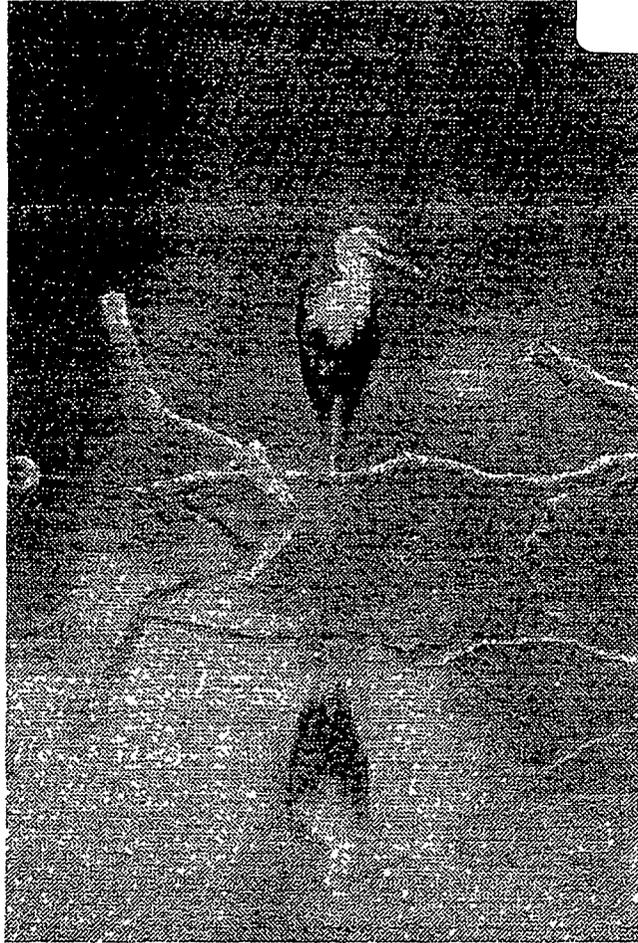


MOBILE RIVER STUDY
1993-1994

10103035



ENVIRONMENTAL SERVICES DIVISION
ECOLOGICAL SUPPORT BRANCH
960 COLLEGE STATION ROAD
ATHENS, GEORGIA 30605-2700

Table of Contents

Summary, Conclusions, and Recommendations	i
1.0 Introduction	1
1.1 Goal	1
2.0 Study Approach	2
2.1 Study Implementation	2
2.2 Study Area	3
3.0 Screening Assessment	4
3.1 Sampling Strategy and Methods	4
3.2 River and Floodplain Sampling Results	5
3.2.1 In Situ Measurements	5
3.2.2 River Water	6
3.2.3 River Sediments	6
3.3 Floodplain Sampling Results	7
3.3.1 Surface Water	7
3.3.2 Sediments	9
4.0 Fish Tissue Contamination Assessment	10
4.1 Sampling Strategy and Methods	10
4.2 Sampling Results	11
4.2.1 Fish Fillets	11
4.2.2 Whole Body Fish	15
4.2.3 Floodplain Fish.	18
5.0 Fish Health Index Assessment	19
5.1 Sampling Strategy and Methods	19
5.2 Autopsy Results	20
6.0 Discussion and Review of Results	21
6.1 Public Health Considerations	25
6.2 Preliminary Ecological Risk Evaluation	26
6.2.1 Assumptions	26
6.2.2 Exposure Pathways	27
6.2.3 Exposure Profiles	28
6.2.3.1 Wood Stork	28
6.2.3.2 Belted Kingfisher	28
6.2.4 Effects Profiles	29
6.2.4.1 Mercury	29
6.2.4.2 DDTr	30
6.2.5 Risk Characterization	32
6.2.6 Sources of Uncertainty	32
6.2.7 Results and Conclusions	33
7.0 References	35
Tables	
Figures	
Appendices	

Tables

1. Potential Chemicals of Concern Associated with Superfund Sites.
2. Sequence of Sampling Efforts for the Mobile River Study.
3. Minimum Detection Limit Ranges for Potential Chemicals of Concern for All Fish Tissue Samples Analyzed.
4. Organic Compounds Detected in River Surface Water Samples. October 1993.
5. Results of Inorganic Analyses of River Surface Water Samples. October 1993.
6. Results of Inorganic Analyses of River Sediment Samples. October 1993.
7. Particle Size and Organic Carbon Content as Percent Dry Weight of River Sediments (October, 1993) and Floodplain Sediments (April, 1994).
8. Mobile River Study, August 7, 1993.
9. Results of Organic Analyses of Surface Water Samples from the Floodplain Wetlands. October 1993.
10. Results of Inorganic Analyses of Surface Water Samples from the Floodplain Wetlands. April 1994.
11. Results of Inorganic Analyses of Sediment from the Floodplain Wetlands. April 1994.
12. Results of Organic Analyses of Floodplain Sediments. April 1994.
13. Results of Organic Analyses of Largemouth Bass Fillet Composite Samples. November 1993.
14. Results of Organic Analyses of Channel Catfish Composite Fillet Samples. November 1993.
15. Mean and Range of Lipid Content for Largemouth Bass and Channel Catfish fillet and Whole Body Samples. 1993 - 94.
16. Results of Inorganic Analyses of Largemouth Bass Fillet Samples. November 1993.
17. Results of Inorganic Analyses of Channel Catfish Fillet Samples. November 1993.
18. Results of Organic Analyses of Largemouth Bass Whole Body Samples. November 1993.
19. Results of Organic Analyses of Channel Catfish Whole Body Samples. November 1993.
20. Mean and Range of Detectable Concentrations of DDE, DDD and DDT in Fillet and Whole Body Samples of Largemouth Bass and Channel Catfish. November 1993.
21. Results of Inorganic Analyses of Largemouth Bass Whole Body Samples. November 1993.
22. Results of Inorganic Analyses of Channel Catfish Whole Body Samples. November 1993.
23. Results of Inorganic Analyses of Whole Body Forage Fish Composite Samples. November 1993.
24. Results of Organic Analyses of Whole Body Forage Fish Composite Samples. November 1993.

25. Results of Inorganic Analyses of Whole Body Samples of Fish Collected from the Floodplain Wetlands. April 1994.
26. Results of Organic Analyses of Whole Body Fish from the Floodplain Wetlands. April 1994.
27. Fish Health Index Scores for Largemouth Bass. October 1994.
28. Fish Health Index Scores for Channel Catfish. October 1994.
29. Mean and Range of TOTAL DDT concentrations in Fillet and Whole Body Samples of Largemouth Bass and Channel Catfish. April 1994.
30. Mean and Range of Mercury Concentrations in Fillet Samples. November 1993.
31. Mean and Range of Mercury Concentrations in Whole Body Samples. November 1993.
32. Summary of Human Risk Levels from Appendix G.
33. Hazard Quotient Calculations with Supporting Documentation for the Wood Stork (*Mycteria americana*) ingesting Mercury-contaminated prey within the 53-mile Mobile River Study Area, 1993-94.
34. Hazard Quotient Calculations with Supporting Documentation for the Wood Stork (*Mycteria americana*) ingesting DDT-contaminated prey within the 53-mile Mobile River Study Area, 1993-94.
35. Hazard Quotient Calculations with Supporting Documentation for the Belted Kingfisher (*Ceryle alcyon*) ingesting Mercury-contaminated prey within the 53-mile Mobile River Study Area, 1993-94.
36. Hazard Quotient Calculations with Supporting Documentation for the Belted Kingfisher (*Ceryle alcyon*) ingesting DDT- contaminated prey within the 53-mile Mobile River Study Area, 1993-94.

