	--	0	--	0
Lepisosteus platostomus Rafinesque, 1820	1	2	1	1	0	0	--
Lepisosteus species	--	0	--	--	--	--	--
Amiidae - bowfins							
Amia calva Linnaeus, 1766	--	--	--	--	1	--	0
Anguillidae - freshwater eels							
Anguilla rostrata (Lesueur, 1817)	--	--	--	--	--	--	--
Clupeidae - herrings							
Dorosoma cepedianum (Lesueur, 1818)	4	7	4	1	4	20	2
Dorosoma petenense (Gunther, 1867)	--	--	--	--	--	--	0
Dorosoma species	--	--	17	--	--	--	--
Cyprinidae - carps and minnows							
Ctenopharyngodon idella (Valenciennes, 1844)	--	0	--	--	--	--	--
Cyprinella camura (Jordan and Meek, 1884)	--	--	--	--	--	--	--
Cyprinella lutrensis (Baird and Girard, 1853)	--	19	--	--	--	--	--
Cyprinella spiloptera (Cope, 1868)	--	--	--	--	--	--	--
Cyprinella venusta Girard, 1856	7	--	1	1	5	0	4
Cyprinus carpio Linnaeus, 1758	4	4	3	3	4	2	2
Cyprinidae species	3	1	1	--	0	--	--
Hybognathus hayi Jordan, 1885	--	--	--	--	19	--	--
Hybognathus nuchalis Agassiz, 1855	--	--	--	--	--	--	--
Lythrurus fumeus (Evermann, 1892)	--	1	--	--	--	--	0
Macrhybopsis aestivalis (Girard, 1856)	--	--	--	--	--	--	--
Macrhybopsis storeriana (Kirtland, 1847)	--	--	--	--	--	--	--
Notemigonus crysoleucas (Mitchill, 1814)	--	--	--	--	1	--	2
Notropis atherinoides Rafinesque, 1818	--	1	--	--	0	--	--
Notropis buchanani Meek, 1896	0	--	0	--	--	--	--
Notropis chalybaeus (Cope, 1869)	--	--	--	--	--	--	2
Notropis maculatus (Hay, 1881)	--	--	--	--	--	--	--
Notropis texanus (Girard, 1856)	--	--	--	--	--	--	21
Notropis volucellus (Cope, 1865)	--	--	0	--	--	--	1
Notropis species	--	--	--	--	--	--	--
Opsopoeodus emiliae Hay, 1881	--	--	--	--	--	--	--
Pimephales notatus (Rafinesque, 1820)	--	--	--	--	--	--	3
Pimephales vigilax (Baird and Girard, 1856)	--	--	--	2	1	--	1
Catostomidae - suckers							
Carpiodes carpio (Rafinesque, 1820)	--	--	--	--	0	--	--
Carpiodes cyprinus Lesueur, 1817	--	--	--	--	--	--	--
Ictiobus bubalus (Rafinesque, 1818)	2	2	3	9	4	--	0
Ictiobus cyprinellus (Valenciennes, 1844)	0	0	0	3	1	--	--
Ictiobus niger (Rafinesque, 1819)	--	--	0	1	2	--	0
Ictiobus species	--	0	--	1	--	3	--
Minytrema melanops (Rafinesque, 1820)	--	--	--	--	--	--	1
Moxostoma macrolepidotum (Leuseur, 1817)	--	--	--	--	--	--	--
Moxostoma species	--	--	--	--	--	--	0
Ictaluridae - bullhead catfishes							
Ameiurus melas (Rafinesque, 1820)	--	--	--	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	--	--	--	--	--	0	--
Ictalurus furcatus (Lesueur, 1840)	1	--	--	--	2	0	--
Ictalurus punctatus (Rafinesque, 1818)	0	0	0	2	1	0	0
Noturus gyrinus (Mitchill, 1817)	--	--	--	--	--	0	1
Noturus nocturnus Jordan and Gilbert, 1886	--	--	--	--	--	--	--
Pylodictis olivaris (Rafinesque, 1818)	1	--	--	1	1	--	--

Table 9. Continued

SCIENTIFIC NAME	Big Sunflower River at Sunflower, MS	Boeuf River near Aarkansas/LA State Line, LA	Bogue Phalia near Leland, MS	Cache River at Egypt, AR	Cache River near Cotton Plant, AR	Cassidy Bayou at Webb, MS	Cockle Burr Slough Ditch near Monette, AR
Esocidae - pikes							
Esox americanus vermiculatus Lesueur, 1846	--	--	--	--	--	--	--
Aphredoderidae - pirate perches							
Aphredoderus sayanus (Gilliams, 1824)	0	--	--	--	3	--	1
Cyprinodontidae - killifishes							
Fundulus chrysotus (Gunther, 1866)	--	--	--	--	--	--	--
Fundulus notatus (Rafinesque, 1820)	--	--	--	--	--	--	1
Fundulus olivaceus (Storer, 1845)	--	--	--	--	2	--	--
Fundulus species	--	--	--	--	--	--	--
Poeciliidae - livebearers							
Gambusia affinis (Baird and Girard, 1853)	43	45	6	36	14	70	0
Atherinidae - silversides							
Labidesthes sicculus (Cope, 1865)	--	0	--	--	--	--	--
Menidia beryllina (Cope, 1866)	--	--	--	--	--	--	--
Percichthyidae - temperate basses							
Morone chrysops (Rafinesque, 1820)	--	--	--	--	--	--	--
Morone mississippiensis Jordan and Eigenmann, 1887	--	--	--	--	--	--	--
Morone saxatilis (Walbaum, 1792)	--	--	--	--	--	--	--
Centrarchidae - sunfishes							
Ambloplites ariommus Viosca, 1936	--	--	--	--	--	--	1
Elassoma zonatum Jordan, 1877	0	--	--	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	--	1	1	1	--	--	2
Lepomis gulosus (Cuvier, 1829)	0	1	0	--	3	--	0
Lepomis humilis (Girard, 1858)	1	1	2	--	3	2	--
Lepomis macrochirus Rafinesque, 1819	0	2	1	4	4	0	4
Lepomis marginatus (Holbrook, 1855)	--	--	--	--	--	--	--
Lepomis megalotis (Rafinesque, 1820)	--	3	0	1	7	1	13
Lepomis microlophus (Gunther, 1859)	--	--	--	--	--	--	1
Lepomis miniatus Evermann, 1899	--	--	--	--	1	--	25
Lepomis hybrid	--	--	--	--	--	--	6
Lepomis species	20	--	55	28	--	--	1
Micropterus punctulatus (Rafinesque, 1819)	--	--	--	--	--	--	1
Micropterus salmoides (Lacepede, 1802)	2	0	0	--	1	0	2
Micropterus species	--	--	0	--	--	--	--
Pomoxis annularis Rafinesque, 1818	2	2	4	2	7	1	0
Pomoxis nigromaculatus (Lesueur, 1829)	0	--	0	--	--	1	--
Percidae - perches							
Ammocrypta vivax Hay, 1882	--	--	--	--	--	--	--
Etheostoma asprigene (Forbes, 1878)	--	--	--	--	0	--	--
Etheostoma chlorosomum (Hay, 1881)	--	--	--	2	--	--	--
Etheostoma gracile (Girard, 1859)	--	--	--	--	1	--	--
Etheostoma histrio Jordan and Gilbert, 1887	--	--	--	--	--	--	--
Etheostoma proeliare (Hay, 1881)	--	--	0	--	--	--	0
Percina caprodes (Rafinesque, 1818)	--	--	--	--	--	--	--
Percina maculata (Girard, 1859)	--	--	--	1	--	--	--
Percina sciera (Swain, 1883)	--	--	--	--	--	--	--
Sciaenidae - drums							
Aplodinotus grunniens Rafinesque, 1819	5	3	1	1	7	0	2
Unclassified fishes							
Unknown fry	--	--	--	--	0	--	--
Number of individuals	289	481	951	379	393	959	543
Number of taxa	21	22	22	19	32	17	35

Table 9. Continued

SCIENTIFIC NAME	Coldwater River at Marks, MS	Deer Creek near Holandale, MS	Elk Chute near Gobler, MO	LaGrue Bayou near Dewitt, AR	L'Anguilla River near Palestine, AR	Little River Ditch near no. 1 near Morehouse, MO	Little River Ditch no. 251 near Lilbourn, MO
Lepisosteidae - gars							
Lepisosteus oculatus (Winchell, 1864)	0	2	1	0	4	1	1
Lepisosteus osseus (Linnaeus, 1758)	1	--	--	--	0	--	0
Lepisosteus platostomus Rafinesque, 1820	1	--	0	1	1	--	0
Lepisosteus species	--	--	--	--	--	--	--
Amiidae - bowfins							
Amia calva Linnaeus, 1766	--	--	0	0	--	1	0
Anguillidae - freshwater eels							
Anguilla rostrata (Lesueur, 1817)	--	--	--	--	--	--	0
Clupeidae - herrings							
Dorosoma cepedianum (Lesueur, 1818)	0	46	0	3	4	--	--
Dorosoma petenense (Gunther, 1867)	--	--	--	--	--	--	--
Dorosoma species	--	--	--	--	--	--	--
Cyprinidae - carps and minnows							
Ctenopharyngodon idella (Valenciennes, 1844)	--	--	--	--	--	--	--
Cyprinella camura (Jordan and Meek, 1884)	1	--	--	--	--	--	--
Cyprinella lutrensis (Baird and Girard, 1853)	47	--	--	--	0	--	--
Cyprinella spiloptera (Cope, 1868)	--	--	--	--	--	--	--
Cyprinella venusta Girard, 1856	7	--	38	--	0	29	11
Cyprinus carpio Linnaeus, 1758	10	2	0	2	10	1	1
Cyprinidae species	--	--	2	--	1	--	6
Hybognathus hayi Jordan, 1885	--	--	--	--	--	--	--
Hybognathus nuchalis Agassiz, 1855	--	--	--	--	--	--	--
Lythrurus fumeus (Evermann, 1892)	--	--	--	--	--	--	--
Macrhybopsis aestivalis (Girard, 1856)	0	--	--	--	--	--	--
Macrhybopsis storeriana (Kirtland, 1847)	--	--	--	--	--	--	--
Notemigonus crysoleucas (Mitchill, 1814)	0	1	0	--	0	--	7
Notropis atherinoides Rafinesque, 1818	1	--	0	--	2	1	1
Notropis buchanani Meek, 1896	3	--	--	--	--	--	--
Notropis chalybaeus (Cope, 1869)	--	--	--	--	--	--	--
Notropis maculatus (Hay, 1881)	--	--	--	--	--	--	--
Notropis texanus (Girard, 1856)	--	--	--	--	--	--	--
Notropis volucellus (Cope, 1865)	--	--	2	--	--	4	--
Notropis species	--	--	--	--	--	--	0
Opsopoeodus emiliae Hay, 1881	--	--	0	1	--	0	--
Pimephales notatus (Rafinesque, 1820)	--	--	--	--	--	4	--
Pimephales vigilax (Baird and Girard, 1856)	3		2	14	0	7	9
Catostomidae - suckers							
Carpiodes carpio (Rafinesque, 1820)	--	--	2	--	1	3	3
Carpiodes cyprinus Lesueur, 1817	--	--	--	--	--	--	0
Ictiobus bubalus (Rafinesque, 1818)	1	--	0	3	18		2
Ictiobus cyprinellus (Valenciennes, 1844)	0	--	--	1	3	0	0
Ictiobus niger (Rafinesque, 1819)	--	--	1	1	2	1	0
Ictiobus species	--	--	--	--	--	--	--
Minytrema melanops (Rafinesque, 1820)	--	--	--	--	--	--	--
Moxostoma macrolepidotum (Leuseur, 1817)	--	--	--	--	--	0	0
Moxostoma species	--	--	--	--	--	--	--
Ictaluridae - bullhead catfishes							
Ameiurus melas (Rafinesque, 1820)	--	0	0	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	--	--	--	--	--	--	0
Ictalurus furcatus (Lesueur, 1840)	0	0	--	--	--	--	--
Ictalurus punctatus (Rafinesque, 1818)	1	0	2	1	3	1	1
Noturus gyrinus (Mitchill, 1817)	--	--	0	--	--	--	0
Noturus nocturnus Jordan and Gilbert, 1886	--	--	--	--	--	--	--
Pylodictis olivaris (Rafinesque, 1818)	--	--	--	1	1	1	--

Table 9. Continued

SCIENTIFIC NAME	Coldwater River at Marks, MS	Deer Creek near Holandale, MS	Elk Chute near Gobler, MO	LaGrue Bayou near Dewitt, AR	L'Anguilla River near Palestine, AR	Little River Ditch near no. 1 near Morehouse, MO	Little River Ditch no. 251 near Lilbourn, MO
Esocidae - pikes							
Esox americanus vermiculatus Lesueur, 1846	--	--	--	--	--	0	1
Aphredoderidae - pirate perches							
Aphredoderus sayanus (Gilliams, 1824)	0	0	--	1	--	--	--
Cyprinodontidae - killifishes							
Fundulus chrysotus (Gunther, 1866)	--	--	--	--	--	--	--
Fundulus notatus (Rafinesque, 1820)	--	--	--	--	--	3	--
Fundulus olivaceus (Storer, 1845)	--	--	0	1	4	1	3
Fundulus species	--	--	--	--	--	--	--
Poeciliidae - livebearers							
Gambusia affinis (Baird and Girard, 1853)	2	22	25	2	14	3	28
Atherinidae - silversides							
Labidesthes sicculus (Cope, 1865)	--	--	--	--	--	1	1
Menidia beryllina (Cope, 1866)	--	--	--	--	--	--	--
Percichthyidae - temperate basses							
Morone chrysops (Rafinesque, 1820)	7	--	--	--	--	--	--
Morone mississippiensis Jordan and Eigenmann,	--	--	--	--	--	--	--
Morone saxatilis (Walbaum, 1792)	--	--	--	--	--	--	--
Centrarchidae - sunfishes							
Ambloplites ariommus Viosca, 1936	--	--	--	--	--	1	0
Elassoma zonatum Jordan, 1877	--	--	--	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	--	--	4	2	--	5	7
Lepomis gulosus (Cuvier, 1829)	--	1	0	6	0	0	1
Lepomis humilis (Girard, 1858)	1	4	4	1	2	--	--
Lepomis macrochirus Rafinesque, 1819	0	6	0	24	7	4	1
Lepomis marginatus (Holbrook, 1855)	--	--	--	--	--	--	--
Lepomis megalotis (Rafinesque, 1820)	--	3	10	10	1	15	8
Lepomis microlophus (Gunther, 1859)	--	--	--	1	0	--	0
Lepomis miniatus Evermann, 1899	--	--	--	1	0	0	1
Lepomis hybrid	--	--	--	--	--	--	--
Lepomis species	5	7	--	--	--	1	2
Micropterus punctulatus (Rafinesque, 1819)	--	--	2	--	3	4	1
Micropterus salmoides (Lacepede, 1802)	0	1	1	4	1	2	0
Micropterus species	--	--	--	--	--	--	--
Pomoxis annularis Rafinesque, 1818	4	4	1	14	4	--	0
Pomoxis nigromaculatus (Lesueur, 1829)	0	--	--	2	0	0	0
Percidae - perches							
Ammocrypta vivax Hay, 1882	--	--	0	--	--	--	--
Etheostoma asprigene (Forbes, 1878)	--	--	--	0	--	--	--
Etheostoma chlorosomum (Hay, 1881)	--	--	--	--	6	--	1
Etheostoma gracile (Girard, 1859)	--	--	--	--	--	--	0
Etheostoma histrio Jordan and Gilbert, 1887	--	--	--	--	--	--	--
Etheostoma proeliare (Hay, 1881)	--	--	--	--	1	--	--
Percina caprodes (Rafinesque, 1818)	--	--	--	--	--	--	--
Percina maculata (Girard, 1859)	--	--	--	--	--	--	--
Percina sciera (Swain, 1883)	--	--	--	--	--	0	--
Sciaenidae - drums							
Aplodinotus grunniens Rafinesque, 1819	3	0	1	6	5	3	0
Unclassified fishes							
Unknown fry	--	--	--	--	--	--	--
Number of individuals	305	384	550	356	289	429	833
Number of taxa	26	16	29	27	31	32	37

