Number and Size of Black Bass Reflect Water Quality in the Lower Mississippi River Delta

Significant Findings:

- Black bass were absent in samples collected at some sites, but were abundant in samples collected at other sites.
- Black bass populations were either more plentiful or the individual fish were larger at sites where the water quality was favorable.
- Black bass populations are considered to be useful indicators of water-quality conditions in the Delta.

Introduction

Black bass are the most popular and most economically important freshwater game fish in the United States, especially in the southeastern part of the country. In a 1996 national recreational survey, 52 percent of anglers in the southeastern United States fished for black bass. Each year, anglers spend billions of dollars in pursuit of black bass. As a result of the popularity and economic importance of black bass, there is widespread interest in maintaining healthy populations.

This particular study shows that black bass populations in streams in the Lower Mississippi River floodplain (locally known as the Delta) reflect differences in stream water quality. This suggests that black bass populations could be expected to improve in some streams if water-quality conditions were to improve.

Successful fisherman on a Delta stream. (Photograph by Keith Sutton, Arkansas Game and Fish Commission)

In the Delta, physical characteristics of the natural streams, combined with human activities and practices, have resulted in a unique set of ecological conditions. For example, compared to upland streams, Delta streams naturally have lower velocities, higher turbidity, and less stable concentrations of dissolved oxygen. Furthermore, clearing of bottomland hardwoods from much of the land in the Delta, including the stream banks, has resulted in a loss of tree canopy, which has affected Delta streams in at least three important ways. There has

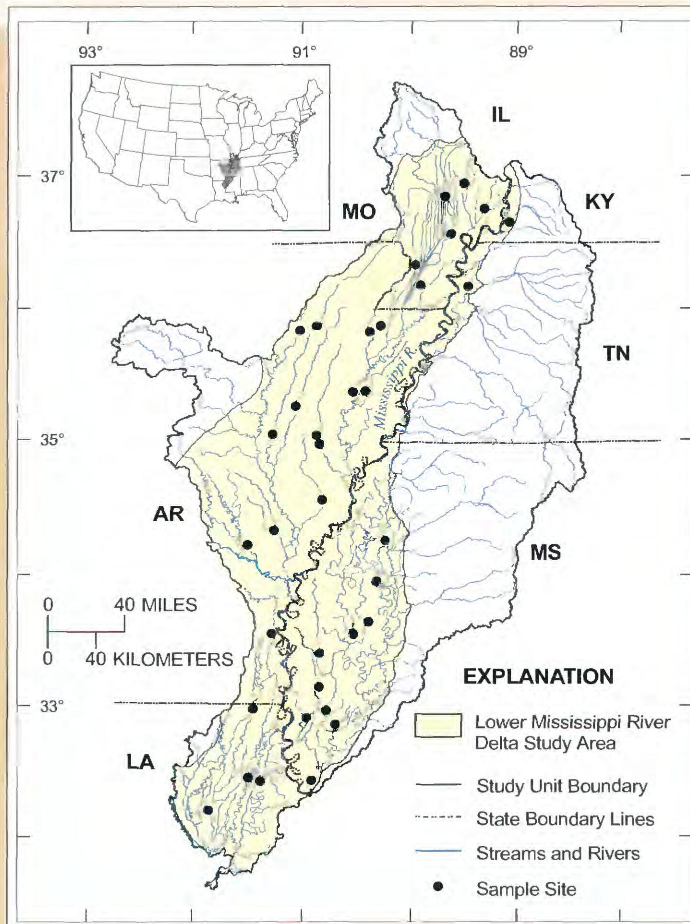

Figure 1. Lower Mississippi River Delta and sampling sites located within the Mississippi Embayment Study Unit boundary.