Figures

1. Mobile/Tombigbee Rivers Sampling Stations and Areas.
2. Site Locations for Water Quality and Sediment Sampling in River and Floodplain Wetlands, Station MT-0 October, 1993 and April, 1994, respectively.
3. Site Location for Water Quality and Sediment Sampling in the Mobile River, Station MT-1, October 1993, respectively.
4. Site Location for Surface Water and Sediment Sampling the river station MT-2 and in the Floodplain Wetlands associated with Cold Creek Swamp. October, 1993 and April, 1994 respectively.
5. Site Locations for Water Quality and Sediment Sampling in the River (MT-7), and Floodplain Wetlands MT-7S, and MT-7N, October 1993, and April 1994, respectively.
6. Site Location for Water Quality and Sediment Sampling in the River MT-9, and MT-8, and Floodplain Wetlands, MT-8, October 1993 and April 1994, respectively.
7. Site Locations for Water Quality and Sediment Sampling in the Floodplain Wetlands, MT-11, April 1994. Tensaw Lake area of Tensaw River.
8. Sampling Site Locations and Results for Total Mercury, and Temperature in the Floodplain Wetlands associated with Cold Creek Swamp, and Station MT-2, April 1994.
9. Sampling Sites and Results for Total Mercury in Canal Surface Water, November, 1994. Barry Steam Electric Generating Facilities, Cooling Water return to the Mobile River.
10. Length of Age Frequency for Largemouth Bass from the Upper Mobile Delta, Mobile River. Fall, 1991.
11. Fillet Samples Exceeding DDE Criteria Relative to Station, Species and Size. November 1993.
12. Fillet Samples Exceeding DDD Criteria Relative to Station, Species and Size. November 1993.
13. Fillet Samples Exceeding DDT Criteria Relative to Station, Species and Size. November 1993.
14. Relationship Between Channel Catfish Length and Fillet Concentration of Total DDT. November 1993.
15. Relationship Between Largemouth Bass Length and Fillet Concentration of Total DDT. November 1993.
16. Relationship Between Size of Channel Catfish and Fillet Concentration of Mercury. November 1993.
17. Relationship Between Size of Largemouth Bass and Fillet Concentration of Mercury. November 1993.
18. Range and Mean Concentration of Mercury in Largemouth Bass Fillet Samples Prepared of Large Fish. November 1993.
19. Range and Mean Concentration of Mercury in Channel Catfish Fillet Samples. November 1993.
20. Relationship Between Largemouth Bass Total Length and Whole Body Concentration of Total DDT. November 1993.

21. Relationship Between Channel Catfish Total Length and Whole Body Concentration of Total DDT. November 1993.
22. Relationship Between Whole Body Lipid Content and Size of Largemouth Bass. November 1993.
23. Relationship Between Whole Body Lipid Content and Size of Channel Catfish. November 1993.
24. Average and Range of Total DDT Concentration of Largemouth Bass Whole Body Samples. November 1993.
25. Average and Range of Total DDT Concentration of Channel Catfish Whole Body Samples. November 1993.
26. Relationship Between Size of Largemouth Bass and Whole Body Concentration of Mercury. November 1993.
27. Relationship Between Size of Channel Catfish and Whole Body Concentration of Mercury. November 1993.
28. Average and Range of Mercury Concentrations in Largemouth Bass Whole Body Samples Relative to Sampling Station. November 1993.
29. Average and Range of Mercury Concentrations in Channel Catfish Whole Body Samples Relative to Sampling Station. 1993-1994.
30. Average and Range of Total DDT Concentration of Forage Fish Whole Body Samples. November 1993.
31. Mean Fish Health Index (FHI) Scores for Largemouth Bass and Channel Catfish. November 1993.
32. Cumulative Distribution Frequency for Largemouth Bass Fillet Concentration of DDE. November 1993.
33. Cumulative Distribution Frequency for Channel Catfish Fillet Concentration of DDE. November 1993.
34. Temporal Trend in Total DDT Concentration of Largemouth Bass Whole Body and Fillet Tissue Samples from the McIntosh Area of Tombigbee River.
35. Temporal Trend in Total Mercury Concentration of Largemouth Bass Whole Body and Fillet Tissue Samples from the McIntosh area of the Tombigbee River.

Appendices

- A. Plan of Study (POS) and Related Amendment.
- B. In Situ Measurements and Results and Mean and Monthly River Flows.
- C. Fish Collection Protocol, Mobile River Study, 1993-94.
- D. Fish Health Index (FHI) Protocol.
- E. Autopsy Field Data Sheets.
- F. Spreadsheets Summarizing of Autopsy Data and Calculated FHI Scores.
- G. Human Health Risk Evaluation of Fish Data, Mobile River Study.
- H. Responsiveness Summary.

Summary, Conclusions, and Recommendations

Summary

- The goal of the Mobile River Study was to assess the contamination of the river, including those hazardous substances and contaminants associated with and potentially emanating from four Superfund National Priority Listed Sites and entering the Mobile-Tombigbee River system. To assess the potential effects of these contaminants, a 53 mile reach of the river system was designated for study. This reach extended upstream from River Mile Marker 19 near the Interstate I-65 bridge to a point approximately 13 miles upstream of McIntosh, Alabama.
- Study objectives included the characterization of the surface water and sediments of the river and associated floodplain wetlands, assessment of the chemical contamination of Largemouth Bass, Channel Catfish and forage fish, and determination of the health condition of the bass and catfish.
- The field investigation activities spanned a period extending from September, 1993 through early November, 1994. During this period, six data collection surveys were conducted. Of this number, five were conducted in the river and one in the floodplain wetlands associated with the river while under a period of inundation by river flow.
- Of the myriad of organic compounds and metals analyzed for in sediments and water, mercury and the pesticide DDT and related metabolites DDE and DDD emerged as the chemical constituents of potential concern in the study reach of the river. The analytical detection of DDT and metabolites was limited mainly to sediments of the river and floodplain wetlands intimately associated with the Olin Basin. Total mercury concentrations exceeding EPA criteria for surface water were restricted to samples collected from the Cold Creek Swamp area when flooded by river water.
- With the exception of cyanide and volatile organic compounds, fish tissues were analyzed for the same chemical constituents as were the sediments and surface water. One hundred sixty-two fillet composite samples of Largemouth Bass and Channel Catfish were prepared from small, medium and large size groups and analyzed. About 120 whole body samples of bass, catfish and forage fish were chemically analyzed. As was the case for the sediments and water, total mercury and the pesticide DDT and related metabolites DDE and DDD emerged from the analyses as the only chemical constituents found to be a potential concern.

- Relative to public health considerations, mercury levels in the fillet samples of Largemouth Bass and Channel Catfish were well below the US Food and Drug Administration (USFDA) action level and EPA criteria of one mg/kg. A limited human health assessment yielded Hazard Quotients (HQs) for mercury between 0.1 and 1.0. These values were within EPA's acceptable level of an HQ less than 1.
- Total DDT concentrations of the Largemouth Bass and Channel Catfish fillet samples were well below the action level of 5 mg/kg established by the USFDA. However, DDE, DDD, and DDT concentrations exceeded the State of Alabama adopted criteria in 10 and 7 percent of the bass and catfish fillet samples analyzed, respectively. Twenty-six and 53 percent of the bass and catfish fillet samples contained concentrations of these compounds that exceeded EPA criteria. A limited human health risk assessment yielded an increased risk (between 1:10,000 and 1:100,000) of cancer under the subsistence fisherman scenario. This scenario assumes a subsistence fisherman eating 6 ounces of contaminated fish from an area of the river adjacent to the Olin Basin and Ciba-Geigy floodplain, twice a week, for 30 years.
- A preliminary ecological risk evaluation was conducted using exposure scenarios involving a Wood Stork and a Belted Kingfisher as representative target receptors for the study area. The evaluation demonstrated a potential for adverse ecological effects, particularly for fish eating birds. The belted kingfisher and the wood stork were chosen as representative receptors for the exposure assessment.
- Results of the Fish Health Index indicate that Largemouth Bass and Channel Catfish were in relatively good condition with the exception of encysted parasitic worms in the spleens, livers, and kidneys which was common to all stations including the reference and background stations. Lipid content of the fish were within the range of values associated with background and reference data.
- The mean concentration of mercury was significantly greater in the fillets of Channel Catfish collected from the river station position adjacent to the Cold Creek Swamp which is associated with drainage from the Stauffer NPL Sites.
- Concentrations of total DDT were detected in nearly all fish samples. The highest mean concentrations of total DDT in fillet and whole body samples of catfish, bass, and forage fish were found in the river area associated with the McIntosh sampling station and the Olin and Ciba-Geigy NPL Sites. Historical data coupled with results of this study suggest a decline in the contamination level of total DDT in the Largemouth Bass and probably also in other fish.