Table 9. Continued

SCIENTIFIC NAME	Main Ditch at Hwy 153 near White Oak, MO	Obion Creek near Hickman, KY	Quiver River near Doddsville, MS	Running Reelfoot Bayou at Hwy 103, TN	Second Creek near Palestine, AR	Silver Creek near Bayland, MS	Spillway Ditch at Hwy 102 near East Prairie, MO
Lepisosteidae - gars							
Lepisosteus oculatus (Winchell, 1864)	1	1	4	1	1	2	--
Lepisosteus osseus (Linnaeus, 1758)	0	--	--	--	--	--	--
Lepisosteus platostomus Rafinesque, 1820	--	1	3	1	--	1	0
Lepisosteus species	--	--	--	--	--	--	--
Amiidae - bowfins							
Amia calva Linnaeus, 1766	--	1	--	--	0	--	0
Anguillidae - freshwater eels							
Anguilla rostrata (Lesueur, 1817)	--	--	--	--	--	--	--
Clupeidae - herrings							
Dorosoma cepedianum (Lesueur, 1818)	--	7	4	32	1	7	7
Dorosoma petenense (Gunther, 1867)	--	--	--	3	--	--	--
Dorosoma species	--	--	8	2	--	--	--
Cyprinidae - carps and minnows							
Ctenopharyngodon idella (Valenciennes, 1844)	--	--	--	--	--	--	--
Cyprinella camura (Jordan and Meek, 1884)	--	--	--	--	--	--	0
Cyprinella lutrensis (Baird and Girard, 1853)	1	--	--	--	--	--	--
Cyprinella spiloptera (Cope, 1868)	--	--	--	--	--	--	1
Cyprinella venusta Girard, 1856	23	--	2	1	--	--	30
Cyprinus carpio Linnaeus, 1758	1	12	22	2	--	3	1
Cyprinidae species	--	--	--	--	--	--	--
Hybognathus hayi Jordan, 1885	--	2	--	0	--	--	--
Hybognathus nuchalis Agassiz, 1855	--	2	--	--	--	--	2
Lythrurus fumeus (Evermann, 1892)	3	--	--	--	0	--	19
Macrhybopsis aestivalis (Girard, 1856)	0	--	--	--	--	--	--
Macrhybopsis storeriana (Kirtland, 1847)	--	--	--	--	--	--	--
Notemigonus crysoleucas (Mitchill, 1814)	--	--	1	--	--	35	2
Notropis atherinoides Rafinesque, 1818	13	21	--	--	--	--	0
Notropis buchanani Meek, 1896	--	--	--	--	--	--	--
Notropis chalybaeus (Cope, 1869)	--	--	--	--	--	--	--
Notropis maculatus (Hay, 1881)	--	--	--	--	--	1	--
Notropis texanus (Girard, 1856)	--	--	--	--	--	--	0
Notropis volucellus (Cope, 1865)	1	--	--	--	--	--	1
Notropis species	--	--	--	--	--	--	--
Opsopoeodus emiliae Hay, 1881	3	2	--	--	--	--	--
Pimephales notatus (Rafinesque, 1820)	1	--	--	--	--	--	0
Pimephales vigilax (Baird and Girard, 1856)	8	0	--	3	--	--	3
Catostomidae - suckers							
Carpiodes carpio (Rafinesque, 1820)	--	1	1	--	--	--	--
Carpiodes cyprinus Lesueur, 1817	--	--	--	--	--	--	--
Ictiobus bubalus (Rafinesque, 1818)	1	3	5	1	--	3	2
Ictiobus cyprinellus (Valenciennes, 1844)	--	--	--	--	--	6	--
Ictiobus niger (Rafinesque, 1819)	0	1	1	--	--	--	1
Ictiobus species	--	--	7	--	--	0	--
Minytrema melanops (Rafinesque, 1820)	--	--	--	--	--	--	--
Moxostoma macrolepidotum (Leuseur, 1817)	--	--	--	--	--	--	--
Moxostoma species	--	--	--	--	--	--	--
Ictaluridae - bullhead catfishes							
Ameiurus melas (Rafinesque, 1820)	--	2	--	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	--	1	--	--	--	--	--
Ictalurus furcatus (Lesueur, 1840)	--	1	1	0	--	--	--
Ictalurus punctatus (Rafinesque, 1818)	3	6	2	0	--	--	2
Noturus gyrinus (Mitchill, 1817)	1	1	1	--	--	--	--
Noturus nocturnus Jordan and Gilbert, 1886	--	--	--	--	--	--	--
Pylodictis olivaris (Rafinesque, 1818)	--	--	4	1	--	--	0

Table 9. Continued

SCIENTIFIC NAME	Main Ditch at Hwy 153 near White Oak, MO	Obion Creek near Hickman, KY	Quiver River near Doddsville, MS	Running Reelfoot Bayou at Hwy 103, TN	Second Creek near Palestine, AR	Silver Creek near Bayland, MS	Spillway Ditch at Hwy 102 near East Prairie, MO
Esocidae - pikes							
Esox americanus vermiculatus Lesueur, 1846	--	--	--	0	1	--	--
Aphredoderidae - pirate perches							
Aphredoderus sayanus (Gilliams, 1824)	--	--	--	0	0	--	0
Cyprinodontidae - killifishes							
Fundulus chrysotus (Gunther, 1866)	--	--	--	--	0	0	--
Fundulus notatus (Rafinesque, 1820)	--	1	--	--	--	--	--
Fundulus olivaceus (Storer, 1845)	7	--	--	--	5	--	0
Fundulus species	--	--	--	--	--	--	--
Poeciliidae - livebearers							
Gambusia affinis (Baird and Girard, 1853)	--	5	14	13	10	2	8
Atherinidae - silversides							
Labidesthes sicculus (Cope, 1865)	0	0	--	--	--	--	1
Menidia beryllina (Cope, 1866)	--	--	--	0	--	--	--
Percichthyidae - temperate basses							
Morone chrysops (Rafinesque, 1820)	--	1	--	2	--	--	--
Morone mississippiensis Jordan and Eigenmann,	--	--	--	2	--	--	--
Morone saxatilis (Walbaum, 1792)	--	1	--	--	--	--	--
Centrarchidae - sunfishes							
Ambloplites ariommus Viosca, 1936	1	--	--	--	--	--	--
Elassoma zonatum Jordan, 1877	--	--	--	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	3	--	1	1	11	--	0
Lepomis gulosus (Cuvier, 1829)	--	--	--	0	6	0	1
Lepomis humilis (Girard, 1858)	--	--	1	--	0	2	0
Lepomis macrochirus Rafinesque, 1819	0	3	--	3	21	13	3
Lepomis marginatus (Holbrook, 1855)	--	--	--	--	--	--	--
Lepomis megalotis (Rafinesque, 1820)	17	4	--	1	31	0	9
Lepomis microlophus (Gunther, 1859)	--	0	--	--	2	--	--
Lepomis miniatus Evermann, 1899	--	--	--	--	5	--	0
Lepomis hybrid	--	--	--	--	0	--	--
Lepomis species	4	3	8	20	0	--	0
Micropterus punctulatus (Rafinesque, 1819)	7	--	--	0	--	--	0
Micropterus salmoides (Lacepede, 1802)	0	3	1	--	2	10	2
Micropterus species	--	--	--	--	0	--	--
Pomoxis annularis Rafinesque, 1818	--	4	8	3	--	7	0
Pomoxis nigromaculatus (Lesueur, 1829)	--	0	--	--	--	5	0
Percidae - perches							
Ammocrypta vivax Hay, 1882	--	--	--	--	--	--	--
Etheostoma asprigene (Forbes, 1878)	--	1	--	--	--	--	--
Etheostoma chlorosomum (Hay, 1881)	0	0	--	--	--	--	--
Etheostoma gracile (Girard, 1859)	--	--	--	--	--	--	--
Etheostoma histrio Jordan and Gilbert, 1887	--	--	--	--	--	--	--
Etheostoma proeliare (Hay, 1881)	--	--	--	--	0	--	--
Percina caprodes (Rafinesque, 1818)	--	--	--	--	--	--	--
Percina maculata (Girard, 1859)	--	--	--	--	--	--	--
Percina sciera (Swain, 1883)	1	--	--	--	--	--	0
Sciaenidae - drums							
Aplodinotus grunniens Rafinesque, 1819	0	9	2	4	0	1	2
Unclassified fishes							
Unknown fry	--	--	--	--	--	--	--
Number of individuals	342	598	167	293	508	261	731
Number of taxa	27	32	19	25	17	18	35

Table 9. Continued

SCIENTIFIC NAME	St. Francis River at Lake City, AR	St. Francis River near Coldwater, AR	St. John's Ditch near Sikeston, MO	Steele Bayou East Prong near Rolling Fork, MS	Tensas River at Tendale, LA	Tyronza River near Twist, AR	Village Creek near Swifton, AR	Yazoo River below Steele Bayou near Long Lake, MS
Lepisosteidae - gars								
Lepisosteus oculatus (Winchell, 1864)	0	5	0	1	2	1	5	--
Lepisosteus osseus (Linnaeus, 1758)	0	--	--	0	--	--	--	0
Lepisosteus platostomus Rafinesque, 1820	0	3	--	0	1	--	0	0
Lepisosteus species	--	--	--	0	--	--	--	--
Amiidae - bowfins								
Amia calva Linnaeus, 1766	--	--	1	--	--	--	0	--
Anguillidae - freshwater eels								
Anguilla rostrata (Lesueur, 1817)	--	--	--	--	--	--	--	--
Clupeidae - herrings								
Dorosoma cepedianum (Lesueur, 1818)	3	2	1	0	2	3	--	9
Dorosoma petenense (Gunther, 1867)	--	4	--	--	--	19	--	44
Dorosoma species	--	--	--	6	--	8	--	--
Cyprinidae - carps and minnows								
Ctenopharyngodon idella (Valenciennes, 1844)	--	--	--	--	--	--	--	--
Cyprinella camura (Jordan and Meek, 1884)	--	--	--	--	--	--	--	0
Cyprinella lutrensis (Baird and Girard, 1853)	--	--	--	--	1	--	--	--
Cyprinella spiloptera (Cope, 1868)	--	--	--	--	--	--	--	--
Cyprinella venusta Girard, 1856	1	50	6	--	--	39	--	--
Cyprinus carpio Linnaeus, 1758	3	3	6	0	1	2	--	0
Cyprinidae species	1	--	--	--	--	--	--	--
Hybognathus hayi Jordan, 1885	--	--	--	--	--	1	--	--
Hybognathus nuchalis Agassiz, 1855	--	--	--	--	--	--	--	--
Lythrurus fumeus (Evermann, 1892)	2	--	6	--	--	--	--	--
Macrhybopsis aestivalis (Girard, 1856)	--	--	--	--	--	--	--	--
Macrhybopsis storeriana (Kirtland, 1847)	--	--	--	--	--	--	--	1
Notemigonus crysoleucas (Mitchill, 1814)	0	--	--	--	--	--	--	--
Notropis atherinoides Rafinesque, 1818	--	5	--	--	--	2	--	8
Notropis buchanani Meek, 1896	--	--	--	--	7	1	--	0
Notropis chalybaeus (Cope, 1869)	--	--	--	--	--	--	--	--
Notropis maculatus (Hay, 1881)	--	--	--	--	--	--	1	--
Notropis texanus (Girard, 1856)	--	--	--	--	--	--	--	--
Notropis volucellus (Cope, 1865)	0	2	--	--	--	--	--	0
Notropis species	--	--	--	--	--	--	--	--
Opsopoeodus emiliae Hay, 1881	--	--	--	3	--	0	--	--
Pimephales notatus (Rafinesque, 1820)	1	--	--	--	--	--	--	--
Pimephales vigilax (Baird and Girard, 1856)	16	1	--	--	3	0	--	0
Catostomidae - suckers								
Carpiodes carpio (Rafinesque, 1820)	--	2	--	0	--	--	--	--
Carpiodes cyprinus Lesueur, 1817	--	--	--	--	--	--	--	--
Ictiobus bubalus (Rafinesque, 1818)	2	--	1	1	12	0	--	0
Ictiobus cyprinellus (Valenciennes, 1844)	2	--	--	1	--	--	--	--
Ictiobus niger (Rafinesque, 1819)	0	2	4	0	1	--	--	--
Ictiobus species	--	--	--	1	--	--	--	--
Minytrema melanops (Rafinesque, 1820)	--	--	--	--	--	--	1	--
Moxostoma macrolepidotum (Leuseur, 1817)	--	--	--	--	--	--	--	--
Moxostoma species	--	--	--	--	--	--	--	--
Ictaluridae - bullhead catfishes								
Ameiurus melas (Rafinesque, 1820)	--	--	--	--	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	--	--	0	--	--	--	0	--
Ictalurus furcatus (Lesueur, 1840)	--	3	--	--	2	--	--	0
Ictalurus punctatus (Rafinesque, 1818)	0	2	1	0	0	1	--	2
Noturus gyrinus (Mitchill, 1817)	--	--	--	--	--	--	--	--
Noturus nocturnus Jordan and Gilbert, 1886	--	1	--	--	--	--	--	--
Pylodictis olivaris (Rafinesque, 1818)	--	1	--	--	--	1	--	0