National Water-Quality Assessment Program

The National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey is designed to describe current water-quality conditions for a large part of the Nation's ground- and surface-water resources, to describe how water quality is changing over time, and to improve our understanding of the natural and human factors that affect water quality. These goals are being achieved through investigations of more than 50 study units that include some of the Nation's most important river basins and aquifer systems. The Mississippi Embayment Study Unit is one area being investigated as part of the NAWQA Program (fig. 1).

been 1) a reduction of fallen limbs and trees in the streams, which is a preferred habitat of many fish species; 2) an increase in water temperatures because there is less shade; and 3) a reduction in the amount of organic matter (for example, leaves), which is an important food source for organisms at the bottom of the food chain in the aquatic environment.

Bass fishing is a sport that appeals to all ages.

Lastly, most streams in the Delta have been channelized to facilitate drainage and to control flooding. As a result of human activities such as stream-channel dredging, the natural in-stream habitats of most Delta streams have been altered.

Data Collection

From 1994 to 1998, the U.S. Geological Survey, through the National Water-Quality Assessment Program (NAWQA), studied water-quality conditions at 36 sites in Delta streams in parts of the States of Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee (fig. 1).

Chemical Sampling

Many chemical measures of the water, sediments, and fish were made at the 36 stream sampling sites. Four of those chemical measures were evaluated relative to black bass populations: turbidity, total ammonia plus organic nitrogen, the total number of herbicides found in the water, and concentrations of residual total DDT found in fish-tissue (carp) samples. These four chemical measures are considered representative of water-quality conditions of streams in the study area.

Turbidity (a measure of water clarity) is used to indicate the amount of material suspended in the stream water. High turbidity levels are common in watersheds where the combination of land use and natural soil properties results in a significant amount of erosion into streams and other water bodies.

Total ammonia plus organic nitrogen (a measure of nutrients) indicates the amount of nitrogen present in the water; nutrients commonly are introduced to streams through runoff of agricultural fertilizers and/or wastewater discharge. Excess nutrients in streams can result in the overgrowth of nuisance algae and aquatic plants. When extensive plant growth dies and decays, oxygen in the stream is depleted, which can stress the aquatic organisms.

The **total number of herbicides** in water is the sum of the number of herbicides detected in all water samples collected at a site. Although herbicides themselves probably have a limited direct influence on fish, the number of herbicides detected likely is representative of the amount of agricultural land use in a watershed upstream from a sampling site.

Finally, **concentrations of total DDT in fish tissue** provide an indication of long-term agricultural land use and insecticide applications in a watershed. DDT has not been actively used as an insecticide in the United States for nearly 30 years, and therefore its presence indicates historical land-use patterns.

Fish Sampling

Like many other fish, black bass are long-lived. For that reason, black bass populations reflect cumulative changes in their environment over time. Consequently, the number and size of black bass could directly reflect long-term water-quality conditions in Delta streams. Various characteristics of a fish population can be assessed and compared to chemical measures in order to evaluate water-quality conditions of a stream. These characteristics simply represent specific aspects of a fish population that are easily measured.

Biologists commonly use measures (or metrics) of a fish population to monitor disturbances in aquatic environments (streams, rivers, and lakes), and to study the effects of land use on those environments.

Electrofishing is a sampling method used to collect fish for water-quality assessments.

Fish were collected for this study with a small electrofishing boat and a fish seine. At 34 of the 36 sampling sites, fish were collected from a stretch of stream that was about 500 yards long. At the two remaining sites, beaver dams and logs limited sampling to a stretch of stream that was about 250 yards long. A total of 94 fish species were collected, identified, weighed, measured, and examined for signs of disease.

Two of the fish species collected were the largemouth bass (*Micropterus salmoides*) and the spotted bass (*Micropterus punctulatus*), both of which are black bass species. In this report, the term "black bass" is used to refer to these two species.

In this study, the sum of the lengths for all black bass collected at a particular site was the measure or "black bass metric" used to compare black bass populations to stream water-quality conditions. This fish metric represents both the number and the size of black bass found at a site.