Conclusions

- The findings of this study demonstrate that sediments of the river and floodplain wetlands that are in close association with the Olin and Ciba-Geigy NPL sites (MT-7), are contaminated with total DDT and mercury. Fish from the river and floodplain wetlands in close association with these same sites, were contaminated with DDT and related metabolites. In addition, elevated concentrations of total mercury occurred in surface water and sediments of the floodplain wetland and in fish from the river area associated with the Stauffer LeMoyne and Cold Creek Plant NPL Sites (MT-2).
- Overall, the limited human health risk assessment indicates that the risk to the general public was marginal or within EPA criteria; however, a potential increased risk to a subsistence fisherman was demonstrated.
- The preliminary ecological risk evaluation indicates that, in general, there is no potential effect to large, fish eating, wading birds as represented by the woodstork. A potential for ecological effects is evident for the belted kingfisher and those fish eating birds having similar ecological functions and feeding regimes.
- These results indicate that the four NPL Sites and their associated wetlands are potential sources to the river system.

Recommendations

- Given the conclusions stated above, this report recommends remedial action for the floodplain wetlands of the four NPL Sites. In addition, active monitoring of the river should be implemented in the vicinity of the Cold Creek Swamp in Axis and the Olin Basin/Ciba-Geigy floodplain in McIntosh. In addition, a continued monitoring program for the river system should be developed to determine that contaminant levels in the river channel continue to decrease, as indicated in the finds of this report, to more acceptable levels.

1.0 Introduction

The Mobile/Tombigbee River is a waterway extending north from Mobile Bay to Pickwick Reservoir on the Tennessee River. Along its course upstream from Mobile Bay are four Superfund National Priority List (NPL) Sites. The Stauffer Chemical (LeMoyne Plant) Site located in Axis, Alabama and the Stauffer Chemical (Cold Creek Plant) Site located in Bucks, Alabama are approximately 20 miles north of Mobile, Alabama, at River Mile 26. The Olin Corporation (McIntosh Plant) and the Ciba-Geigy Corporation (McIntosh Plant) are located in McIntosh, Alabama, approximately 50 miles north of Mobile, Alabama at River Mile 60 (Figure 1).

Each of these Sites has backwater or floodplain wetland areas that are adjacent to and are hydrologically connected to the Mobile/Tombigbee river system. From review of background information and results of on-going investigations initiated through the CERCLA process, it has been shown that each of these wetland areas contain sediments containing elevated levels of hazardous substances. This information survey provided a basis for the development of a list of Chemicals of Concern (Table 1). The presence of these contaminants in the wetland areas and the knowledge that the wetland areas are intimately related to the Mobile/Tombigbee river system, lead the U.S. Environmental Protection Agency (EPA) to suspect that the River system had been contaminated by the activities of these four NPL Sites. In addition, other study findings reported by the U.S. Fish and Wildlife Service (USFWS), Alabama Department of Environmental Management (ADEM), and EPA have shown elevated levels of mercury and DDT in the tissue of fish captured from the river segment and in the vicinity of the CERCLA sites. Mercury is a potentially toxic constituent known to be associated with the Stauffer and Olin NPL sites. The compound DDT and its metabolites DDE and DDD are also Chemicals of Concern associated with the Olin and Ciba-Geigy NPL Sites.

EPA believes that the demonstrated potential releases of contamination may pose a threat to human health and the environment. Therefore, the EPA, Region IV, Waste Management Division, Office of Superfund, initiated the Mobile River Study to address the Agency's concern.

1.1 Goal

The goal of the Mobile River Study is to assess the contamination of the river, including those hazardous substances, pollutants and contaminants associated with and potentially emanating from each or all of the NPL Sites and entering the designated river segment. To facilitate this goal, the following objectives were established:

- Characterization of the quality of water and sediments of the river segment and associated wetland areas in

terms of potential chemicals of concern,

- Assessment of the chemical contamination of selected and representative fish species or communities of the river segment,
- Determination of the health condition of a selected top predator game fish species of the river segment.

The data collected from the Mobile River Study will be used to better characterize the contamination in the river segment, assess the potential risks to human health and the environment, and assess contributions of contamination from the four NPL Sites.

2.0 Study Approach

2.1 Study Implementation

The technical approach to this study was described in a Plan of Study (POS). Preceding implementation of the POS, the document was subject to technical and program review by the EPA, the four companies associated with the NPL Sites, the federal and state Natural Resource Trustees, and the Public. With some exceptions as later discussed, the study proceeded as indicated in the POS. An amendment to the POS was implemented in the later stages to reflect some special sampling considerations during high water level conditions in selected floodplain wetland areas of the river. The POS and amendment are provided in Appendix A. In brief, the POS describes study rationale, study design considerations including quality assurance and data quality objectives, sampling design and methods, and general data analysis. The implementation of the POS is next reported including deviations and additions, study observations and results, data discussions and summary and conclusion.

The principle activities of the study were conducted in two phases. The first phase, or screening assessment segment of the study, involved sampling at strategically selected stations to determine the general presence, relative distribution and concentration of constituents for characterizing the quality of surface water and sediments of the study reach. From this effort, the results were used to determine the scope of sampling, if required, to complete the chemical characterization of the water and sediments in a following effort of sampling.

The sampling framework for the second phase of study was organized to provide a basis for comparisons between station parameters, with a primary focus upon assessing fish tissue contamination and the fish health condition of Largemouth Bass and Channel Catfish. The combined sampling activities for the

complete study spanned the period of time extending from mid September, 1993 through early November, 1994. The sequence of sample activities are provided in Table 2.

2.2 Study Area

The study as implemented involved a reach of the Mobile/Tombigbee River system extending approximately 53 miles upstream from River Mile 20 marker located near the Interstate I-65 bridge. Seven stations were sampled for analysis of surface water and sediment. Nine stations were sampled for fish analysis, as indicated in Figure 1. Stations MT-8 and MT-9 were used as background sites. Two additional sites were also selected for reference purposes with one located on the Alabama River (MT-10) near Chrysler, Alabama and the second site on the Tensaw River in the Tensaw Lake region (MT-11). The former site was chosen because of its long term use in the USFWS's National Fish Contamination Study, while the latter was selected for purposes of providing a reference location for characterizing chemicals of concern in the river associated floodplain wetlands. The study reach was fairly typical of the Mobile/Tombigbee River system in terms of general near shore condition and habitat, river width, and depth. Although the river's navigation channel was maintained at a minimum depth of nine feet, depths exceeding 35 feet were frequently encountered over the course of the study reach.

River currents were most pronounced in the maintained channel even at stages of low flow. Common to the near shore areas of the river were eddies created by a meandering shoreline characterized by land points and shore pockets which appeared to be mostly created by bank erosion. The bank erosion appeared more severe and common along the shoreline of the Tombigbee River section of the study reach. Tidal amplitude effects of Mobile Bay were only readily apparent in the vicinity of stations MT-0 and MT-2 which were located at the most downstream segment of the study area.

From a reconnaissance of the study reach in September, 1993, the principle types of substrate characterizing the navigational channel of the Tombigbee section of the study were primarily a mixture of coarse to medium sand, small gravel, and shell fragments. This prominent substrate feature reflected the effects of strong, scouring currents and to some degree, possibly barge traffic. The near shore substrate of the Tombigbee River featured mainly fine to medium sand and traces of silt.

For the Mobile River section of the study area, beginning at the confluence of the Alabama River, sediment composition was typically represented by a substrate of medium to coarse sand in the navigation channel. The bottom areas flanking the channel and the shoreline were generally characterized by a sediment

mixture of fine sand and silt.

Since the Mobile/Tombigbee waterway is maintained for navigation and not flood control, overbanking of the river during storm flow conditions occurs. With overbanking, nutrients and settleable solids are supplied to the river floodplain wetlands. These organic and inorganic materials could include the potential chemicals of concern. For these reasons, selected floodplain areas were included in the sampling strategies.