Table 9. Continued

SCIENTIFIC NAME	St. Francis River at Lake City, AR	St. Francis River near Coldwater, AR	St. John's Ditch near Sikeston, MO	Steele Bayou East Prong near Rolling Fork, MS	Tensas River at Tendale, LA	Tyronza River near Twist, AR	Village Creek near Swifton, AR	Yazoo River below Steele Bayou near Long Lake, MS
Esocidae - pikes								
Esox americanus vermiculatus Lesueur, 1846	--	--	1	--	--	--	--	--
Aphredoderidae - pirate perches								
Aphredoderus sayanus (Gilliams, 1824)	1	--	1	--	0	--	1	0
Cyprinodontidae - killifishes								
Fundulus chrysotus (Gunther, 1866)	--	--	--	--	--	--	--	--
Fundulus notatus (Rafinesque, 1820)	--	--	--	--	--	--	--	--
Fundulus olivaceus (Storer, 1845)	4	--	4	--	--	--	1	0
Fundulus species	--	--	--	--	--	--	--	--
Poeciliidae - livebearers								
Gambusia affinis (Baird and Girard, 1853)	4	4	41	50	31	19	6	6
Atherinidae - silversides								
Labidesthes sicculus (Cope, 1865)	--	--	--	--	--	--	--	0
Menidia beryllina (Cope, 1866)	--	--	--	--	--	--	--	0
Percichthyidae - temperate basses								
Morone chrysops (Rafinesque, 1820)	0	--	--	0	--	--	--	0
Morone mississippiensis Jordan and Eigenmann,	--	--	--	0	--	--	--	--
Morone saxatilis (Walbaum, 1792)	--	--	--	--	--	--	--	--
Centrarchidae - sunfishes								
Ambloplites ariommus Viosca, 1936	0	--	0	--	--	--	--	--
Elassoma zonatum Jordan, 1877	--	--	0	--	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	2	--	0	1	1	0	4	0
Lepomis gulosus (Cuvier, 1829)	2	--	2	--	0	--	2	1
Lepomis humilis (Girard, 1858)	0	--	--	4	2	0	1	0
Lepomis macrochirus Rafinesque, 1819	10	--	7	2	--	--	47	15
Lepomis marginatus (Holbrook, 1855)	--	--	--	--	--	--	1	--
Lepomis megalotis (Rafinesque, 1820)	17	1	9	1	1	--	9	0
Lepomis microlophus (Gunther, 1859)	--	--	--	--	--	--	11	--
Lepomis miniatus Evermann, 1899	--	--	2	--	--	--	4	--
Lepomis hybrid	--	--	--	--	--	--	--	--
Lepomis species	2	--	--	22	24	2	--	0
Micropterus punctulatus (Rafinesque, 1819)	6	1	1	0	--	--	--	--
Micropterus salmoides (Lacepede, 1802)	1	1	3	1	--	--	4	0
Micropterus species	--	--	--	--	--	--	--	--
Pomoxis annularis Rafinesque, 1818	1	1	--	3	3	0	--	6
Pomoxis nigromaculatus (Lesueur, 1829)	0	--	1	1	0	--	1	0
Percidae - perches								
Ammocrypta vivax Hay, 1882	1	--	--	--	--	--	--	--
Etheostoma asprigene (Forbes, 1878)	0	--	--	--	--	--	--	--
Etheostoma chlorosomum (Hay, 1881)	12	--	--	--	--	--	1	--
Etheostoma gracile (Girard, 1859)	0	--	--	--	--	--	--	--
Etheostoma histrio Jordan and Gilbert, 1887	--	--	0	--	--	--	--	--
Etheostoma proeliare (Hay, 1881)	0	--	--	--	--	--	--	--
Percina caprodes (Rafinesque, 1818)	--	--	--	--	--	--	--	--
Percina maculata (Girard, 1859)	4	--	--	--	--	--	--	--
Percina sciera (Swain, 1883)	--	--	1	--	--	--	--	--
Sciaenidae - drums								
Aplodinotus grunniens Rafinesque, 1819	1	8	1	2	6	1	--	3
Unclassified fishes								
Unknown fry	--	--	--	--	--	--	--	--
Number of individuals	585	131	341	1176	250	507	290	1908
Number of taxa	36	21	27	24	20	18	20	31

Table 10. Results of the ten species richness and composition metrics for fish communities collected at the thirty-six sites within the Mississippi Alluvial Plain Ecoregion, 1998.

Site Name	Total number of taxa	Number of minnow taxa	Average standard length of *Lepomis* *(mm)*	Percent of buffalo species	Ratio tol/intol taxa
Bayou DeView at Morton, AR	26	5	81.1	6.2	2.4
Bayou Macon near Delhi, LA	16	2	47.5	0.0	8.0
Bayou Macon near Halley, AR	24	4	50.2	8.1	6.0
Bayou Meto near Bayou Meto, AR	32	4	58.8	7.3	2.0
Big Creek at Poplar Grove, AR	29	4	69.2	11.5	3.0
Big Creek near Sligo, LA	23	3	64.3	0.5	5.5
Big Sunflower River at Sunflower, MS	21	2	21.9	2.4	5.5
Big Sunflower River near Anguilla, MS	19	0	56.7	14.1	11.0
Boeuf River near Arkansas/LA State Line, LA	22	3	63.6	2.7	10.0
Bogue Phalia near Leland, MS	22	3	35.2	3.0	2.8
Cache River at Egypt, AR	19	2	23.4	13.2	4.5
Cache River near Cotton Plant, AR	32	5	76.3	5.9	3.8
Cassidy Bayou at Webb, MS	17	1	42.7	2.5	4.0
Cockle Burr Slough Ditch near Monette, AR	35	9	68.1	0.6	1.5
Coldwater River at Marks, MS	26	7	34.4	1.0	3.0
Deer Creek near Hollandale, MS	16	1	61.0	0.0	8.0
Elk Chute near Gobler, MO	29	6	50.7	0.7	2.2
LaGrue Bayou near Dewitt, AR	27	2	94.8	4.5	4.3
L'Anguille River near Palestine, AR	31	5	55.5	23.2	3.3
Little River Ditch no. 1 near Morehouse, MO	32	6	70.1	1.6	1.6
Little River Ditch no. 251 near Lilbourn, MO	37	4	62.1	2.2	2.0
Main Ditch at Hwy. 153 near White Oak, MO	27	9	66.2	0.9	1.0
Obion Creek near Hickman, KY	32	5	60.9	3.8	2.0
Quiver River near Doddsville, MS	19	2	20.3	13.2	5.0
Running Reelfoot Bayou at Hwy 103, TN	25	3	32.2	0.7	11.0
Second Creek near Palestine, AR	19	1	76.5	0.0	4.0
Silver Creek near Bayland, MS	18	2	60.4	10.0	8.0
Spillway Ditch at Hwy 102 near East Prairie, MO	35	8	76.8	2.7	2.0
St. Francis River at Lake City, AR	36	7	77.4	4.1	1.4
St. Francis River near Coldwater, AR	21	4	84.0	2.3	1.8
St. Johns Ditch near Sikeston, MO	27	2	89.5	5.0	2.4
Steele Bayou East Prong near Rolling Fork, MS	24	1	37.2	2.6	3.7
Tensas River at Tendal, LA	20	3	26.5	12.8	12.0
Tyronza River near Twist, AR	18	6	21.6	0.2	3.5
Village Creek near Swifton, AR	20	1	92.6	0.0	5.0
Yazoo River below Steele Bayou near Long Lake, MS	31	6	52.5	0.1	2.2
MIN	16	0	20.3	0.0	1.0
MAX	37	9	94.8	23.2	12.0
MEAN	25	4	57.3	4.7	4.4
MEDIAN	25	4	60.6	2.6	3.6
ST. DEVI	6.2	2	21.1	5.4	3.0

Table 10. Continued.

Site Neme	Number of tolerant taxa	Number of intolerent taxe	Percent of carp	Shannon diversity	Eveness
Bayou DeView at Morton, AR	12	5	4.1	3.74	0.796
Bayou Macon near Delhi, LA	8	1	0.7	3.09	0.772
Bayou Macon near Halley, AR	12	2	2.9	2.71	0.590
Bayou Meto near Bayou Meto, AR	12	6	3.6	4.22	0.845
Big Creek at Poplar Grove, AR	12	4	4.1	3.86	0.794
Big Creek near Sligo, LA	11	2	3.4	2.67	0.590
Big Sunflower River at Sunflower, MS	11	2	4.5	2.56	0.583
Big Sunflower River near Anguilla, MS	11	1	2.1	3.42	0.805
Boeuf River near Arkansas/LA State Line, LA	10	1	3.7	2.82	0.633
Bogue Phalia near Leland, MS	11	4	2.6	3.51	0.788
Cache River at Egypt, AR	9	2	3.4	2.80	0.658
Cache River near Cotton Plant, AR	15	4	4.3	4.18	0.836
Cassidy Bayou at Webb, MS	8	2	1.9	1.32	0.323
Cockle Burr Slough Ditch near Monette, AR	12	8	1.7	3.63	0.709
Coldwater River at Marks, MS	12	4	9.8	2.91	0.619
Deer Creek near Hollandale, MS	8	1	2.1	2.33	0.582
Elk Chute near Gobler, MO	13	6	0.2	2.91	0.599
LaGrue Bayou near Dewitt, AR	13	3	1.7	3.66	0.769
L'Anguille River near Palestine, AR	13	4	10.7	4.07	0.822
Little River Ditch no. 1 near Morehouse, MO	11	7	1.4	3.83	0.766
Little River Ditch no. 251 near Lilbourn, MO	14	7	1.4	3.60	0.692
Main Ditch at Hwy. 153 near White Oak, MO	9	9	1.2	3.61	0.758
Obion Creek near Hickman, KY	10	5	12.2	4.07	0.814
Quiver River near Doddsville, MS	10	2	22.2	3.32	0.783
Running Reelfoot Bayou at Hwy 103, TN	11	1	2.4	3.20	0.689
Second Creek near Palestine, AR	8	2	0.0	2.99	0.703
Silver Creek near Bayland, MS	8	1	3.1	3.20	0.768
Spillway Ditch at Hwy 102 near East Prairie, MO	12	6	0.7	3.51	0.684
St. Francis River at Lake City, AR	14	10	3.1	3.94	0.761
St. Francis River near Coldwater, AR	7	4	3.1	2.98	0.678
St. Johns Ditch near Sikeston, MO	12	5	5.9	3.34	0.703
Steele Bayou East Prong near Rolling Fork, MS	11	3	0.3	2.00	0.435
Tensas River at Tendal, LA	12	1	0.8	3.05	0.707
Tyronza River near Twist, AR	7	2	1.8	2.37	0.569
Village Creek near Swifton, AR	10	2	0.0	2.89	0.669
Yazoo River below Steele Bayou near Long Lake, MS	11	5	0.2	2.80	0.564
MIN	7	1	0.0	1.32	0.323
MAX	15	10	22.2	4.22	0.845
MEAN	11	4	3.5	3.20	0.690
MEDIAN	11	4	2.5	3.20	0.703
ST. DEVI	2	2	4.3	0.64	0.114

Table 11. Results of the three trophic composition and seven fish abundance and condition metrics for fish communities collected at the thirty-six sites within the Mississippi Alluvial Plain Ecoregion, 1998.

Site Name	Relative abundance of top carnivores	Relative abundance of omnivores	Relative abundance of insectivores	Abundance	Average standard length of black bass (mm)
Bayou DeView at Morton, AR	0.1400	0.1035	0.1202	657	185.9
Bayou Macon near Delhi, LA	0.0548	0.0129	0.1032	310	81.2
Bayou Macon near Halley, AR	0.0179	0.1201	0.0536	616	43.0
Bayou Meto near Bayou Meto, AR	0.1290	0.1091	0.1270	504	44.9
Big Creek at Poplar Grove, AR	0.1152	0.1599	0.2379	269	191.8
Big Creek near Sligo, LA	0.1446	0.0441	0.0907	408	64.2
Big Sunflower River at Sunflower, MS	0.0727	0.0796	0.1834	289	31.2
Big Sunflower River near Anguilla, MS	0.1162	0.0954	0.0622	482	234.0
Boeuf River near Arkansas/LA State Line, LA	0.0811	0.0665	0.0748	481	51.0
Bogue Phalia near Leland, MS	0.0547	0.0578	0.0410	951	33.0
Cache River at Egypt, AR	0.0501	0.1794	0.1187	379	0.0
Cache River near Cotton Plant, AR	0.1349	0.1298	0.2214	393	121.0
Cassidy Bayou at Webb, MS	0.0177	0.0250	0.0365	959	47.0
Cockle Burr Slough Ditch near Monette, AR	0.0487	0.0449	0.0861	534	151.4
Coldwater River at Marks, MS	0.1508	0.1311	0.1246	305	37.0
Deer Creek near Hollandale, MS	0.0677	0.0286	0.0885	384	89.0
Elk Chute near Gobler, MO	0.0382	0.0291	0.2473	550	142.9
LaGrue Bayou near Dewitt, AR	0.2051	0.0758	0.0421	356	91.9
L'Anguille River near Palestine, AR	0.1453	0.3668	0.1903	289	179.8
Little River Ditch no. 1 near Moorehouse, MO	0.0862	0.0443	0.3054	429	138.4
Little River Ditch no. 251 near Lilbourn, MO	0.0408	0.0480	0.1849	833	149.6
Main Ditch at Hwy. 153 near White Oak, MO	0.0848	0.0468	0.4269	342	137.3
Obion Creek near Hickman, KY	0.1120	0.2542	0.1288	598	263.6
Quiver River near Doddsville, MS	0.2096	0.3114	0.1737	167	27.0
Running Reelfoot Bayou at Hwy 103, TN	0.1160	0.0375	0.1195	293	102.0
Second Creek near Palestine, AR	0.0571	0.0000	0.1339	508	132.2
Silver Creek near Bayland, MS	0.2184	0.1264	0.3295	261	61.8
Spillway Ditch at Hwy 102 near East Prairie, MO	0.0383	0.0547	0.2052	731	142.2
St. Francis River at Lake City, AR	0.0838	0.0735	0.1983	585	163.1
St. Francis River near Coldwater, AR	0.1450	0.0992	0.3664	131	118.0
St. Johns Ditch near Sikeston, MO	0.0762	0.1173	0.1965	341	197.8
Steele Bayou East Prong near Rolling Fork, MS	0.0553	0.0230	0.0519	1176	62.3
Tensas River at Tendal, LA	0.0760	0.1560	0.1320	250	0.0
Tyronza River near Twist, AR	0.0197	0.0256	0.1617	507	0.0
Village Creek near Swifton, AR	0.1034	0.0034	0.0966	290	177.6
Yazoo River below Steele Bayou near Long Lake, MS	0.0545	0.0294	0.0849	1908	91.5
MIN	0.0177	0.0000	0.0365	131	0.0
MAX	0.2184	0.3668	0.4269	1908	263.6
MEAN	0.0934	0.0919	0.1540	513	105.1
MEDIAN	0.0825	0.0700	0.1279	419	96.9
ST. DEVI	0.0532	0.0825	0.0938	332	68.4