The largemouth bass is probably the most important freshwater gamefish in the United States. (Photograph by Eugene Hester)

Understanding the Data

Two different methods of analysis were used to evaluate the relation between the black bass metric and the four chemical measures. Initially, data for all of the chemical measures were grouped into low, medium, and high values; each site was then color-coded and plotted on maps of the Delta. Trends observed from a visual comparison of the data were then tested by using statistical techniques.

Visual Comparison

In the maps shown in figures 2 through 5, sites having the lowest values for turbidity, total ammonia plus organic nitrogen, the total number of herbicides in the water, and the concentrations of residual total DDT measured in fish tissue are depicted as small blue triangles. Sites having medium values are shown as green squares on the maps, and sites having the highest values are depicted as yellow circles.

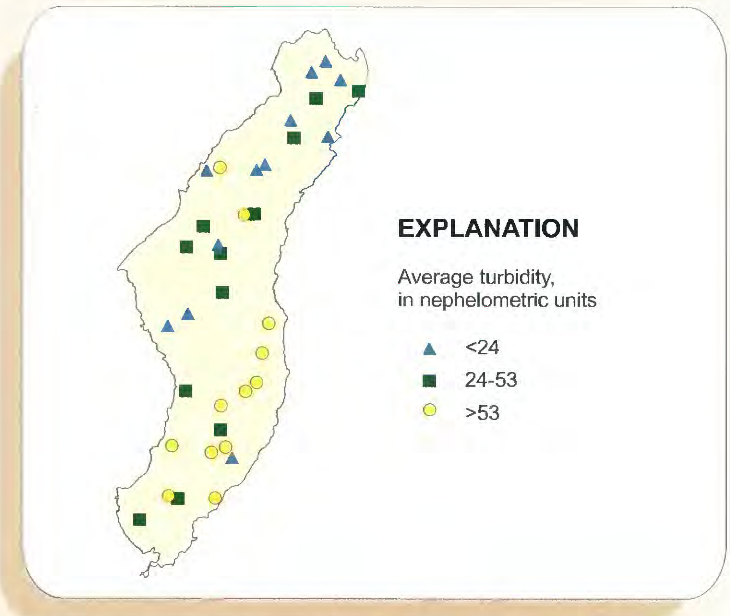

Figure 2. Average turbidity measured in samples collected at 36 sites in the Lower Mississippi River Delta, 1997-98.

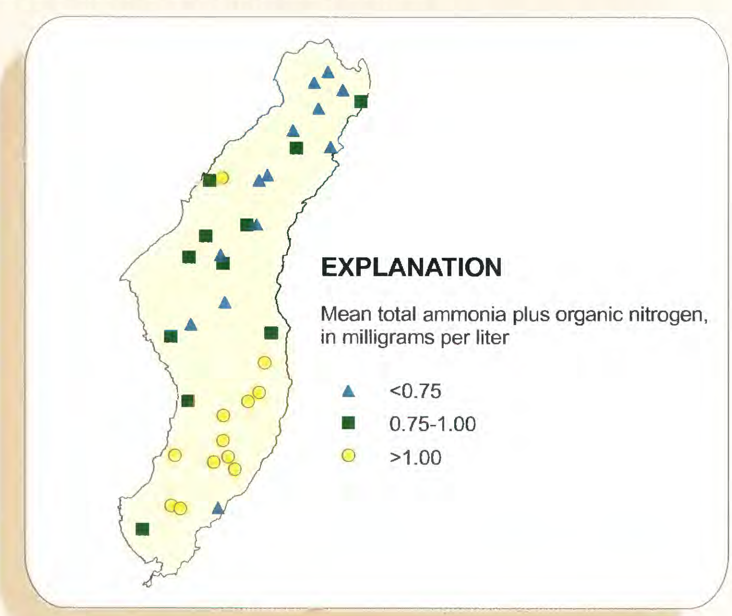

Figure 3. Mean total ammonia plus organic nitrogen measured in samples collected at 36 sites in the Lower Mississippi River Delta, 1998.