To help characterize flow conditions of the river monthly mean flow records for the study period were compared to long terms records in Figures B-1 and B-2 (Appendix B). The flow information was provided by the U.S. Geological Survey for the Coffeeville and Claiborne Lock and Dam locations. These records reflect runoff from about 93 percent of the Mobile River drainage basin.

3.0 Screening Assessment

3.1 Sampling Strategy and Methods

To narrow the array of potential chemicals of concern as listed in Table 1, the screening phase of the study involved two sampling periods. In early October, 1993, the river was sampled during low flow stages. The floodplain wetlands associated with the river were later sampled under conditions of inundation in early April, 1994. The flooded condition provided access to the sampling areas by boat.

A selected number of sediment and water samples from the study reach were collected and analytically screened for the chemical constituents. The stations sampled were MT-0 (downstream of I-65 bridge), MT-1 (upstream approximately one mile from I-65 bridge), MT-2 (downstream of Cold Creek swamp), MT-7 (downstream of Olin Basin at McIntosh), MT-8 (Three Rivers Lake, a backwater area approximately four miles upstream of McIntosh), MT-9 (approximately five miles upstream of McIntosh), and MT-11 in the Tensaw Lake area of the Tensaw River near Brant's Landing, Alabama.

The sampling scheme at each of the screening stations on the river was initiated by first determining the vertical distribution of temperature, dissolved oxygen (DO), conductivity, and pH in the water column using field calibrated electronic probes. These profiles help to determine the presence and degree of physical and chemical stratification of the water column and the depth at which to obtain the most representative samples of the river's water column. Sampling of the water column was accomplished with a DC electrically operated peristaltic pump which served to evacuate a precleaned four liter sample bottle.

From the bottle, an intake line of precleaned teflon tubing was extended to the water depth selected for sampling. The four liter collection bottle when full was used to pour into separate sample bottles for analyses. Samples for volatile analyses were taken directly from the teflon intake line when used as a capillary tube.

Water sampling of the inundated floodplain wetlands was accomplished from a boat. Individual sample bottles were directly submerged to a depth of approximately one foot and filled. For collection of water samples for ultra trace level analysis of mercury, the person collecting the sample wore a second pair of plastic gloves which extended the length of the arm. For each floodplain station, multiple sites were sampled for surface water and sediment analyses (Figures 2, 3, 4, 5, 6 and 7). The sampling sites in the floodplain wetlands are bracketed for clarity. These sites were haphazardly selected and not georeferenced with GPS readings; thus, their position shown in the former figures were general approximations relative to the river and other land marks. During the course of sampling in the floodplain wetlands, samples of fish were also collected for tissue analyses. Because of the active sampling strategy of electrofishing, the fish samples represented a composite of specimens rather than discreet samples for a specific site as was the case for water and sediments. Results of the fish tissue analyses are reported later in the fisheries section.

Sediment samples were collected from the river's navigation channel and the shallower, off channel areas of the river bed. Initially, sampling was accomplished at the first station (MT-0) with diver operated hand cores, this was subsequently discontinued, for the efficiency and safety of a petite ponar dredge deployed from the boat. In the floodplain wetlands, sampling was accomplished with a hand held auger which was fitted with an extension handle, which was operated from a sampling boat. By either means of sampling, multiple samples of sediments from each site were composited to ensure a sufficient sample size was obtained for chemical and particle size analyses.

3.2 River and Floodplain Sampling Results

3.2.1 In Situ Measurements

The results of the in situ measurements of DO, temperature, conductivity and pH are detailed in Appendix B. These data indicated the water column of the river was well mixed vertically with the exception of the navigation channel at station MT-0 and MT-2. The depth at which water sampling was conducted are indicated in Table B-1. Density stratification in conjunction with safety concerns associated with prolonged anchoring in the navigator's channel were principal considerations in choosing sampling locations. The type sampling device employed for the

collection of water samples required sustained anchoring for a period exceeding one hour. Barge traffic during the anchoring period proved to be a significant safety concern.

3.2.2 River Water

Although the water samples were analyzed for a great number of organic compounds, very few contaminants were found at concentrations exceeding minimum detection limits (MDL) of the selected analytical procedures (Table 3). This table provides the range of minimum detection limits per parameter as encountered during the course of their respective analyses. The variation mainly reflected differences in individual sample variables such as moisture content, sample size of extraction aliquot, and matrix composition. Subsequently, the MDL varied greatly between some of the samples which were analyzed for the same constituent.

The results of the organic analyses identified only three compounds (Table 4). Atrazine was detected at low concentrations in samples from station MT-7 near McIntosh and Stations MT-8 and MT-9 which were both background locations located about four to five miles upstream from McIntosh. Atrazine is listed as a chemical of concern associated with the Ciba-Geigy NPL site. EPTC, a thiocarbamate compound, was detected in low concentrations at station MT-2, MT-0 and MT-1, near the I-65 bridge.

The results of the inorganic analyses indicated an array of metals present in all water samples (Table 5). Of this array, copper and mercury were the only constituents listed among the chemicals of concern. Mercury was found at very low concentrations at all stations with values ranging from 1.7 to 4.9 ng/l. Copper concentrations ranged from less than 2.0 ug/l to 7.4 ug/l. Other than copper, the concentrations of the metals detected were generally comparable to or less than what was observed at the two background stations MT-8 and MT-9.

3.2.3 River Sediments

The objective of sediment sampling in the screening study was to characterize the chemical quality of sediments and determine if the chemical constituents and concentrations varied according to sources such as the NPL Sites and particle size of the bottom substrate. An assumption involved in this sampling approach was that sorptive processes coupled with settling properties of inorganic and organic particles would favor the accumulation of chemicals in sediments characterized by finer substrate particles.

The sediment analyses resulted in the quantification of 15 metals and no detectable concentrations of organic compounds. Of

the quantified metals, copper and lead were the only chemicals of concern detected. Their concentrations, as well as the other metals reported, were subject to a wide degree of variation between samples (Table 6).

The sediment samples were subjected to a particle size analyses which yielded a suite of size fractions reported as percent composition by dry weight (Table 7). Two principal types of bottom substrates were determined from the analyses. Sampling sites designated as MT-0C, MT-2A1, A2, A3, and MT-8 were characterized by a substrate comprised primarily of fine sand and silt. Sediments from sites MT-0B and MT-1C were characterized by a predominance of coarse to medium sand and traces of silt. A characterization also applied to station MT-9 as determined by a field inspection rather than a laboratory analysis. A sediment sample of station MT-9 was returned to the laboratory for analyses but lost in the process. Given these physical differences in sediment, those substrates sharing like particle size composition also appear to share similar metal concentrations (Table 6).

Two months prior to the above sampling, the personnel of the Center for Applied Isotope Studies of the University of Georgia (UGA) conducted a survey of bottom sediments for trace and heavy metal concentrations (Noakes 1993). Their sampling effort extended from River Mile 5 on the Mobile River and upstream to RM 78 on the Tombigbee River. Within this reach, box core grab samples of sediments were collected from 22 locations along the center line of the river. Each sediment sample was sieved and the particle fraction passing through a 200 mesh screen (75 micron mesh opening) was analyzed for metals. Their findings are summarized in Table 8. Many of the elements reported in the UGA study such as Cadmium and Mercury were not detected in the screening study of EPA. One aspect of the UGA study was that the metal analysis involved exclusively very fine sediments because of the sieving process in preparing the samples for analysis. The results of the UGA study indicate that the metals concentrations of the river sediments both upstream and downstream of the NPL Sites were similar, as the EPA survey.

3.3 Floodplain Sampling Results

3.3.1 Floodplain Surface Water

Of the organic compounds analyzed in water samples from the floodplain survey, Atrazine and Simazine were the only compounds found at detectable concentrations (Table 9). Both compounds are labeled as selective herbicides with the former being in wide use and Simazine to a lesser extent. These compounds also feature relatively low solubility in water and are common constituents of farm field runoff (Grover 1989). With the exception of station MT-0, Simazine, a listed chemical of concern associated with the

Ciba-Geigy NPL site, was detailed in at least one of the three sites sampled at each station. Atrazine was common to all stations. Concentrations of these herbicides ranged from 0.020 to 0.55 ug/l and 0.037 to 0.06 ug/l, respectively. The wide distribution of these two herbicides across the study area including the background and reference stations suggests watershed sources of these compounds other than or in addition to the Ciba-Geigy NPL site.