Table 11. Continued

Site Name	Average standard lengths of all individuals (mm)	Total fish biomass (kg)	Percent of biomass buffalo and carp	Relative abundance of fish with anomalies	Percent contribution by dominant taxa
Bayou DeView at Morton, AR	134.5	147.1	69.8	0.1096	22.4
Bayou Macon near Delhi, LA	55.9	14.3	43.3	0.0194	26.1
Bayou Macon near Halley, AR	136.7	108.7	84.6	0.0276	49.0
Bayou Meto near Bayou Meto, AR	120.5	135.7	67.1	0.0258	38.7
Big Creek at Poplar Grove, AR	141.7	71.2	74.8	0.0818	27.5
Big Creek near Sligo, LA	113.2	41.4	58.3	0.0147	53.2
Big Sunflower River at Sunflower, MS	101.4	40.5	74.0	0.0242	42.9
Big Sunflower River near Anguilla, MS	172.2	89.4	69.8	0.0415	34.9
Boeuf River near Arkansas/LA State Line, LA	153.1	61.1	60.5	0.0187	44.7
Bogue Phalia near Leland, MS	105.3	53.7	81.7	0.0189	55.3
Cache River at Egypt, AR	166.6	90.6	83.7	0.0369	35.9
Cache River near Cotton Plant, AR	130.1	107.8	73.7	0.0840	18.3
Cassidy Bayou at Webb, MS	69.4	25.3	77.8	0.0042	70.0
Cockle Burr Slough Ditch near Monette, AR	91.1	53.7	51.7	0.0356	26.2
Coldwater River at Marks, MS	116.8	56.1	88.9	0.0426	46.6
Deer Creek near Hollandale, MS	114.8	30.1	47.0	0.0469	46.1
Elk Chute near Gobler, MO	76.8	28.4	24.0	0.0127	37.5
LaGrue Bayou near Dewitt, AR	142.0	178.8	67.9	0.0787	23.9
L'Anguille River near Palestine, AR	211.9	93.1	89.0	0.0969	18.0
Little River Ditch no. 1 near Moorehouse, MO	93.7	39.0	31.1	0.0396	28.4
Little River Ditch no. 251 near Lilbourn, MO	90.3	68.1	46.1	0.0252	28.5
Main Ditch at Hwy. 153 near White Oak, MO	76.4	19.7	57.0	0.0175	22.8
Obion Creek near Hickman, KY	169.3	152.6	61.0	0.0569	21.2
Quiver River near Doddsville, MS	167.7	78.7	72.8	0.0479	22.2
Running Reelfoot Bayou at Hwy 103, TN	111.0	25.0	38.3	0.0273	31.7
Second Creek near Palestine, AR	80.9	15.2	0.0	0.0157	31.1
Silver Creek near Bayland, MS	107.6	60.4	80.9	0.0307	34.9
Spillway Ditch at Hwy 102 near East Prairie, MO	95.5	40.2	47.0	0.0109	30.2
St. Francis River at Lake City, AR	106.6	123.8	73.9	0.0188	17.3
St. Francis River near Coldwater, AR	146.9	29.4	33.9	0.0534	49.6
St. Johns Ditch near Sikeston, MO	130.9	51.9	70.1	0.0176	40.8
Steele Bayou East Prong near Rolling Fork, MS	86.2	40.4	65.4	0.0264	49.7
Tensas River at Tendal, LA	141.2	57.6	79.1	0.0360	31.2
Tyronza River near Twist, AR	78.5	19.7	72.7	0.0178	39.3
Village Creek near Swifton, AR	106.8	20.7	0.0	0.0241	46.6
Yazoo River below Steele Bayou near Long Lake, MS	64.9	33.8	25.8	0.0241	43.8
MIN	55.9	14.3	0.0	0.0042	17.3
MAX	211.9	178.8	89.0	0.1096	70.0
MEAN	116.9	64.0	59.5	0.0364	35.7
MEDIAN	112.1	53.7	67.5	0.0268	34.9
ST. DEVI	35.4	42.9	23.0	0.0254	12.3

Table 12. Basin parameters calculated for the thirty-six sites sampled within the Mississippi Alluvial Plain Ecoregion, 1998. [*, indicates sites that were dropped from the multivariate analysis]

Site Name	Drainage area (km^2)	Elevation (meters above sea level)	Segment gradient (m)	Average runoff (cm)	Average precipitation (cm)	Population	Pop/acre
Bayou DeView at Morton, AR	1080.7	57	0.001	43	127	30715	9
Bayou Macon near Delhi, LA	2141.3	15	0.001	43	137	16789	30
Bayou Macon near Halley, AR	376.3	40	0.001	43	127	3787	24
Bayou Meto near Bayou Meto, AR	2078.0	47	0.500	46	127	5500	93
Big Creek at Poplar Grove, AR	1160.3	44	0.600	48	127	6651	43
Big Creek near Sligo, LA	1310.8	11	0.710	41	137	20098	16
Big Sunflower River at Sunflower, MS	2009.6	28	0.001	46	137	57725	9
Big Sunflower River near Anguilla, MS *	6675.3	16	0.001	46	137	119461	14
Boeuf River near Arkansas/LA State Line, LA	1822.3	22	0.001	41	137	28410	16
Bogue Phalia near Leland, MS	1301.3	26	0.760	46	137	15307	21
Cache River at Egypt, AR	1792.4	68	0.001	41	117	11633	38
Cache River near Cotton Plant, AR *	2995.5	50	0.001	46	127	4643	63
Cassidy Bayou at Webb, MS	535.9	39	0.330	51	137	5500	24
Cockle Burr Slough Ditch near Monette, AR	146.0	71	0.001	46	127	1670	22
Coldwater River at Marks, MS *	4936.6	37	0.001	53	137	94857	13
Deer Creek near Hollandale, MS	230.8	29	0.001	46	137	5893	10
Elk Chute near Gobler, MO	218.2	79	0.001	46	117	2085	26
LaGrue Bayou near Dewitt, AR	594.1	53	1.660	46	127	1940	76
L'Anguille River near Palestine, AR	1982.8	51	0.700	46	127	24492	20
Little River Ditch no. 1 near Morehouse, MO	1143.8	86	0.990	46	117	11970	23
Little River Ditch no. 251 near Lilbourn, MO	626.5	80	0.820	48	117	11198	14
Main Ditch at Hwy. 153 near White Oak, MO	356.0	83	0.001	46	117	9415	9
Obion Creek near Hickman, KY	784.0	92	0.560	48	127	8756	22
Quiver River near Doddsville, MS	651.4	30	0.001	48	137	4443	36
Running Reelfoot Bayou at Hwy 103, TN	751.3	83	0.250	46	117	6627	28
Second Creek near Palestine, AR	111.7	60	1.060	46	127	269967	0.1
Silver Creek near Bayland, MS	47.9	32	0.130	46	137	691	17
Spillway Ditch at Hwy 102 near East Prairie, MO	186.3	91	0.001	51	117	6325	7
St. Francis River at Lake City, AR *	6149.6	66	0.570	46	127	100236	15
St. Francis River near Coldwater, AR *	13774.1	66	0.400	46	127	249136	13
St. Johns Ditch near Sikeston, MO	101.2	94	0.001	46	117	932	24
Steele Bayou East Prong near Rolling Fork, MS	1121.6	23	1.720	46	127	55693	5
Tensas River at Tendal, LA	721.0	15	0.001	43	137	8331	22
Tyronza River near Twist, AR	1368.4	65	0.001	46	127	20831	16
Village Creek near Swifton, AR	410.5	76	0.210	41	117	8886	11
Yazoo River below Steele Bayou near Long Lake, MS *	34850.0	31	0.001	43	137	553326	16
MIN	47.9	11	0.001	41	117	691	0.1
MAX	34850.0	94	1.720	53	137	553326	93
MEAN	2681.8	52	0.333	46	128	49553	23
MEDIAN	1101.2	50	0.001	46	127	10307	19
ST. DEVI	6091.2	25.3	0.469	2.8	8.0	106527.6	19

Table 13. Percent contribution by each crop type within each of the thirty-six drainage basins of the Mississippi Alluvial Plain Ecoregion. 1998.

Basin Name	Soybeans	Cotton	Rice	Corn	Other (oats, sorghum, wheat)
Bayou Deview at Morton, AR	21.7	11.1	13.8	0.9	25.7
Bayou Macon near Delhi, LA	21.4	19.2	7.6	1.2	28.0
Bayou Macon near Halley, AR	26.0	19.0	10.7	0.2	29.9
Bayou Meto near Bayou Meto, AR	23.4	3.2	12.1	0.2	15.5
Big Creek at Poplar Grove, AR	28.3	14.2	12.9	0.3	27.5
Big Creek near Sligo, LA	5.3	31.4	2.5	1.5	35.4
Big Sunflower River at Sunflower, MS	29.9	17.9	7.2	0.5	25.7
Big Sunflower River near Anguilla, MS	27.2	17.5	7.2	0.9	25.6
Boeuf River near Arkansas/LA State Line, LA	26.3	17.7	10.3	0.3	28.4
Bogue Phalia near Leland, MS	33.0	11.8	11.6	0.4	23.8
Cache River at Egypt, AR	24.4	6.6	14.7	5.4	26.8
Cache River near Cotton Plant, AR	35.4	3.8	16.9	1.3	22.0
Cassidy Bayou at Webb, MS	32.1	20.7	5.3	0.7	26.7
Cockle Burr Slough Ditch near Monette, AR	18.5	32.6	4.5	1.6	38.8
Coldwater River at Marks, MS	16.4	9.1	2.3	2.1	13.4
Deer Creek near Holandale, MS	28.5	15.0	10.2	1.4	26.6
Elk Chute near Gobler, MO	40.1	21.7	1.0	4.7	27.4
LaGrue Bayou near Dewitt, AR	33.3	0.8	17.5	0.4	18.7
L'Anguilla River near Palestine, AR	32.7	5.5	16.4	0.3	22.1
Little River Ditch no. 1 near Morehouse, MO	18.7	5.9	3.3	11.7	20.9
Little River Ditch no. 251 near Lilbourn, MO	25.3	13.1	11.6	6.3	30.9
Main Ditch at Hwy 153 near Whit Oak, MO	4.0	16.6	10.6	25.2	31.3
Obion Creek near Hickman, KY	12.4	0.0	0.0	9.8	9.8
Quiver River near Doddsville, MS	25.3	20.6	6.0	1.5	28.1
Running Reelfoot Bayou at Hwy 103, TN	17.1	0.0	0.0	9.9	9.9
Second Creek near Palestine, AR	34.1	2.6	12.3	0.6	15.5
Silver Creek near Bayland, MS	11.2	18.3	1.6	2.1	22.0
Spillway Ditch at Hwy 102 near East Prairie, MO	44.0	1.7	0.0	16.7	18.4
St. Francis River at Lake City, AR	7.7	4.1	3.3	2.9	10.3
St. Francis River near Coldwater, AR	17.7	10.0	5.6	5.3	20.9
St. Johns Ditch near Sikeston, MO	33.0	5.0	0.0	18.4	23.4
Steele Bayou East Prong near Rolling Fork, MS	20.0	16.5	5.3	1.1	22.9
Tensas River at Tendal, LA	19.8	17.7	3.6	6.0	27.4
Tyronza River near Twist, AR	30.0	26.1	4.4	0.4	30.9
Village Creek near Swifton, AR	37.9	0.1	26.1	1.1	27.3
Yazoo River below Steele Bayou near Long Lake, MS	13.0	10.5	2.4	1.2	14.2
MIN	4.0	0.0	0.0	0.2	9.8
MAX	44.0	32.6	26.1	25.2	38.8
MEAN	24.3	12.4	7.8	4.0	23.7
MEDIAN	25.3	12.4	6.6	1.3	25.7
ST. DEV	9.7	8.8	6.1	5.8	6.9

Table 14. Percentage urban land use, listed by type, for thirty-six drainage basins within the Mississippi Alluvial Plain Ecoregion, 1998.