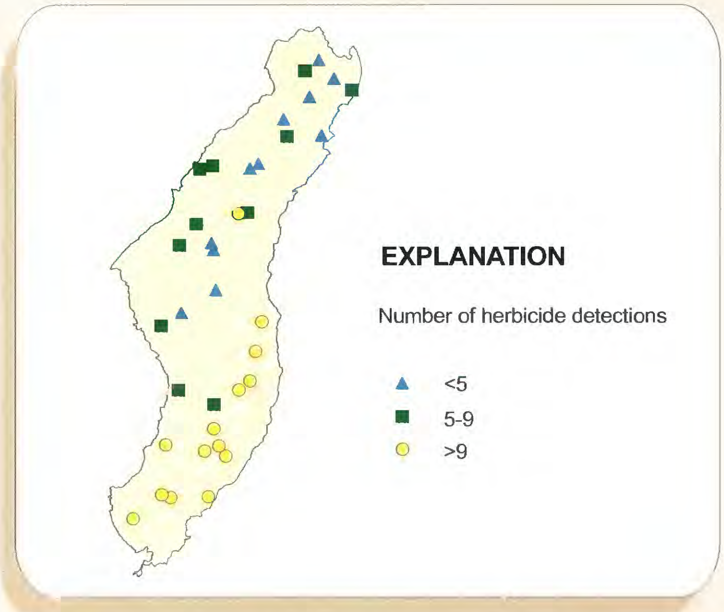

Figure 4. Number of herbicide detections in samples collected at 36 sites in the Lower Mississippi River Delta, 1998.

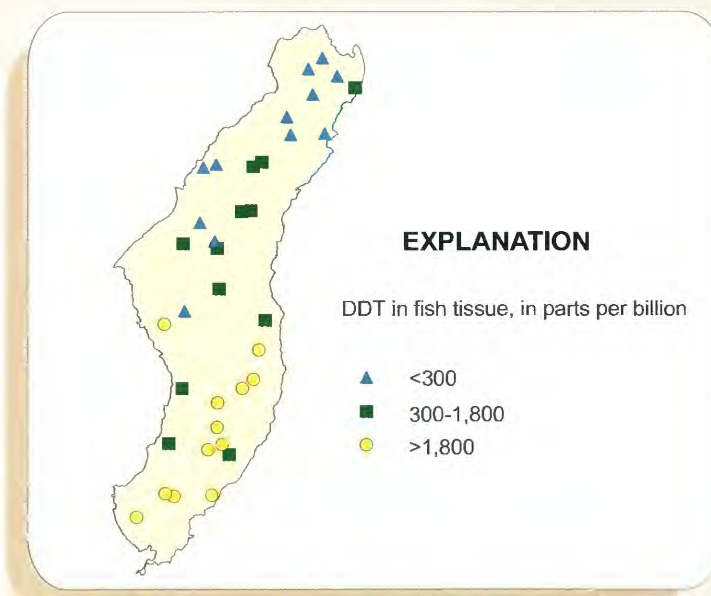

Figure 5. Amounts of DDT in fish tissue collected at 36 sites in the Lower Mississippi River Delta, 1998.

In general, chemical measures with high values are associated with less favorable water-quality conditions, whereas chemical measures with low values are associated with more favorable water-quality conditions. Sites associated with high chemical values were generally in the southern part of the study area in northwestern Mississippi and in northeastern Louisiana. Sites associated with low chemical values were generally in the northernmost parts of the study area, primarily in southeastern Missouri and northeastern Arkansas.

The distribution of the black bass metric at the 36 sampling sites is shown in figure 6. Blue triangles indicate where metric values were the highest, green squares indicate where values were medium, and yellow circles depict where metric values were the lowest. Unlike chemical measures where low values indicate favorable (or good) water quality, low black bass metric values indicate black bass populations that are few in number and/or small in size. Consequently, low black bass metric values indicate unfavorable water-quality conditions.