The inorganic analyses of the floodplain water samples yield an array of trace and heavy metals (Table 10). Among these metals reported, copper, lead, and mercury were the only elements identified as potential chemicals of concern. Mercury was common to all the surface water samples. Except for station MT-2, total mercury concentrations ranged from 2.8 to 9.6 ng/l. The exception involved the three floodplain sites of station MT-2 in the lower floodplain wetland area of Cold Creek Swamp (Figure 4). Water samples from these three sites contained total mercury concentrations ranging from 37 to 63 ng/l. These values exceeded EPA criteria for surface water and background and reference sites by an order-of-magnitude. The detection of copper in surface waters was limited to the three sampling sites of the floodplain of the lower Cold Creek Swamp MT-2(A), 2(B), and 2(C) and one background site at station MT-8(C). Concentrations of copper were 6.0, 6.6, 7.0, and 3.2 ug/l for these sites, respectively.

Another aspect of the survey findings from the inundated floodplain of the lower Cold Creek Swamp were elevated surface water temperatures. At the time of the sampling, surface water temperatures of 22.0, 22.1, and 26.0 C were measured at sites MT-2(A), 2(B), and 2(C), respectively. Floodplain surface water temperatures measured elsewhere at stations MT-0, 7, 8, and 11 ranged from 16.8 to 18.0 C. The elevated water temperature appeared attributable to the circulation of heated water into the swamp from the nearby Barry steam electric generating facility. At the time of these observations, overbanking of the discharge canal was evident. This overbanking could explain the apparent circulation pattern.

Assuming there is circulation of heated effluent to the Cold Creek Swamp, this effluent did not appear to be as a factor contributing to the elevated values of mercury in the swamp. The temperature gradient coupled with that of the mercury concentration observed in the swamp suggests the heated effluent may be having a diluting effect on the mercury regime of the swamp (Figure 8). Sampling of the steam electric facility's intake and discharge canal were later sampled for mercury analyses. Results of these analyses indicated that the waste water discharges from the facility was not an apparent source of the mercury (Figure 9). Samples for these analyses were collected in November, 1994 during a river stage when flows were

contained within the banks of the canal. The concentration of these samples ranged from 2.5 to 3.9 ng/l and were comparable to background concentrations reported for the October, 1993, survey of the river. These results would suggest that the elevated mercury concentrations in Cold Creek Swamp were not likely derived from the waste water discharge of the Barry steam electric generating facility but rather from drainage originating in the swamp.

3.3.2 Floodplain Sediments

Organic analyses of sediments from the river's floodplain wetlands indicated the presence of few quantifiable compounds (Table 12). The compound DDT and related metabolites were found mainly in the sediments of the floodplain wetlands between the Olin Basin and the river (Figure 5). Of the three sampling sites, MT-7C(A), MT-7S(B), and MT-7S(C), the latter station was positioned about 40 feet southwest of the vegetational edge of the floodplain and actually in the river bed. Sediment concentrations of total DDT at these stations were 338, 95, and 30 mg/kg, respectively. The latter two concentration were an order-of-magnitude greater than the ER-L value of 3 mg/kg which was established by Long and Morgan, 1990 as a concentration above which adverse effects to sensitive species of aquatic may be initiated. For station MT-7S(A), the sediment concentrations of 338 mg/kg of total DDT approached the ER-M value which was considered to be a concentrations above which adverse effects are almost always observed or predicted.

Concentrations of trace and heavy metals from MT-7S(C) were substantially less when compared to the other floodplain sites but similar to the river's bottom substrate characterized by fine sediments at river sites MT-0C and MT-2A, 2B, and 2C (Table 6). The sediments from site MT-7S(C) were also characterized by the predominance of fine sand and silt (Table 7).

The other floodplain sediments were also in sharp contrast to MT-7S(C) as well as the other river sediments. The silt-clay fractions of the floodplain sediments were two to three times greater than observed at MT-7S(C) and elsewhere in the river. The greater content of silt and clay of the floodplain sediments probably helps explain the greater concentration regimes of metals which were found in the floodplain substrates of the river.

The analytical results for the floodplain sampling sites indicate similar inorganic chemical constituents and concentrations among the stations with the exception of mercury at sites MT-0(C), MT-2(B), MT-2(C) and MT-7S(A) (Table 11). At these sites, sediments concentrations of mercury ranged from 3.3 to 32 mg/kg. The concentrations were one to two orders-of-magnitude greater in concentrations compared to other sites and

exceed the ER-M value of 1.3 mg/kg. The EM-L value is a sediment concentration above which adverse effects can be expected or predicted (Long and Morgan, 1990). Mercury is a chemical of concern identified for both the Stauffer and Olin NPL Sites which was associated with the latter three sampling sites, respectively. Site MT-0(C) was located downstream of the Stauffer Site.

4.0 Fish Tissue Contamination Assessment

4.1 Sampling Strategy and Methods

The focus of the fishery work was to assess the chemical contamination of Largemouth Bass, Channel Catfish and forage fish. The study approach to this objective involved electrofishing from a boat and the use of cheese baited slat box traps measuring 15 X 15 X 72 inches. The fish collection efforts for the river and inundated floodplain wetlands occurred at different times of the year. For the river sampling, fish collection efforts were in November and December, 1993. Fish collection in the floodplain wetlands occurred in April, 1994.

To assess chemical contamination of the targeted species, fillet and whole body samples were analyzed for most of the chemicals of concern listed in Table 1. Cyanide and volatile organic compounds were excluded from these analyses. The fish sampling and processing protocols leading to these analyses involved the collection of sufficient numbers of the desired species of different size groups.

For the Largemouth Bass, length at age frequency data for the upper Mobile River Delta area were obtained from the Alabama Division of Game and Fish, Fishery District 5 at Spanish Fort, Alabama (Figure 10). From these data, three size groups were selected for the Largemouth Bass which were: 170 to 225 mm (small), 226 to 300 mm (medium), and 301 to 400 mm (large). In each size group, the length of the smallest fish size was targeted to equal to or greater than 75 percent of the length of the largest fish of the group. In most cases, the targeted size range was obtained. To develop the three size groups for Channel Catfish, samples of the species were collected from the upper and lower reaches of the study area. From these collections, a size distribution for the species was obtained and the following length determined: 200 to 275 mm (small), 276 to 375 mm (medium), and 376 to 500 mm (large). Total length was the standard unit of length measurement for both bass and catfish. The protocol for processing the fish after capture is provided in Appendix C.

Each size group was represented by three replicate composite samples of fillets for inorganic analyses and three replicate composite samples of fillets for organic analyses. To accomplish

the whole body analyses, several specimens of the two predator species were collected from each station. For each species, an array of sizes were selected. The forage fish samples were comprised of an assemblage of small species which usually included menhaden, silversides, small sunfish, shad and minnows. Six replicate composite samples of forage fish were collected from each station and divided between the organic and inorganic analyses.

As expected the catch per unit of effort for the species of interest varied among the study stations. For this reason, the river area for the collection of fish also varied among stations because of the fixed sample size need. The general fishing areas are depicted in Figure 1. These same fishing areas also served for the Fish Health Index as later reported.

A special sampling effort was extended to the floodplain wetlands when they were inundated during a high river flow period in April, 1994. The purpose of the special sampling was to gain some understanding of the presence and chemical condition of the targeted species inhabiting the wetlands during the inundation period. The sampling strategy was to collect adequate numbers of fish to constitute a sample of sufficient fillet and whole body biomass to represent the three size groups of the targeted species. The stomach contents of the captured fish were examined to determine the types of food items consumed; these contents were analyzed for the chemicals of concern. The limited fish sampling was accomplished with electrofishing gear.