Stream Basin Name	Low intensity residential	High intensity residential	High intensity commercial	Total urban
Bayou DeView at Morton, AR	1.1	0.6	0.3	2.0
Bayou Macon near Delhi, LA	0.3	0.0	0.1	0.4
Bayou Macon near Halley, AR	0.6	0.1	0.2	0.8
Bayou Meto near Bayou Meto, AR	2.8	0.8	1.0	4.6
Big Creek at Poplar Grove, AR	0.7	0.2	0.3	1.3
Big Creek near Sligo, LA	0.6	0.0	0.4	1.0
Big Sunflower River at Sunflower, MS	1.2	0.2	0.3	1.8
Big Sunflower River near Anguilla, MS	0.7	0.1	0.3	1.1
Boeuf River near Arkansas/LA State Line, LA	0.7	0.1	0.4	1.2
Bogue Phalia near Leland, MS	0.4	0.1	0.2	0.7
Cache River at Egypt, AR	0.1	0.0	0.2	0.4
Cache River near Cotton Plant, AR	0.1	0.1	0.2	0.4
Cassidy Bayou at Webb, MS	0.5	0.1	0.1	0.7
Cockle Burr Slough Ditch near Monette, AR	0.2	0.2	0.2	0.6
Coldwater River at Marks, MS	0.7	0.1	0.2	1.0
Deer Creek near Hollandale, MS	1.2	0.1	0.4	1.8
Elk Chute near Gobler, MO	0.5	0.1	0.7	1.3
LaGrue Bayou near Dewitt, AR	0.1	0.0	0.2	0.3
L'Anguille River near Palestine, AR	0.4	0.1	0.2	0.7
Little River Ditch no. 1 near Morehouse, MO	0.4	0.1	0.1	0.6
Little River Ditch no. 251 near Lilbourn, MO	1.2	0.5	0.4	2.1
Main Ditch at Hwy 153 near White Oak, MO	0.9	0.6	0.5	2.0
Obion Creek near Hickman, KY	0.4	0.0	0.1	0.5
Quiver River near Doddsville, MS	0.2	0.0	0.1	0.3
Running Reelfoot Bayou at Hwy 103, TN	0.3	0.0	0.1	0.4
Second Creek near Palestine, AR	0.0	0.0	0.0	0.0
Silver Creek near Bayland, MS	0.9	0.1	0.1	1.1
Spillway Ditch at Hwy 102 near East Prairie, MO	1.9	0.3	0.6	2.8
St. Francis River at Lake City, AR	0.7	0.2	0.3	1.1
St. Francis River near Coldwater, AR	0.7	0.3	0.4	1.4
St. Johns Ditch near Sikeston, MO	1.0	0.3	0.4	1.6
Steele Bayou East Prong near Rolling Fork, MS	0.2	0.0	0.1	0.4
Tensas River at Tendal, LA	0.5	0.0	0.1	0.7
Tyronza River near Twist, AR	0.6	0.3	0.6	1.4
Village Creek near Swifton, AR	1.0	0.5	1.1	2.6
Yazoo River below Steele Bayou near Long Lake, MS	0.6	0.1	0.2	0.9
MIN	0.0	0.0	0.0	0.0
MAX	2.8	0.8	1.1	4.6
MEAN	0.7	0.2	0.3	1.2
MEDIAN	0.6	0.1	0.2	1.0
ST. DEVI	0.5	0.2	0.2	0.9

Table 15. Percentage forest land use, listed by type, for thirty-six drainage basins within the Mississippi Alluvial Plain Ecoregion, 1998.

Stream Basin Name	Deciduous forest	Evergreen forest	Mixed forest	Total forest
Bayou DeView at Morton, AR	6.9	1.1	2.2	10.2
Bayou Macon near Delhi, LA	1.3	0.7	3.3	5.2
Bayou Macon near Halley, AR	1.4	0.3	1.6	3.4
Bayou Meto near Bayou Meto, AR	10.9	0.7	4.1	15.6
Big Creek at Poplar Grove, AR	10.6	0.5	4.8	15.9
Big Creek near Sligo, LA	1.2	1.0	9.5	11.8
Big Sunflower River at Sunflower, MS	1.0	0.2	0.6	1.8
Big Sunflower River near Anguilla, MS	0.8	0.2	0.5	1.6
Boeuf River near Arkansas/LA State Line, LA	1.2	0.3	2.3	3.8
Bogue Phalia near Leland, MS	0.8	0.1	0.4	1.3
Cache River at Egypt, AR	10.8	1.6	3.3	15.7
Cache River near Cotton Plant, AR	6.9	1.0	2.2	10.1
Cassidy Bayou at Webb, MS	0.6	0.3	0.4	1.2
Cockle Burr Slough Ditch near Monette, AR	0.7	0.0	0.1	0.8
Coldwater River at Marks, MS	16.6	3.3	5.5	25.4
Deer Creek near Hollandale, MS	0.8	0.1	0.5	1.4
Elk Chute near Gobler, MO	0.6	0.2	0.2	1.0
LaGrue Bayou near Dewitt, AR	2.2	0.3	2.3	4.8
L'Anguille River near Palestine, AR	6.2	0.3	2.8	9.3
Little River Ditch no. 1 near Morehouse, MO	8.7	0.5	2.9	12.1
Little River Ditch no. 251 near Lilbourn, MO	1.2	0.2	0.7	2.1
Main Ditch at Hwy 153 near White Oak, MO	2.6	0.1	0.7	3.4
Obion Creek near Hickman, KY	12.8	0.5	2.8	16.1
Quiver River near Doddsville, MS	0.8	0.3	0.6	1.7
Running Reelfoot Bayou at Hwy 103, TN	15.9	1.2	8.8	25.9
Second Creek near Palestine, AR	8.1	0.2	5.4	13.7
Silver Creek near Bayland, MS	0.5	0.4	0.7	1.6
Spillway Ditch at Hwy 102 near East Prairie, MO	0.9	0.3	0.8	2.0
St. Francis River at Lake City, AR	39.7	4.1	6.6	50.5
St. Francis River near Coldwater, AR	19.1	2.0	3.4	24.4
St. Johns Ditch near Sikeston, MO	4.9	0.2	2.1	7.2
Steele Bayou East Prong near Rolling Fork, MS	0.2	0.0	0.1	0.3
Tensas River at Tendal, LA	1.3	1.3	2.0	4.5
Tyronza River near Twist, AR	1.1	0.2	0.5	1.8
Village Creek near Swifton, AR	1.5	0.0	0.4	1.9
Yazoo River below Steele Bayou near Long Lake, MS	15.9	6.8	6.3	29.1
MIN	0.2	0.0	0.1	0.3
MAX	39.7	6.8	9.5	50.5
MEAN	6.0	0.9	2.5	9.4
MEDIAN	1.5	0.3	2.1	4.7
ST. DEVI	8.0	1.4	2.5	10.8

Table 16. Percentage agriculture land use, listed by type, for thirty-six drainage basins within the Mississippi Alluvial Plain Ecoregion,1998.

Stream Basin Name	Pasture and hay	Row crops	Small grains	Other grasses	Total agriculture
Bayou DeView at Morton, AR	5.6	69.9	2.9	0.1	78.6
Bayou Macon near Delhi, LA	7.2	65.8	12.1	0.6	85.7
Bayou Macon near Halley, AR	8.2	76.3	8.5	0.4	93.4
Bayou Meto near Bayou Meto, AR	6.2	50.6	4.4	0.3	61.4
Big Creek at Poplar Grove, AR	6.7	75.2	9.3	0.0	91.2
Big Creek near Sligo, LA	1.3	68.4	7.8	0.0	77.4
Big Sunflower River at Sunflower, MS	5.4	66.8	14.5	0.3	87.1
Big Sunflower River near Anguilla, MS	5.5	65.4	13.0	0.2	84.1
Boeuf River near Arkansas/LA State Line, LA	8.1	71.0	11.9	0.1	91.2
Bogue Phalia near Leland, MS	5.5	71.2	9.3	0.3	86.3
Cache River at Egypt, AR	4.6	75.0	3.0	0.0	82.6
Cache River near Cotton Plant, AR	4.0	75.0	3.6	0.1	82.7
Cassidy Bayou at Webb, MS	4.1	74.7	10.3	0.0	89.0
Cockle Burr Slough Ditch near Monette, AR	1.9	89.8	6.0	0.1	97.7
Coldwater River at Marks, MS	21.4	41.2	2.1	0.2	64.9
Deer Creek near Hollandale, MS	3.6	70.5	10.2	0.9	85.2
Elk Chute near Gobler, MO	2.1	82.2	12.6	0.1	96.9
LaGrue Bayou near Dewitt, AR	5.8	64.3	6.4	0.1	76.6
L'Anguille River near Palestine, AR	3.9	71.5	5.4	0.0	80.9
Little River Ditch no. 1 near Morehouse, MO	23.6	60.6	0.3	0.2	64.7
Little River Ditch no. 251 near Lilbourn, MO	7.7	83.7	3.5	0.1	94.9
Main Ditch at Hwy 153 near White Oak, MO	6.2	75.4	12.2	0.5	94.3
Obion Creek near Hickman, KY	45.2	31.8	0.0	0.0	77.0
Quiver River near Doddsville, MS	4.9	70.7	10.8	0.0	86.4
Running Reelfoot Bayou at Hwy 103, TN	19.5	35.7	1.5	0.1	56.8
Second Creek near Palestine, AR	3.7	60.5	4.5	0.0	68.7
Silver Creek near Bayland, MS	32.1	48.1	7.5	0.0	87.7
Spillway Ditch at Hwy 102 near East Prairie, MO	11.9	69.7	10.9	0.2	92.7
St. Francis River at Lake City, AR	14.5	26.6	1.6	0.1	42.8
St. Francis River near Coldwater, AR	9.8	54.9	4.5	0.2	69.4
St. Johns Ditch near Sikeston, MO	10.4	76.2	3.1	0.1	89.8
Steele Bayou East Prong near Rolling Fork, MS	6.8	52.9	12.9	1.0	73.6
Tensas River at Tendal, LA	12.0	59.8	14.7	0.5	87.0
Tyronza River near Twist, AR	2.6	83.5	8.4	0.2	94.7
Village Creek near Swifton, AR	1.2	89.2	3.3	0.7	94.4
Yazoo River below Steele Bayou near Long Lake, MS	14.4	36.8	4.6	0.2	55.9
MIN	1.2	26.6	0.0	0.0	42.8
MAX	45.2	89.8	14.7	1.0	97.7
MEAN	9.4	65.0	7.2	0.2	81.8
MEDIAN	6.2	69.8	6.9	0.1	85.5
ST. DEVI	9.1	15.9	4.3	0.3	12.9

Table 17. Percentage wetland land use, listed by type, for thirty-six drainage basins within the Mississippi Alluvial Plain Ecoregion, 1998.

Stream Basin Name	Woody wetlands	Herbaceous wetlands	Total wetlands
Bayou DeView at Morton, AR	7.4	0.1	7.5
Bayou Macon near Delhi, LA	6.2	0.0	6.2
Bayou Macon near Halley, AR	1.8	0.0	1.8
Bayou Meto near Bayou Meto, AR	13.3	0.4	13.7
Big Creek at Poplar Grove, AR	13.8	0.0	13.8
Big Creek near Sligo, LA	9.1	0.0	9.1
Big Sunflower River at Sunflower, MS	7.8	0.0	7.8
Big Sunflower River near Anguilla, MS	9.0	0.0	9.1
Boeuf River near Arkansas/LA State Line, LA	1.9	0.0	1.9
Bogue Phalia near Leland, MS	10.5	0.0	10.5
Cache River at Egypt, AR	0.7	0.0	0.8
Cache River near Cotton Plant, AR	6.0	0.1	6.1
Cassidy Bayou at Webb, MS	7.8	0.0	7.8
Cockle Burr Slough Ditch near Monette, AR	0.6	0.0	0.6
Coldwater River at Marks, MS	5.8	0.2	6.0
Deer Creek near Hollandale, MS	9.3	0.0	9.3
Elk Chute near Gobler, MO	0.5	0.0	0.5
LaGrue Bayou near Dewitt, AR	13.5	0.3	13.8
L'Anguille River near Palestine, AR	8.1	0.0	8.1
Little River Ditch no. 1 near Morehouse, MO	1.8	0.2	2.0
Little River Ditch no. 251 near Lilbourn, MO	0.6	0.1	0.6
Main Ditch at Hwy 153 near White Oak, MO	0.1	0.0	0.2
Obion Creek near Hickman, KY	5.9	0.0	5.9
Quiver River near Doddsville, MS	9.8	0.0	9.8
Running Reelfoot Bayou at Hwy 103, TN	9.2	1.5	10.7
Second Creek near Palestine, AR	16.1	0.1	16.2
Silver Creek near Bayland, MS	8.0	0.0	8.0
Spillway Ditch at Hwy 102 near East Prairie, MO	2.2	0.1	2.2
St. Francis River at Lake City, AR	3.9	0.1	4.0
St. Francis River near Coldwater, AR	3.5	0.1	3.6
St. Johns Ditch near Sikeston, MO	0.5	0.7	1.2
Steele Bayou East Prong near Rolling Fork, MS	1.9	0.0	1.9
Tensas River at Tendal, LA	6.6	0.0	6.6
Tyronza River near Twist, AR	1.2	0.2	1.4
Village Creek near Swifton, AR	0.8	0.0	0.8
Yazoo River below Steele Bayou near Long Lake, MS	9.9	0.1	10.1
MIN	0.1	0.0	0.2
MAX	16.1	1.5	16.2
MEAN	6.0	0.1	6.1
MEDIAN	6.1	0.0	6.1
ST. DEVI	4.5	0.3	4.5

Table 18. Percentage miscellaneous land use, listed by type, for thirty-six drainage basins within the Mississippi Alluvial Plain Ecoregion, 1998.

Stream Basin Name	Bare rock, sand, and clay	Quarries, strip mines, and gravel pits	Transitional
Bayou DeView at Morton, AR	0.03	0.00	0.24
Bayou Macon near Delhi, LA	0.00	0.01	0.01
Bayou Macon near Halley, AR	0.00	0.00	0.00
Bayou Meto near Bayou Meto, AR	0.00	0.00	0.06
Big Creek at Poplar Grove, AR	0.00	0.03	0.20
Big Creek near Sligo, LA	0.00	0.00	0.00
Big Sunflower River at Sunflower, MS	0.00	0.01	0.00
Big Sunflower River near Anguilla, MS	0.00	0.00	0.00
Boeuf River near Arkansas/LA State Line, LA	0.00	0.00	0.00
Bogue Phalia near Leland, MS	0.00	0.00	0.00
Cache River at Egypt, AR	0.03	0.01	0.14
Cache River near Cotton Plant, AR	0.02	0.01	0.09
Cassidy Bayou at Webb, MS	0.00	0.00	0.00
Cockle Burr Slough Ditch near Monette, AR	0.00	0.00	0.01
Coldwater River at Marks, MS	0.00	0.07	0.03
Deer Creek near Hollandale, MS	0.00	0.00	0.02
Elk Chute near Gobler, MO	0.00	0.00	0.01
LaGrue Bayou near Dewitt, AR	0.01	0.00	0.00
L'Anguille River near Palestine, AR	0.00	0.02	0.12
Little River Ditch no. 1 near Morehouse, MO	0.00	0.00	0.02
Little River Ditch no. 251 near Lilbourn, MO	0.00	0.00	0.02
Main Ditch at Hwy 153 near White Oak, MO	0.00	0.00	0.03
Obion Creek near Hickman, KY	0.00	0.05	0.07
Quiver River near Doddsville, MS	0.00	0.00	0.00
Running Reelfoot Bayou at Hwy 103, TN	0.00	0.00	0.02
Second Creek near Palestine, AR	0.00	0.00	0.00
Silver Creek near Bayland, MS	0.00	0.00	0.00
Spillway Ditch at Hwy 102 near East Prairie, MO	0.00	0.00	0.00
St. Francis River at Lake City, AR	0.01	0.08	0.05
St. Francis River near Coldwater, AR	0.00	0.04	0.06
St. Johns Ditch near Sikeston, MO	0.00	0.00	0.00
Steele Bayou East Prong near Rolling Fork, MS	0.00	0.00	0.00
Tensas River at Tendal, LA	0.00	0.00	0.02
Tyronza River near Twist, AR	0.00	0.00	0.01
Village Creek near Swifton, AR	0.00	0.00	0.01
Yazoo River below Steele Bayou near Long Lake, MS	0.01	0.02	0.43
MIN	0.00	0.00	0.00
MAX	0.03	0.08	0.43
MEAN	0.00	0.01	0.05
MEDIAN	0.00	0.00	0.01
ST. DEVI	0.01	0.02	0.09

Table 19. Spearman rho correlations for significant relations between elevation and the physical environmental parameters.