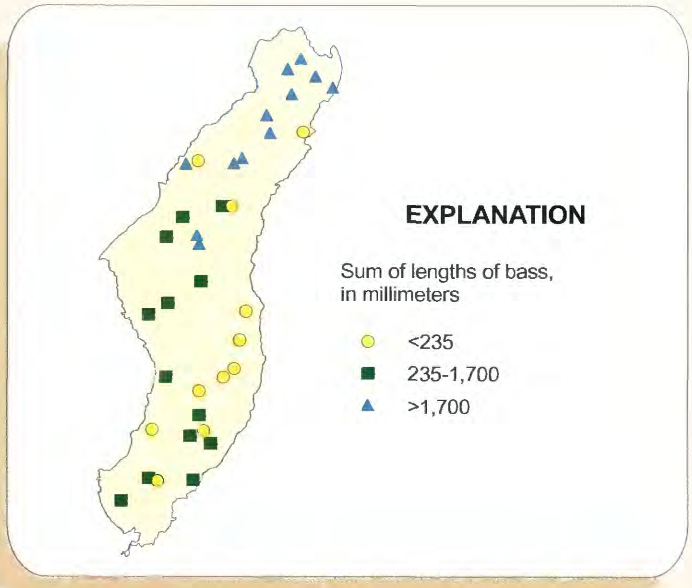

Figure 6. Sum of lengths of all bass collected at 36 sites in the Lower Mississippi River Delta, 1998.

In general, the distribution of the black bass metric values was similar to that of the chemical measures. High metric values, which reflect favorable water-quality conditions, were generally associated with sites in the northern part of the study area. Low metric values, which reflect unfavorable water-quality conditions, were generally associated with sites in the southernmost parts of the study area.

Statistical Comparison

Statistical techniques allow data to be compared in a more objective manner. A statistical test called a T-test indicated that the four chemical measures and the black bass metric at the 18 northernmost sites of the study area were statistically different from those at the 18 southernmost sites ($p<0.002$).

A second statistical procedure used to compare the bass metric to the four chemical measures was the correlation procedure. The four chemical measures were all negatively correlated with the black bass metric. In other words, as turbidity, nutrients, numbers of herbicides, and DDT concentrations increased, the size and abundance of the black bass decreased. Correlations between the four chemical measures and the black bass metric ranged from -0.52 to -0.63 (table 1). Statistically, a value of 0 would mean that there was no correlation or relation between the chemical measure and the black bass metric, whereas a value of 1.0 or -1.0 would indicate a "perfect" correlation.

Table 1. Spearman rho correlations of a black bass metric and four chemical measures of water quality at 36 sites in the Lower Mississippi River Delta
[All correlations are significant, $p<0.005$]

	Ammonia[1]	Turbidity[1]	DDT[2]	Number of herbicides detected[1]
Sum of lengths of all black bass	-0.55	-0.63	-0.52	-0.62

[1] - Values are averages of multiple measurements
[2] - Measured in fish tissue (carp)

Conclusion

In general, more black bass and larger black bass were collected at sites where the water quality was good or favorable; conversely, fewer black bass and smaller black bass were collected at sites where the water quality was less favorable. Sites having the most and the largest black bass and having the most favorable water quality were generally in the northern part of the study area. The results of this study suggest that changes in ecological conditions could change water-quality conditions and potentially affect black bass populations in some Delta streams.

Sources of Additional Information

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of Census, 1997, Black bass fishing in the U.S.: Addendum to the 1996 national survey of fishing, hunting and wildlife-associated recreation, 16 p.

Copies of this fact sheet and information about the Mississippi Embayment NAWQA Program can be obtained from:

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or from our web site at http://ms.water.usgs.gov/misenawqa

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