4.2 Sampling Results

4.2.1 Fish Fillets

Approximately 820 specimens of Largemouth Bass and Channel Catfish, were collected and processed for laboratory analyses. The identification and quantification of several organic compounds resulted (Tables 13 and 14). Of these compounds DDT and related metabolites DDE and DDD were the only observed organic chemicals of concern. Other pesticides reported were detected in only a few samples and were widely dispersed among the sampling stations including background and reference sites.

As indicated in Tables 13 and 14, composite samples of fillets representing stations MT-0, MT-2, MT-3, and MT-7 underwent partial thawing in shipment to the laboratory for analyses. Seventeen duplicates of these samples were later shipped and received in the frozen condition by the same laboratory and analyzed. With one exception, which was a bass fillet composite from station MT-0, the duplicate results were in good agreement with the original analyses. The difference in the total DDT concentration between the thawed and frozen duplicates were within the range of variance expected in split samples for

an inter-laboratory analyses of fish tissue for total DDT (EPA, 1993a, 1995a). Subsequently, the initially reported results for the partially thawed samples were treated as uncompromised samples.

The pesticide DDT and its related metabolites were listed as chemicals of concern because of their association with the Olin and Ciba-Geigy NPL sites at McIntosh, Alabama (Table 1). The metabolites DDE and DDD are typically a result of natural degradation processes of DDT. Subsequently, the presence of DDE or DDD in fish tissue at concentrations greater than DDT are common since DDT was banned from manufacturing in 1972. Such is the case for the results of the fillet analyses.

The metabolite DDE was found at detectable concentrations in 94 percent of all samples for both Largemouth Bass and Channel Catfish with DDD occurring in 28 percent and DDT in 6 percent of the total fillet samples. Several of these samples yielded concentrations exceeding Alabama's recently adopted criteria and EPA criteria for human consumption (USEPA 1993). Concentrations of DDE in the fillets of the bass ranged from the MDL to 0.270 mg/kg with 21 and six percent of the values equal to or greater than EPA's and Alabama's criteria of 0.0316 and 0.069 mg/kg, respectively. The concentrations for DDD ranged from less than detection to 0.350 mg/kg with three observations exceeding the EPA criteria of 0.0449 mg/kg and two exceeding the Alabama criteria of 0.096. The measured concentrations for DDT ranged from 0.007 to 0.130 mg/kg and were limited to four composite samples from station MT-7 at McIntosh. Only one of these samples exceeded the EPA and Alabama criteria of 0.0316 and 0.069 mg/kg, respectively.

In Channel Catfish fillet composite samples, concentrations of DDE ranged from 0.005 to 0.290 mg/kg with 53 and seven percent of the values exceeding the EPA and Alabama criteria which are cited above. For DDD, the catfish fillet samples ranged in detectable concentrations from 0.005 to 0.091 mg/kg with five percent of the samples exceeding the EPA criteria. Detectable levels of DDT were limited to five samples from station MT-7 at McIntosh where concentrations ranged from 0.005 to 0.048 mg/kg. Two of these samples exceeded the EPA criteria.

With respect to station location, species, and size group, the distributions of those samples exceeding EPA criteria for DDE, DDD, DDT are shown in Figures 11, 12, and 13. The bioaccumulation of these pesticides to levels exceeding EPA criteria was most prominent in Channel Catfish. The incidence of excessive concentrations was mainly represented in the large and medium size catfish. The large bass were the size class appearing most effected. No detectable concentrations of any of the pesticides were found in fillet samples from Station MT-10 on the Alabama River.

The distribution of samples exceeding EPA criteria among the stations downstream of MT-7 was fairly uniform. Excluding MT-7, the proportion of samples exceeding the DDE criteria at each of the Mobile/Tombigbee stations ranged from 22 to 44 percent with the extreme of this range being represented by reference station MT-8. The number of possible samples for any one station was 18. At station MT-7, 72 percent of the fillet samples exceed the EPA criteria for DDE. For DDD and DDT, samples exceeding the EPA criteria were fewer in number but exclusive to station MT-7 (Figures 12 and 13).

To determine if total DDT concentrations were significantly different between stations, the data were treated in the following manner. A data set was first examined for normality of distribution and homogeneity of variance. Where necessary, the data sets were transformed and tested to assure a normal distribution and homogeneity of variance. A model I ANOVA was followed by an unplanned multiple comparison procedure which employed Duncans multiple range test to discern differences between stations. This particular test was chosen because of its power to detect differences. Total DDT values in the data sets were determined by adding together the reported concentrations of DDE, DDD, and DDT for each of the samples analyzed. In many cases, the respective compounds were reported at a concentration defined as minimum detection limit (MDL). The MDL observations were included in the total DDT calculations by assuming that the median of the MDL as a concentration representing the compound.

Using the Duncans Multiple Range Test at the Alpha 0.05 level, a comparison of mean fillet concentrations between station was conducted for total DDT concentrations in the fish samples. For catfish fillet composite samples, the mean concentration of total DDT for station MT-7 was significantly greater than all other stations. The mean concentration of total DDT in bass fillets was also significantly greater than other stations except in the comparison with the reference station MT-8 where no significant differences in mean concentrations were detected.

Another observation that can be derived from Figures 11, 12, and 13 is that the larger fish reflected a greater proportion of the samples exceeding criteria with catfish appearing to be more prone to the accumulation of these pesticides in the fillet tissue than the bass. Since DDT and its metabolites are lipophilic soluble, bioaccumulation would be more favored in those fish and species with the greater body lipid content. This appears to be the case with the Channel Catfish and Largemouth Bass. The present lipid content of the catfish fillets appeared greater when compared to the bass (Table 15).

To examine the relationship between fish size and pesticide concentration, average length of the five fish comprising each fillet composite and the total DDT concentration of the composite

sample were compared through linear regression (Figures 14 and 15). Total DDT was determined as the sum of detectable DDT, DDE, and DDD concentrations for each fillet composite. The median of the reported MDL were included in the determination. As shown in these two figures, the fillet concentration of total DDT was weakly correlated with fish length. The R SQUARE values for the Channel Catfish and Largemouth Bass regression lines were 0.143 and 0.090, respectively. Of the concentration array plotted for total DDT, no concentration approached the value of 5 mg/kg which is the action level designated for total DDT by the USFDA as protective of human health.

Several trace and heavy metals were detected in the inorganic analyses of fillet samples. For both species, about half of these elements were represented by one or at most a few observations scattered among the stations (Tables 16 and 17). Of these infrequently occurring elements, copper and lead were included.

The array of metals of common detection among the fillet samples included calcium, magnesium, manganese, nickel, potassium, sodium, zinc, and mercury. In most instances, the range in the concentrations per constituent remained similar to values observed for the background and reference stations. Since mercury was identified as a particular metal of concern, its distribution relative to species, size of fish and station are considered in the following.

Through linear regression analyses, the relationship between the total length of fish and fillet concentration was considered for Channel Catfish and Largemouth Bass (Figures 16 and 17). As shown in the former figure, the relationship between fish length and mercury concentration in the catfish was weakly developed as indicated by a low R Square value of 0.067. The regression analyses indicates that on the average, mercury concentrations in the catfish fillet samples remained fairly independent of the fish size. The relationship between fish length and mercury concentration in the Largemouth Bass fillet samples was much more developed as indicated by a R Square value of 0.653. In this analyses, the mercury concentration of the bass fillets appear much more dependent on size of fish than the catfish.

With a more focused view on size effects, the mean and range of concentrations of fillets prepared from the large size groups of Largemouth Bass were plotted relative to station number (Figure 18). For the large size bass, the average concentration of mercury in the fillet samples were bounded by a large degree of variation about the average including the background stations. Stations MT-2, MT-3, MT-4, MT-8, MT-9 and MT-10 appeared similar in range and concentrations.

Mercury concentrations reported for the Channel Catfish

fillets appeared less variable about the mean than with the bass (Figure 19). With exception of station MT-2, the average concentration of mercury for each station varied from 0.05 to 0.11 mg/kg. At station MT-2, mercury ranged from 0.06 to 0.54 mg/kg and averaged 0.23 mg/kg which was nearly twice the value for other stations. The maximum mercury concentration in the reference sites ranged from 0.04 to 0.16 mg/kg. Based upon the observed distribution of this metal among the sampling sites, mercury contamination of the Channel Catfish was most evident at station MT-2, a site in close association with Cold Creek Swamp and the Stauffer NPL site. A Duncan's multiple range test at alpha 0.05 shows the mean concentration of fillets for station MT-2 was significantly greater compared to all other stations.