Physical environmental parameter	Elevation (meters above sea level)
Latitude	0.9681
Latitude - p-value	< 0.0001
Longitude	-0.6586
Longitude - p-value	< 0.0001
Average channel width (m)	-0.4302
Average channel width (m) - p-value	0.0088
Average thalweg depth (m)	-0.5707
Average thalweg depth (m) - p-value	0.0003
Average water depth (m)	-0.5543
Average water depth (m) - p-value	0.0005
Secchi depth (cm)	0.3874
Secchi depth (cm) - p-value	0.0196
Average precipitation (cm)	-0.8797
Average precipitation (cm) - p-value	< 0.0001
Drainage area (km2)	-0.3747
Drainage area (km2) - p-value	0.0244

Table 20. Spearman rho correlations for significant relations between elevation and the fish community metrics.

Fish community metric	Elevation (meters above sea level)
Total number of taxa	0.5312
Total number of taxa - p-value	0.0009
Number of minnow taxa	0.4440
Number of minnow taxa - p-value	0.0067
Average standard length of Lepomis (mm)	0.4297
Average standard length of Lepomis (mm) - p-value	0.0089
Ratio tol/intol taxa	-0.6281
Ratio tol/intol taxa - p-value	< 0.0001
Number of intolerant taxa	0.6132
Number of intolerant taxa - p-value	< 0.0001
Shannon diversity	0.3959
Shannon diversity - p-value	0.0169
Relative abundance of insectivores	0.4806
Relative abundance of insectivores - p-value	0.003
Average standard length of black bass (mm)	0.5234
Average standard length of black bass (mm) - p-value	0.0011
Percent contribution by dominant taxa	-0.3569
Percent contribution by dominant taxa - p-value	0.0326

Table 21. Summary of correspondence analysis (CA) of fish communities, from thirty sites.

Summary	Axis 1 loadings	Axis 2 loadings	Total variance
Eigenvalue	0.356	0.299	
Proportion of total variance (percent)	13.3	11.3	
Cumulative proportion (percent)	13.3	24.6	43.0

Table 22. Summary of correspondence analysis (CA) of fish communities, from twenty-nine sites.

Summary	Axis 1 loadings	Axis 2 loadings	Total variance
Eigenvalue	0.353	0.268	
Proportion of total variance (percent)	14.5	11.0	
Cumulative proportion (percent)	14.5	25.5	44.8

Table 23. List of eighteen environmental parameters selected to be used in canonical correspondence analysis (CCA) along with their associate surrogates from the Spearman rho correlations [N/A, indicates no surrogate parameter].

Environmental parameter used in CCA	Correlation parameter (Surrogate)	r_s-value	p-value
average channel width	N/A		
discharge	average thalweg depth	0.5390	0.0021
	average water depth	0.5281	0.0027
	water temperature	0.5246	0.0029
secchi	N/A		
percent total urban	percent high intensive residential	0.8981	0.0001
	percent low intensive residential	0.9515	0.0001
	percent high intensive commercial	0.8469	0.0001
percent quarries, strip mines, and gravel pits	N/A		
percent deciduous forest	percent mixed forest	0.7829	0.0001
	percent total forest	0.9359	0.0001
	percent evergreen forest	0.5066	0.0043
	percent transitional	0.5853	0.0007
	percent herbaceous wetlands	0.5147	0.0036
	percent cotton	-0.6659	0.0001
percent hay and pasture	N/A		
percent small grains	N/A		
percent other grasses	N/A		
percent total agriculture	percent open water	-0.5003	0.0049
	percent oats, sorghum, and wheat	0.6538	0.0001
	percent row crops	0.7940	0.0001
	percent total wetlands	-0.6458	0.0001
	percent woody wetlands	-0.6156	0.0003
percent soybeans	N/A		
percent rice	N/A		
percent corn	longitude	0.5153	0.0036
segment gradient	N/A		
average runoff	N/A		
populations per acre	population	-0.5458	0.0018
pH	N/A		
specific conductance	N/A		

Table 24. Summary of canonical correspondence analysis (CCA), from thirty sites.

Summary	Axis 1 loadings	Axis 2 loadings	Axis 3 loadings	Axis 4 loadings		Total inertia
Eigenvalue	0.329	0.302	0.257	0.231		3.850
Species-environmential correlations	0.918	0.967	0.983	0.944		
Cumulative proportion (percent)						
of species data	10.4	20.0	28.2	35.5		
of species-environmental relation	14.7	28.1	39.6	49.9		
Sum of all unconstrained eigenvalues					3.179	
Sum of all canconical eigenvalues					2.243	

Table 25. Correlation (r^2) of the CA site scores to the eighteen selected environmental parameters, for thirty sites.

Environmental parameter	Axis 1	Axis 2	Axis 3	Axis 4
average channel width	**0.4607**	-0.2662	-0.2060	-0.2091
discharge	0.1968	0.0049	**0.7838**	**-0.3540**
secchi	-0.0012	-0.1616	0.2558	-0.1843
percent total urban	0.0167	-0.0669	-0.0197	0.3722
percent quarries, strip mines, and gravel pits	-0.2462	-0.2882	0.0537	-0.1280
percent deciduous forest	-0.1802	-0.4279	-0.2315	-0.0072
percent hay and pasture	-0.4511	-0.1230	0.1175	0.2306
percent small grains	-0.1477	**0.4902**	0.3407	-0.0790
percent other grasses	-0.0076	-0.0109	0.0406	**-0.2448**
percent total agriculture	0.0976	0.2666	0.3792	0.0877
percent soybeans	-0.0185	-0.0591	0.0884	-0.1225
percent rice	0.2806	**-0.6720**	0.1064	0.0307
percent corn	**-0.4769**	0.2762	0.0635	-0.1084
segment gradient	0.0133	0.0158	-0.1043	0.1112
average runoff	-0.3231	0.2300	-0.0551	0.2044
populations per acre	0.0971	-0.1784	-0.2476	0.2681
pH	-0.3484	0.2735	**0.3855**	-0.1753
specific conductance	0.0538	0.1300	0.0799	0.0691

Table 26. Summary of canonical correspondence analysis (CCA), from twenty-nine sites.

Summary	Axis 1 loadings	Axis 2 loadings	Axis 3 loadings	Axis 4 loadings		Total inertia
Eigenvalue	0.329	0.256	0.245	0.214		3.479
Species-environmential correlations	0.973	0.981	0.963	0.997		
Cumulative proportion (percent)						
of species data	11.7	20.8	29.5	37.1		
of species-environmental relation	15.6	27.7	39.3	49.4		
Sum of all unconstrained eigenvalues					2.816	
Sum of all canconical eigenvalues					2.113	

Table 27. Correlation (r^2) of the CA site scores to the eighteen selected environmental parameters, for twenty-nine sites.

Environmental parameter	Axis 1	Axis 2	Axis 3	Axis 4
average channel width	-0.3755	-0.1275	-0.0512	0.3174
discharge	-0.0497	**0.7184**	**-0.4822**	0.0772
secchi	-0.2340	0.2709	-0.1038	0.2623
percent total urban	-0.0714	0.0134	**0.3252**	0.2668
percent quarries, strip mines, and gravel pits	-0.2113	-0.0786	-0.1816	-0.4756
percent deciduous forest	-0.3681	-0.3297	-0.0032	-0.1797
percent hay and pasture	-0.0478	-0.0296	0.1111	**-0.6829**
percent small grains	**0.4922**	0.3454	-0.1591	-0.0727
percent other grasses	-0.0126	0.0113	-0.2245	0.2693
percent total agriculture	0.2049	**0.4592**	0.0747	0.0539
percent soybeans	-0.0674	0.0934	-0.1326	**0.5588**
percent rice	**-0.7138**	0.1349	0.0520	0.2890
percent corn	0.3664	-0.0447	-0.2119	-0.5104
segment gradient	-0.0050	-0.0246	0.1531	-0.0707
average runoff	0.3183	-0.0864	0.0996	-0.1454
populations per acre	-0.1815	-0.2186	0.2928	0.0489
pH	0.3331	0.2979	-0.3233	-0.1926
specific conductance	0.0944	0.1771	0.1367	0.1187

Table 28. Spearman rho correlations for significant relationships between the twenty fish metrics and eighteen environmental parameters.

	Secchi (cm)	Percent quarries, strip mines, and gravel pits	Percent deicduous forest	Percent small grains	Percent corn	Population per acre
Average standard length of black bass (mm)		0.4989		-0.4515	0.3651	
Average standard length of black bass (mm) (p-value)		0.0050		0.0123	0.0473	
Average standard length of Lepomis (mm)	0.4631					
Average standard length of Lepomis (mm) (p-value)	0.0100					
Average standard lengths of all individuals		0.4623				
Average standard lengths of all individuals (p-value)		0.0101				
Number of intolerant taxa					0.5382	
Number of intolerant taxa (p-value)					0.0022	
Number of minnow taxa					0.4749	
Number of minnow taxa (p-value)					0.0080	
Percent of biomass buffalo and carp	-0.4903					
Percent of biomass buffalo and carp (p-value)	0.0059					
Relative abundance of insectivores					0.6114	
Relative abundance of insectivores (p-value)					0.0003	
Relative abundance of omnivores		0.5437				
Relative abundance of omnivores (p-value)		0.0019				
Shannon diversity		0.3790	0.4694			
Shannon diversity (p-value)		0.0389	0.0089			
Total fish biomass (kg)		0.3983				0.5727
Total fish biomass (kg) (p-valuc		0.0293				0.0009

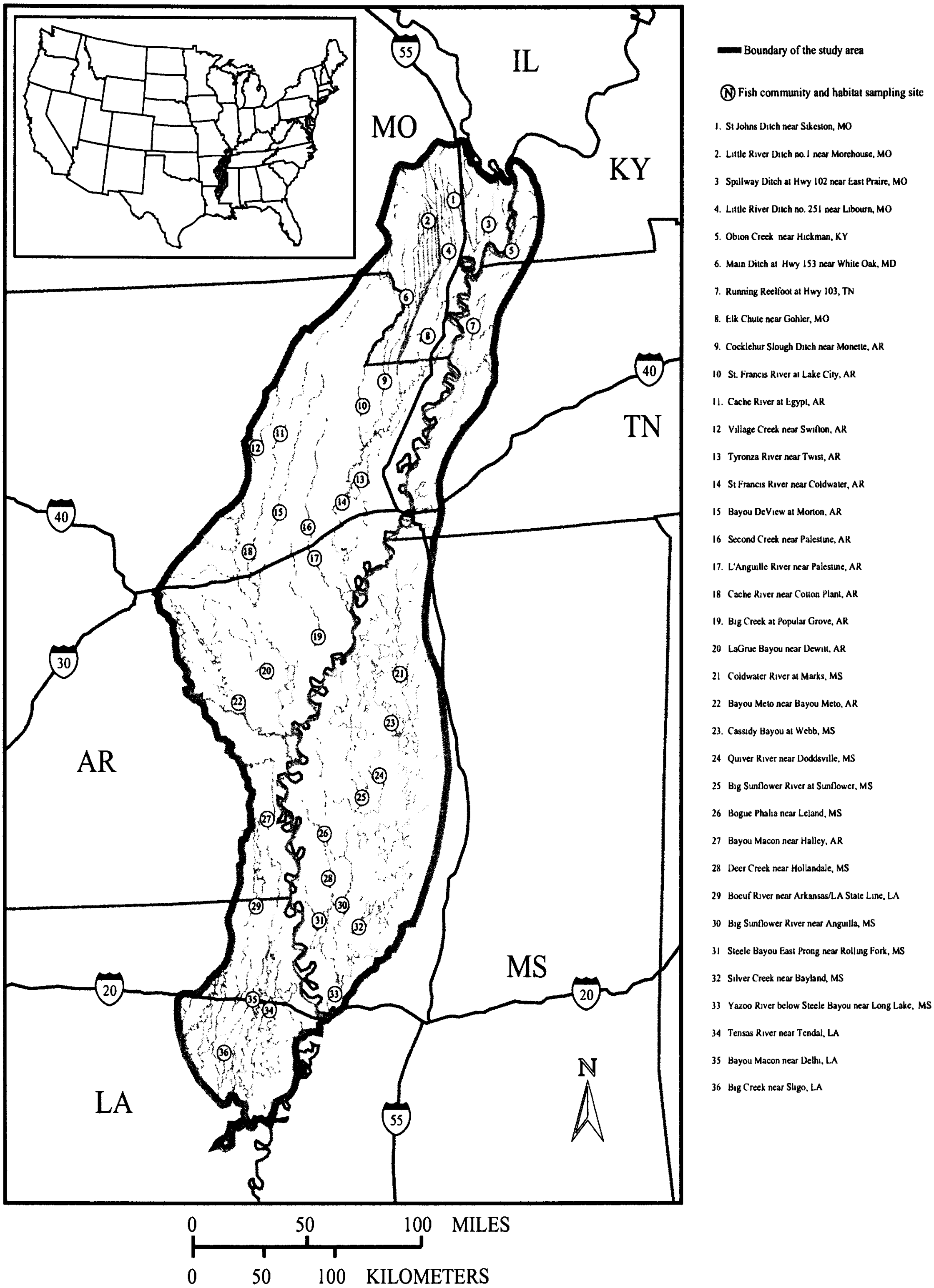

Figure 1. Location of thirty-six fish community sampling sites in the study area; nothern part of the Mississippi Alluvial Plain Ecoregion.

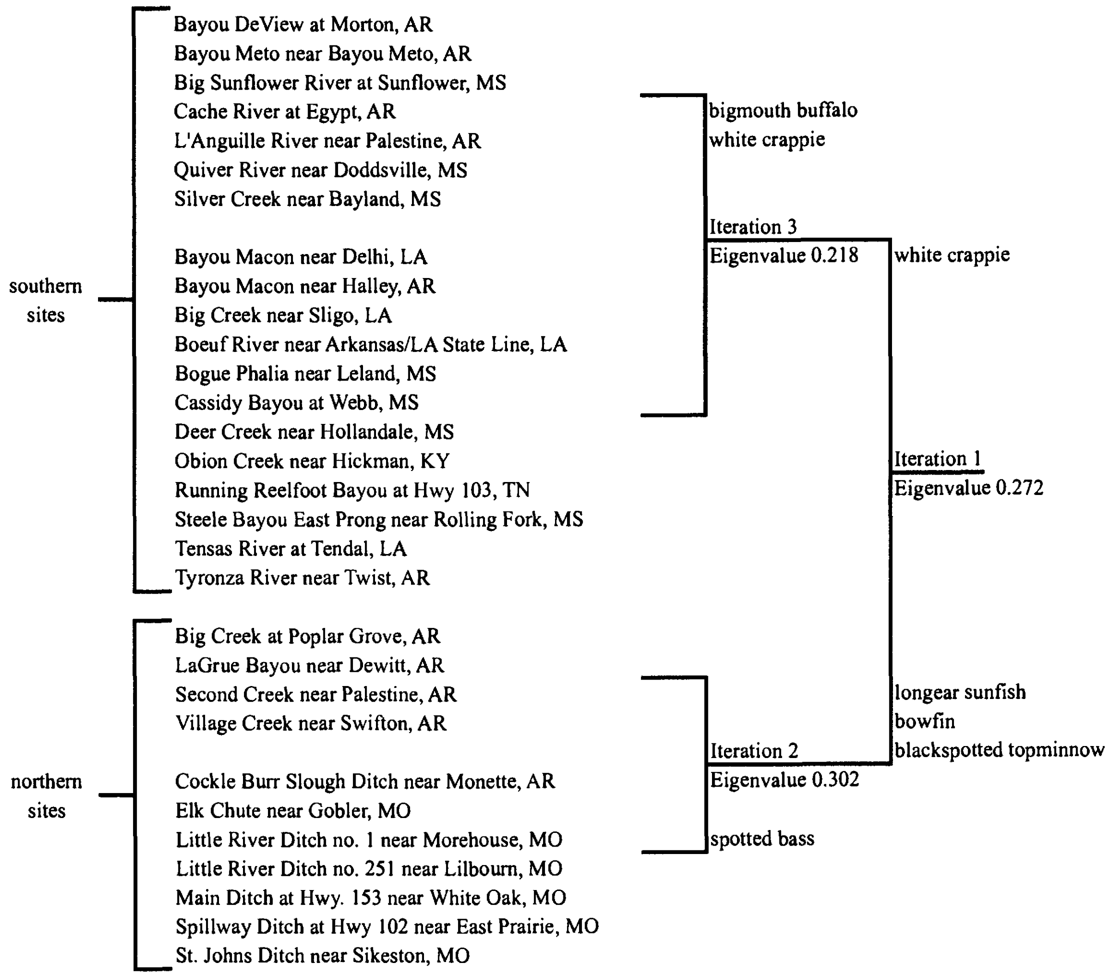

Figure 2. TWINSPAN analysis of fish comminities at thirty sites within the Mississippi Alluvial Plain Ecoregion, 1998.

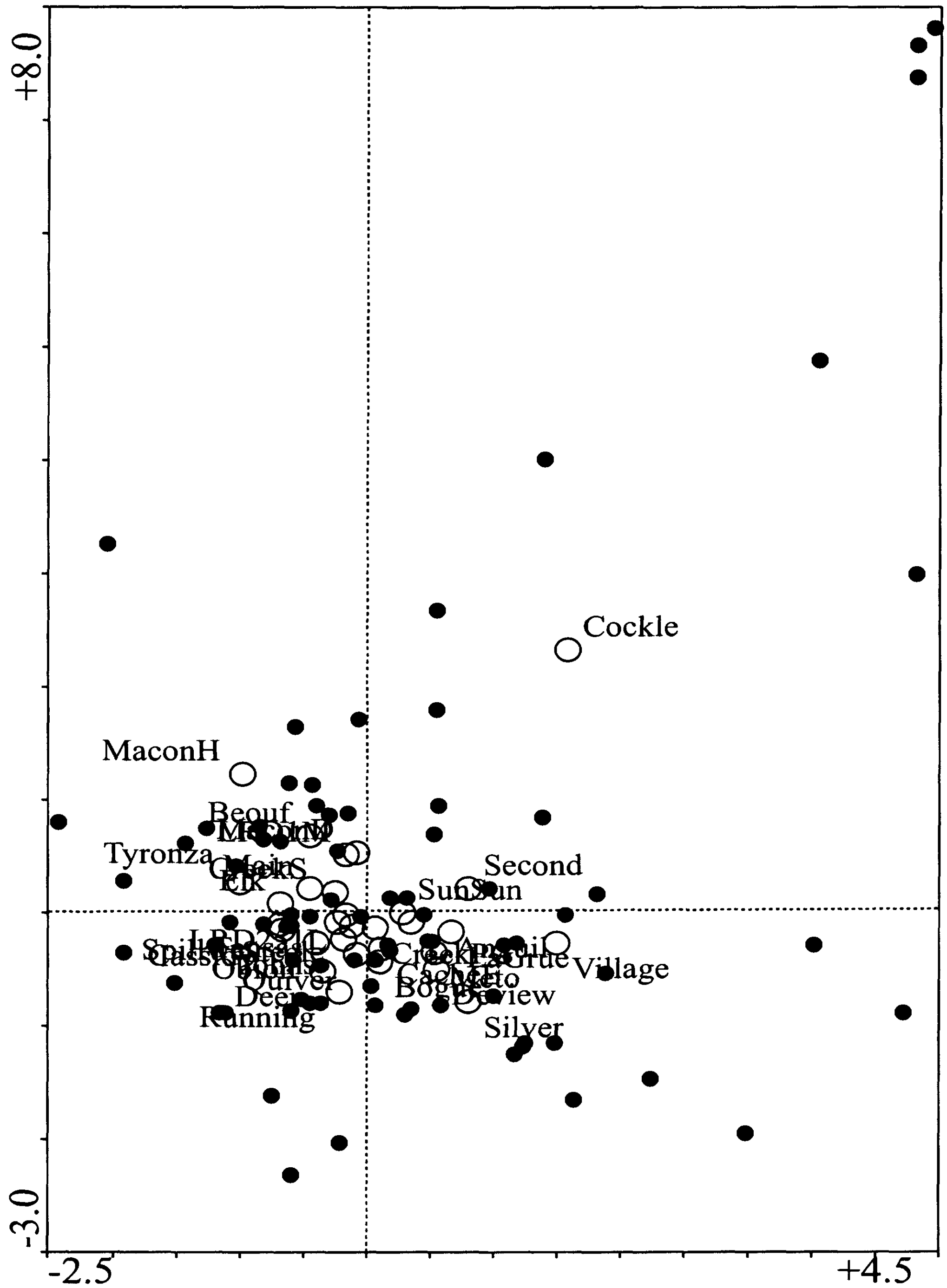

Figure 3. Correspondence analysis (CA) biplot, using the arsine fish data from thirty sites, while partialing for four naturally occurring environmental variables.

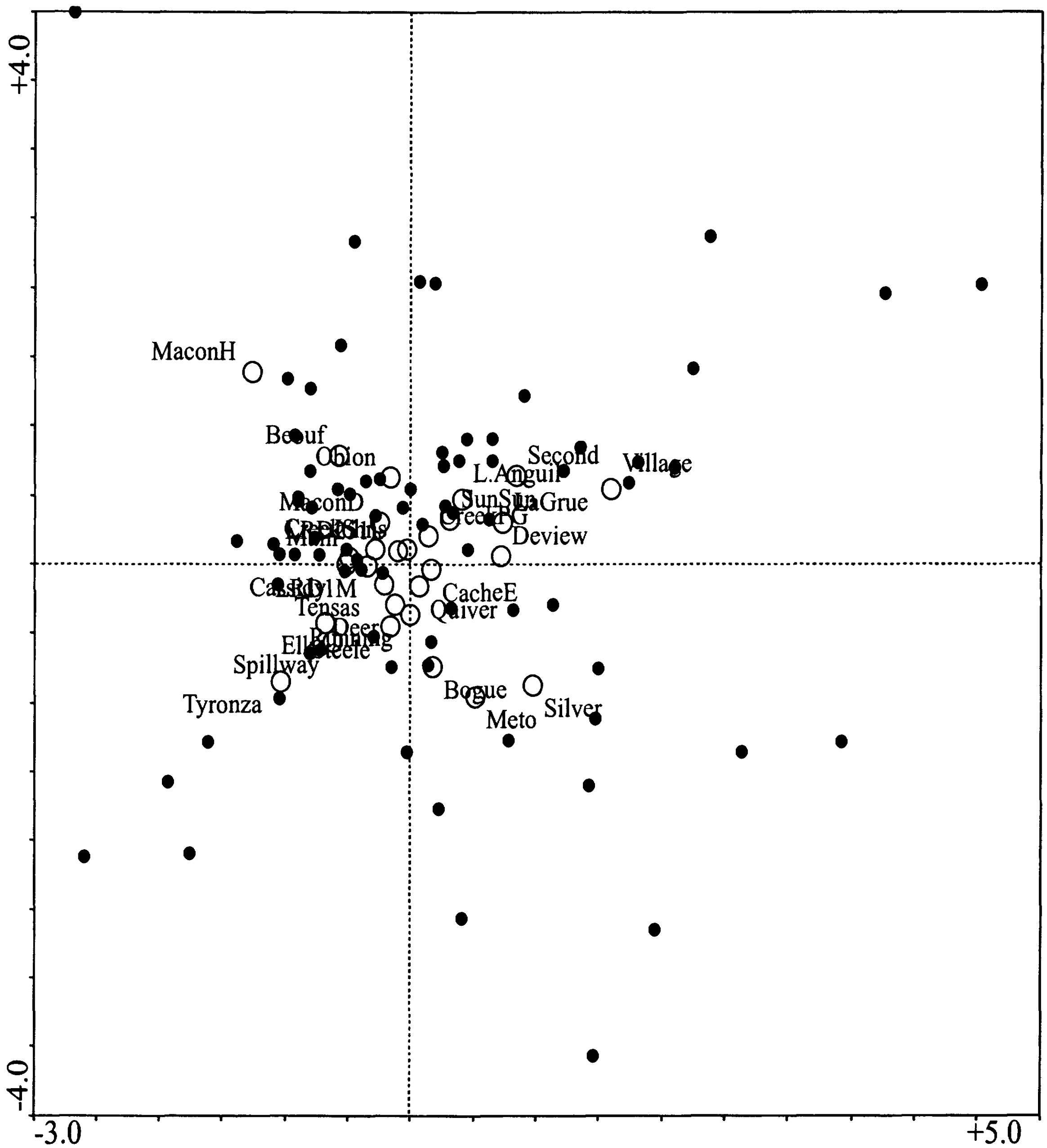

Figure 4. Correspondence analysis (CA) biplot, using the fish data from twenty-nine sites, while partialing for four naturally occuring environmental variables.

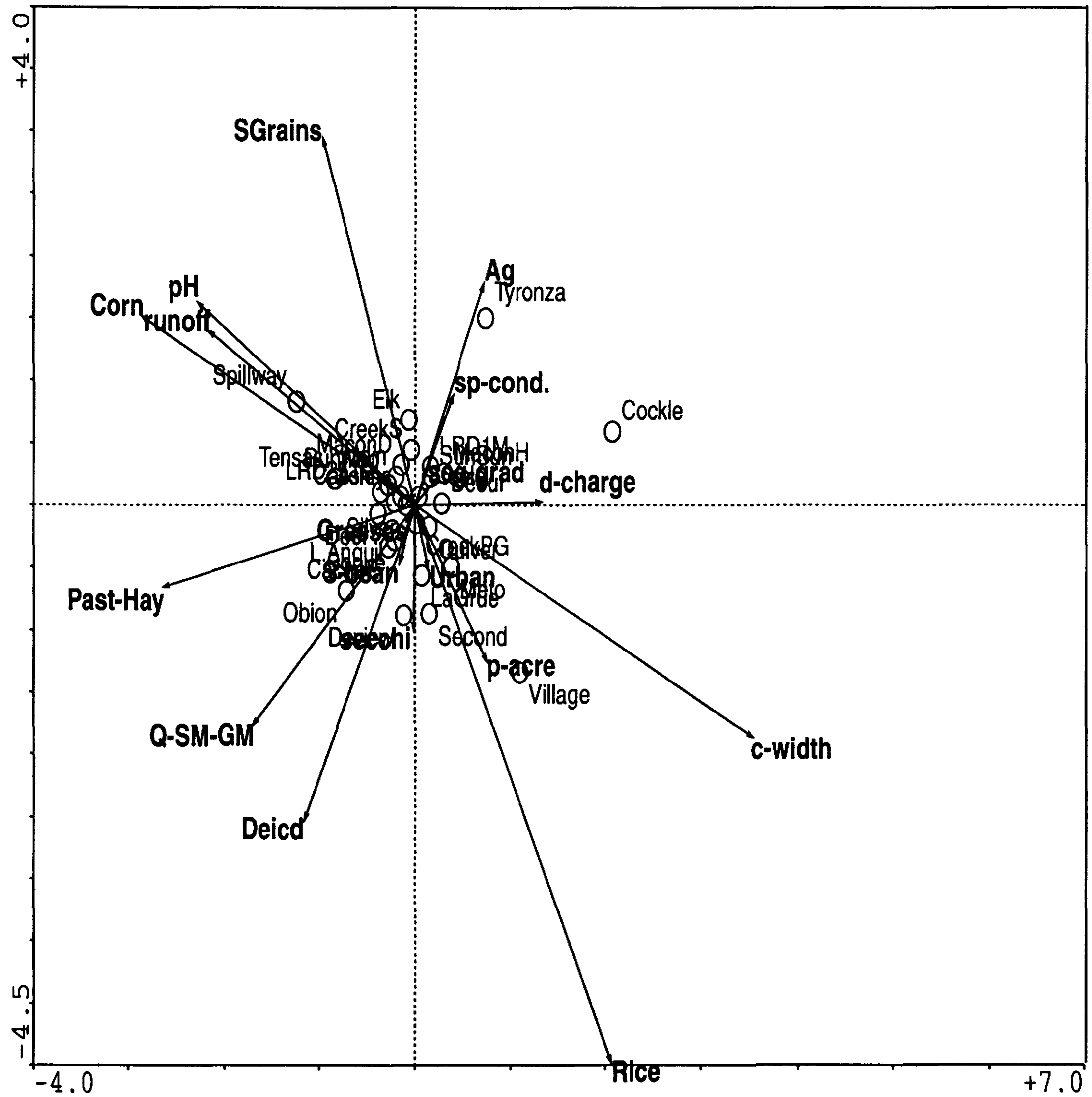

Figure 5. Canonical correspondence analysis (CCA) biplot, using the arsine fish data and eighteen standardized environmental variables from thirty sites, while partialing for four naturally occuring variables.