The reported mercury concentrations for the catfish and bass fillet samples were all substantially less than 1 mg/kg which is the action level of the USFDA and EPA criteria for human consumption (USFDA AND EPA 1995).

4.2.2 Whole Body Fish

The organic analyses of the whole body samples of Channel Catfish and Largemouth Bass resulted in the quantification of five organic compounds which were Endosulfan I (ALPHA), Chlorobenzilate, DDT, DDE, and DDD (Tables 18 and 19). The last four compounds were identified as chemicals of concern. Endosulfan I was limited to a single Largemouth Bass sample from station MT-10, a reference site on the Alabama River. Chlorobenzilate was detected in three of five whole body catfish samples found at station MT-3. This same pesticide was detected in a whole body sample of bass from each of the five different stations including a reference and background site. Collectively among the two species, the detectable concentrations of Chlorobenzilate ranged from 0.041 to 0.083 mg/kg with 0.054 and 0.065 mg/kg representing the background and reference stations (MT-9 and MT-10).

Principal pesticides of concern in this study were DDT and its related metabolites DDE and DDD. Of the total number of whole body analyses of Largemouth Bass (49 fish) and Channel Catfish (42 fish), 96 and 100 percent, respectively, contained detectable concentrations of DDE. For DDD, 35 and 42 percent of the respective samples contained this compound with DDT being limited to 12 percent of the whole body samples. As expected, the DDE levels in both species represented maximum concentrations relative to DDD and DDT. Regarding the latter two compounds, little differences occurred between the fillet and whole body concentrations per species.

The relationship between fish size and concentration of total DDT was examined through linear regression analysis. The median values for the reported MDL observations were included in

the calculation of total DDT concentrations. The correlation of fish length with total DDT concentration was considered through linear regression analyses for both bass and catfish (Figures 20 and 21). Both regression analyses yielded relatively low R SQUARE values of 0.17 and 0.18, respectively. These values suggest that total DDT concentration for whole body were weakly dependent of fish size. Over all, the whole body concentrations of total DDT for the Largemouth Bass averaged about 30 percent greater than the average reported for Channel Catfish (Table 20). This difference between the two species; however, does not appear to be a function of whole body percent lipid content as might be expected (Table 15). Percent lipid content of both whole body and fillets were, with few exceptions, greater in catfish than in the bass. Increased concentration of total DDT, however, favored the bass in terms of whole body contamination. The range of percent lipid content for both species were comparable to those values reported in National Contamination Bioaccumulation Program of the USFWS (Schmitt, Zajicek, and Perterman, 1990). Recent lipid content of whole body bass correlated moderately well with fish size as indicated by a R-SQUARE of 0.38 (Figure 22). For whole body catfish, the correlation between size and percent lipid concentration was poor as indicated by a R-SQUARE of 0.08 (Figure 23).

The distributions of total DDT concentrations in terms of means and ranges for whole body samples of the bass and catfish relative to sampling station are depicted in Figures 24 and 25. The median of the of the reported MDL were include in the determination of total DDT. Using Duncan's multiple range test at an alpha of 0.05, the mean concentration of total DDT in whole body Largemouth Bass was not significantly different between any station sampled except for the reference site (MT-10). Similarly, mean whole body concentrations of total DDT in catfish were not significantly different between stations except for sampling sites MT-8 and MT-10 where the mean concentrations were significantly less.

The inorganic analyses of the whole body samples of Largemouth Bass and Channel Catfish resulted in the detection of 15 and 18 trace and heavy metals, respectively (Table 21 and 22). Lead, chromium, and arsenic were unique to the Channel Catfish samples. These elements were limited to only a few observations among the samples as were cobalt, copper, and nickel for both species. Those elements common to both the bass and catfish samples included aluminum, barium, calcium, iron, magnesium, manganese, potassium, selenium, sodium, vanadium, and mercury. The range of concentrations for these elements were generally similar among all stations with the exception of mercury.

The relationship between the whole body concentration of mercury and fish length was considered through linear regression analysis (Figures 26 and 27). For both Largemouth Bass and

Channel Catfish the small R SQUARE values of 0.077 and 0.038 indicate that mercury concentration was nearly independent of body length. The distribution of bass and catfish whole body mercury concentrations among the sampling stations is illustrated in Figures 28 and 29. With the exception of station MT-2, the average and range of mercury for the bass remained relatively consistent among the stations with average concentrations varying from between 0.11 to 0.26 mg/kg. Mercury concentrations of whole body bass from station MT-2 averaged about three times greater than mean values of the other stations. Using Duncan's multiple range test at an alpha of 0.05, a comparison of the means showed that average concentrations of mercury were not significantly different between stations MT-2 and MT-8, a background site but significantly increased above the means for all other sampling sites.

Concentrations of mercury for the whole body samples of catfish appeared more variable among the stations than with the bass. Mean values for total mercury ranged from 0.04 to 0.74 mg/kg. The latter concentration was associated with station MT-3 which was not significantly different from either the background site at MT-9 or the reference station MT-10, per the Duncan's multiple range test at an Alpha of 0.05.

The forage fish assemblage sampled in the study was mainly represented by juvenile menhaden, silversides, small sunfish, shad and assorted minnows. Results of the inorganic analyses of the forage fish composites are provided in Table 23. Detectable concentrations of arsenic, chromium, copper, and lead were found in less than 20 percent of the samples analyzed (N=29) and were scattered among the stations. Concentrations of barium, magnesium, potassium, selenium, sodium, vanadium and mercury were common to all stations. Mercury concentrations varied from 0.02 to 0.07 mg/kg across all stations. Thirty-three percent of the forage fish samples analyzed yield MDL results. Of the remaining elements detected, the concentrations of aluminum, iron, manganese, and zinc were generally about 10 times greater in forage fish than in either Largemouth Bass or Channel Catfish.

The results of the organic analyses of the forage fish composite samples indicated the presence of one Aroclor compound which was PCB-1260 and the pesticide DDT, DDE and DDD (Table 24). The PCB compound was detected in one sample from station MT-0 and MT-10, a reference site on the Alabama River. The observed levels of DDE ranged from a MDL of 0.005 to a maximum detectable concentration of 0.250 mg/kg. DDT concentrations ranged from the MDL which varied from 0.005 to 0.020 mg/kg to a maximum detectable level of 0.029 mg/kg. The distribution of total DDT relative to sampling station is shown in Figure 30. The calculation of total DDT included median values for all the observed MDL results. With the exception of station MT-7, the maximum concentration remained less than 0.10 mg/kg at all

stations with the average varying from 0.008 to 0.067 mg/kg. The concentrations for the three replicate samples of forage fish from station MT-7 ranged from 0.074 to 0.310 mg/kg and averaged 0.158 mg/kg. This mean, when compared to other stations, was not significantly different from station MT-2 as determined from Duncan's multiple range test at an alpha of 0.05. These two stations both yield mean concentrations significantly greater than all other stations.

4.2.3 Floodplain Fish

The floodplain wetlands were sampled during the first week of April, 1994 when the river stage was sufficient to inundate the area and provide access by boat. Those stations involved in the sampling included MT-0, MT-2, MT-7, MT-8, and MT-11. Few specimens of the targeted species were collected. The dispersion opportunities of the fish in these inundated areas of the floodplain were greatly enhanced relative to the river when flow was within bank, thus making the fish more difficult to locate and capture. Those fish collected included forage fish, from all stations, Largemouth Bass from all stations except MT-7, and Channel Catfish from only station MT-2. The forage fish were represented primarily by juvenile shad. All the fish collected were processed for whole body chemical analyses because of their few numbers. Also the stomach content of the collected Largemouth Bass and Channel Catfish were examined and chemically characterized when sufficient sample biomass was available.