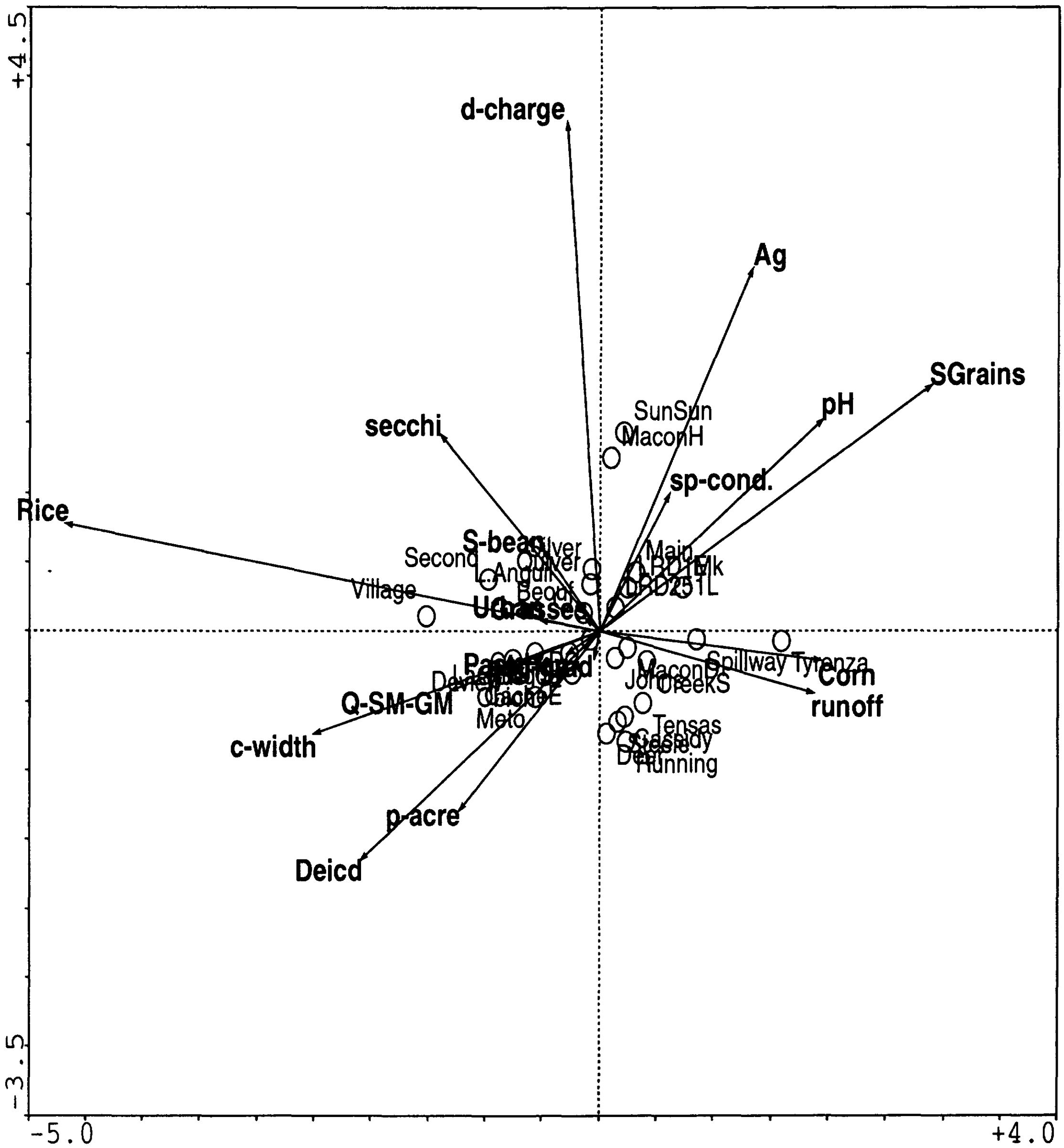

Figure 6. Canonical correspondence analysis (CCA) biplot using the arsine fish data, eighteen standardized environmental variables, and four naturally occuring variables from twenty-nine sites.

Appendix 1. Number of seine hauls and effort for each of the thirty-six sites sampled within the Mississippi Alluvial Plain Ecoregion, 1998.

Site number	Site name	# Hauls	Effort (min)
07077700	Bayou DeView at Morton, AR	8	45
07370000	Bayou Macon near Delhi, LA	8	45
073676595	Bayou Macon near Halley, AR	9	45
07265099	Bayou Meto near Bayou Meto, AR	6	45
07077950	Big Creek at Poplar Grove, AR	9	50
07368580	Big Creek near Sligo, LA	7	45
07288500	Big Sunflower River at Sunflower, MS	9	45
07288700	Big Sunflower River near Anguilla, MS	8	45
07367700	Boeuf River near Arkansas/LA State Line, LA	9	45
07288650	Bogue Phalia near Leland, MS	6	45
07077380	Cache River at Egypt, AR	9	45
07077555	Cache River near Cotton Plant, AR	9	45
07280900	Cassidy Bayou at Webb, MS	9	45
07040496	Cockle Burr Slough Ditch near Monette, AR	10	45
07279950	Coldwater River at Marks, MS	8	45
07288770	Deer Creek near Hollandale, MS	9	45
07046515	Elk Chute near Gobler, MO	10	45
07078040	LaGrue Bayou near Dewitt, AR	7	45
07047950	L'Anguille River near Palestine, AR	10	45
07043500	Little River Ditch no. 1 near Morehouse, MO	9	45
07042500	Little River Ditch no. 251 near Lilbourn, MO	9	45
07041120	Main Ditch at Hwy. 153 near White Oak, MO	9	45
07023800	Obion Creek near Hickman, KY	11	50
07288570	Quiver River near Doddsville, MS	9	45
07027050	Running Reelfoot Bayou at Hwy 103, TN	9	45
07047947	Second Creek near Palestine, AR	9	45
0728872008	Silver Creek near Bayland, MS	8	45
07024160	Spillway Ditch at Hwy 102 near East Prairie, MO	9	45
07040450	St. Francis River at Lake City, AR	8	45
07047520	St. Francis River near Coldwater, AR	9	45
07043300	St. Johns Ditch near Sikeston, MO	9	45
07288870	Steele Bayou East Prong near Rolling Fork, MS	6	45
07369500	Tensas River at Tendal, LA	7	45
07047700	Tyronza River near Twist, AR	9	45
07074660	Village Creek near Swifton, AR	9	45
07288955	Yazoo River below Steele Bayou near Long Lake, MS	7	45
	MIN	6	45
	MAX	11	50
	MEAN	9	45
	MEDIAN	9	45
	ST. DEVI	1.2	1.2

Appendix 2. Electrofisher settings for the thirty-six sites sampled within the Mississippi Alluvial Plain Ecoregion, 1998.
[*, indicates values not recorded]

Site number	Site Name	Gear CD.	Voltage	Pulse	Frequency	Amps	Effort (sec)
07077700	Bayou DeView at Morton, AR	13A	500	60	45	6.5	1446
07077700	Bayou DeView at Morton, AR	13B	500	60	45	6.5	1397
07370000	Bayou Macon near Delhi, LA	13A	*	*	*	7.5	1228
07370000	Bayou Macon near Delhi, LA	13B	*	*	*	7.5	1208
073676595	Bayou Macon near Halley, AR	13A	500	60	40	6.5	1350
073676595	Bayou Macon near Halley, AR	13B	500	60	40	6.5	727
07265099	Bayou Meto near Bayou Meto, AR	13A	500	*	*	*	1023
07265099	Bayou Meto near Bayou Meto, AR	13B	500	*	*	*	1249
07077950	Big Creek at Poplar Grove, AR	13A	500	60	60	9	876
07077950	Big Creek at Poplar Grove, AR	13B	500	60	60	9	841
07368580	Big Creek near Sligo, LA	13A	500	60	45	10	1300
07368580	Big Creek near Sligo, LA	13B	500	60	45	11	1286
07288500	Big Sunflower River at Sunflower, MS	13A	1000	60	40	7.0	1065
07288500	Big Sunflower River at Sunflower, MS	13B	1000	60	40	7.0	1158
07288700	Big Sunflower River near Anguilla, MS	13A	500	60	50	6.5	1351
07288700	Big Sunflower River near Anguilla, MS	13B	500	60	50	6.5	1420
07367700	Boeuf River near Arkansas/LA State Line, LA	13A	500	60	35	6.5	1265
07367700	Boeuf River near Arkansas/LA State Line, LA	13B	500	60	50	10	912
07288650	Bogue Phalia near Leland, MS	13A	500	60	40	6.5	1407
07288650	Bogue Phalia near Leland, MS	13B	500	60	40	6.5	1294
07077380	Cache River at Egypt, AR	13A	1000	60	35	5.0	1300
07077380	Cache River at Egypt, AR	13B	1000	60	35	5.0	1412
07077555	Cache River near Cotton Plant, AR	13A	500	60	55	6.5	1293
07077555	Cache River near Cotton Plant, AR	13B	500	60	60	6.5	934
07280900	Cassidy Bayou at Webb, MS	13A	500	120	50	8	845
07280900	Cassidy Bayou at Webb, MS	13B	500	120	40	6.5	810
07040496	Cockle Burr Slough Ditch near Monette, AR	13A	500	60	65	6.5	1479
07040496	Cockle Burr Slough Ditch near Monette, AR	13B	500	60	65	6.5	1356
07279950	Coldwater River at Marks, MS	13A	1000	120	35	5	1169
07279950	Coldwater River at Marks, MS	13B	1000	120	25	3.5	1000
07288770	Deer Creek near Hollandale, MS	13A	1000	60	35	4	1343
07288770	Deer Creek near Hollandale, MS	13B	500	60	70	6.5	1153
07046515	Elk Chute near Gobler, MO	13A	500	60	65	6.5	1288
07046515	Elk Chute near Gobler, MO	13B	500	60	65	6.5	1025
07078040	LaGrue Bayou near Dewitt, AR	13A	500	60	50	11	690
07078040	LaGrue Bayou near Dewitt, AR	13B	500	60	50	11	690
07047950	L'Anguille River near Palestine, AR	13A	500	60	40	6.5	1427
07047950	L'Anguille River near Palestine, AR	13B	500	60	40	6.5	1688
07043500	Little River Ditch no. 1 near Morehouse, MO	13A	500	60	50	6.5	1295
07043500	Little River Ditch no. 1 near Morehouse, MO	13B	500	60	50	6.5	1100
07042500	Little River Ditch no. 251 near Lilbourn, MO	13A	500	60	55	6.5	965
07042500	Little River Ditch no. 251 near Lilbourn, MO	13B	500	60	55	6.5	1353
07041120	Main Ditch at Hwy. 153 near White Oak, MO	13A	1000	60	40	4.5	1226
07041120	Main Ditch at Hwy. 153 near White Oak, MO	13B	1000	60	40	4.5	1194
07023800	Obion Creek near Hickman, KY	13A	500	60	80	7	1432
07023800	Obion Creek near Hickman, KY	13B	500	60	80	7	1490
07288570	Quiver River near Doddsville, MS	13A	500	60	45	6.5	1376
07288570	Quiver River near Doddsville, MS	13B	500	60	45	6.5	1175
07027050	Running Reelfoot Bayou at Hwy 103, TN	13A	500	50	60	*	1238
07027050	Running Reelfoot Bayou at Hwy 103, TN	13B	500	50	60	*	1021
07047947	Second Creek near Palestine, AR	13A	500	60	50	6.5	825
07047947	Second Creek near Palestine, AR	13B	500	60	50	6.5	771
0728872008	Silver Creek near Bayland, MS	13A	1000	60	45	4	1850
0728872008	Silver Creek near Bayland, MS	13B	1000	60	45	4	1650
07024160	Spillway Ditch at Hwy 102 near East Prairie, MO	13A	500	60	55	6.5	1120
07024160	Spillway Ditch at Hwy 102 near East Prairie, MO	13B	500	60	55	6.5	1282
07040450	St. Francis River at Lake City, AR	13A	500	60	55	6.5	1978
07040450	St. Francis River at Lake City, AR	13B	500	60	55	6.5	1400

Appendix 2. Continued

Site number	Site Name	Gear CD.	Voltage	Pulse	Frequency	Amps	Effort (sec)
07047520	St. Francis River near Coldwater, AR	13A	500	60	45	6.5	900
07047520	St. Francis River near Coldwater, AR	13B	500	60	45	6.5	1181
07043300	St. Johns Ditch near Sikeston, MO	13A	500	60	45	6.5	920
07043300	St. Johns Ditch near Sikeston, MO	13B	500	60	45	6.5	930
07288870	Steele Bayou East Prong near Rolling Fork, MS	13A	500	120	40	6.5	1076
07288870	Steele Bayou East Prong near Rolling Fork, MS	13B	500	120	40	6.5	1082
07369500	Tensas River at Tendal, LA	13A	500	60	50	6.8	1262
07369500	Tensas River at Tendal, LA	13B	500	60	50	6.8	1320
07047700	Tyronza River near Twist, AR	13A	500	60	40	6.5	1215
07047700	Tyronza River near Twist, AR	13B	500	60	40	6.5	932
07074660	Village Creek near Swifton, AR	13A	500	60	50	6.5	1300
07074660	Village Creek near Swifton, AR	13B	500	60	50	6.5	1320
07288955	Yazoo River below Steele Bayou near Long Lake, MS	13A	500	120	50	9	1258
07288955	Yazoo River below Steele Bayou near Long Lake, MS	13B	500	120	50	9	1189
		MIN	500	50	25	3.5	690
		MAX	1000	120	80	11.0	1978
		MEAN	579	67	49	6.8	1199
		MEDIAN	500	60	50	6.5	1233
		ST. DEVI	183	20	10	1.5	254

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