The inorganic analyses of the whole body tissue from the floodplain wetlands identified 17 trace and heavy metals (Table 25). Of these elements, aluminum, chromium, cobalt, copper, nickel, and vanadium were found at detectable concentrations in only the forage samples. Barium and iron were common to the forage fish but only detected in two bass and one catfish samples, respectively. The remaining elements of calcium, magnesium, manganese, potassium, selenium, sodium, zinc, and mercury were found at detectable concentrations in all fish from all stations. The range of Largemouth Bass and forage fish whole body concentrations of this latter group of elements were comparable to the values reported for the river samples of fish with the exception of mercury in the forage fish from the floodplain of stations MT-2 and MT-11. Mercury ranged from 0.02 to 0.07 mg/kg in forage samples from the river when sampled six months prior to the floodplain sampling (Table 23). The floodplain composite samples of the forage fish yielded mercury concentrations of 0.05, 0.05, 0.10, 0.21, and 0.23 mg/kg with the latter two observations coming from the reference site MT-11 on the Tensaw River and MT-2 in the Cold Creek Swamp, respectively.

The organic analyses of the whole body fish samples from the floodplain wetlands indicated the presence of two pesticides at detectable concentrations. These compounds were Methoxychlor

which was found only at station MT-7 and DDT and related metabolites DDE and DDD (Table 26). The metabolite DDE was detected at all stations in samples of the Largemouth Bass and forage fish. Concentrations ranged from the MDL's which varied from 0.005 to 0.010 mg/kg to a maximum detectable concentration of 1.20 mg/kg which occurred in the forage fish sample from the wetland associated with station MT-7 at McIntosh. The second greatest concentration was 0.85 mg/kg from stations MT-8, a background site.

Total DDT concentrations were at least in order-of-magnitude greater in the forage fish at MT-7 and 8 than the other floodplain stations. The former location represented the general floodplain area between the Olin Basin and the Tombigbee River at McIntosh. The latter station was a background station located about 4 river miles upstream from McIntosh in the Three Rivers Lake region (Figure 1). Total DDT concentrations of forage fish samples from the river at these two stations in the November 1993 survey were one to two orders of magnitude less (Table 24 and 26).

For mercury, concentrations in the forage fish were about four times greater in the floodplain at stations MT-2 and 7 than at the other sampling areas (Table 25). As was the case with DDT, the forage samples collected from the floodplain, contained 10 times the mercury concentrations found in forage samples from the river. In the case of the few Largemouth Bass collected maximum concentrations of mercury were observed in samples from MT-2 and MT-7 which were associated with the Stauffer and Olin NPL Sites where mercury has been identified as a chemical of concern. The concentration of mercury in these floodplain samples of bass were well within the range reported for river samples at MT-2.

5.0 Fish Health Index Assessment

5.1 Sampling Strategy and Methods

The Fish Health Index (FHI) assessment was initially planned to involve Largemouth Bass as the predator species of interest. When the assessment was implemented in the period of October 25 to November 2, 1994, the Channel Catfish was selected as a second target species. This species was added to the study because of its popularity as a commercial species and its distribution throughout the study area.

Largemouth bass were collected by electrofishing. Channel catfish were collected by electrofishing and cheese baited slat traps. Fish samples were collected from the same nine sampling stations used to collect fillet and whole body samples for tissue analyses (Figure 1). Upon collection in the field, fish were

placed in a live well and disturbed as little as possible until anesthetized for the autopsies. The minimum collectable length for Largemouth Bass was 250 mm and for Channel Catfish 325 mm. An attempt was made to collect 15 bass and 15 catfish at each sampling location. Internal and external examinations were performed on over 200 individual fish according to EPA Region IV protocol for conducting a Fish Health Index (FHI) (Appendix D).

All autopsies were performed in the field in a mobile laboratory. In general the autopsy consisted of an external and internal examination and a blood analyses. Observations were recorded on field data sheets as a number or letter code. The codes used on field data sheets were the same codes used by Goede (1993). Copies of field data sheets are included in this report in Appendix F.

After completing autopsies, the number/letter code describing the physical/pathological condition of each tissue or organ examined was assigned a numerical score (except for sex, fat deposits, and the gall bladder). Next, an accumulative score for each fish was calculated and then a mean FHI score was calculated for groups of fish from the same sampling station. All scoring of physical/pathological conditions and subsequent calculations were performed automatically upon entering field data into a computerized spreadsheet. The spreadsheet was designed specifically to manipulate fish health data. Some of the number/letter codes on the field data sheets had to be replaced with a new code number/letter before entering on the spreadsheet before manipulations and calculations could be executed. The new codes are listed in the protocol for conducting the FHI. Spreadsheets reflecting these code changes as well as displaying the calculated scores mentioned above are included in this document as Appendix E.

5.2 Autopsy Results

A total of 218 fish were collected from 9 sampling stations on the Mobile, Tombigbee, and Alabama Rivers (121 largemouth bass and 97 channel catfish). At least 10 fish of each species were collected at each station except for catfish. Only four catfish were collected at station MT-4 and no catfish were collected at station MT-10. Autopsies were performed on all 218 fish and the condition of their tissues and organs are summarized in the field data sheets and spreadsheets included in Appendix B and Appendix C respectively. Note that calculated scores for catfish did not include blood data because criteria for determining "normal" and "abnormal" conditions of blood in this fish species had not been established at the time this study was conducted. The FHI scores for fish collected at each sampling station are summarized in Tables 27 and 28.

Externally all fish appeared healthy. All fish had good

color and, except for an occasional lesion or external parasite ("Anchor Worm"), all fish had healthy-looking skin, fins, and opercula.

Internally, fish from all stations showed, to some degree, abnormalities of the liver, spleen, and/or kidney. The primary abnormality encountered was the presence of nodules. In Largemouth Bass all three organs were usually affected. In catfish the nodules were restricted to the liver. Dissection of several liver nodules produced encysted parasitic worms in both bass and catfish. Discoloration of the liver was the second most frequently encountered abnormality, especially in bass. No gross abnormalities were detected in the blood of either fish species.

In general, the health of the Largemouth Bass was poorer at the upper and lower reaches of the study area, including the background (MT-9) and reference (MT-10) stations (Figure 31). The healthiest bass (i.e. lowest score) were found at station MT-5. The mean FHI score for this station was significantly better (statistically) than the mean score for the reference station. Overall, the FHI scores for catfish were lower (i.e. better health) than those for bass. The highest score (i.e. poorest health) was generated by catfish from station MT-3. However, this score is not significantly different (statistically) from the score for the background station MT-9.

6.0 Discussion and Review of Results

The analytical approach to this study involved the analyses of water, sediment, and fish tissue for numerous organic compounds and metals. Of this number, 39 were identified as chemicals of concern because of their known association with the four NPL Sites. The results of the chemical analyses identified the presence of only a few of these selected chemicals and elements. Of the more limited array, mercury and the pesticide DDT and related metabolites DDE and DDD emerged as the most salient constituents of environmental concern.

Through the screening study efforts, these chemical constituents were found in elevated concentrations, relative to background and reference conditions, in sediments and surface water in close proximity to the NPL Sites. These areas were the floodplain wetlands of Cold Creek Swamp where concentrations of mercury in water and sediments were increased many times above background and reference conditions. To a lesser extent, the same scenario for mercury applied to the floodplain wetlands associated with the Olin Basin. The pesticide DDT and related metabolites were also detected in the floodplain and river sediments closely associated with the Olin Basin but not elsewhere in the study's sampling regime. Based upon these

findings, the NPL Sites were recognized as source factors of contamination to be considered in the assessment of public health and ecology associated with the river.

Of the pesticide DDT and related metabolites, DDF was found in measurable concentrations in nearly all of the fillet samples of Largemouth Bass and Channel Catfish. The compound DDD was detected in fillet samples. DDT was limited to fillet samples from station MT-7 at McIntosh. Total DDT concentrations of the composited fillet samples were substantially less than the action level of 5 mg/kg of the USFDA.

The fish tissue criteria promulgated by EPA for the protection of human health is considerably more stringent than either the USFDA action level or the Alabama criteria. EPA's criteria is specific to DDT, DDE, and DDD and values of 0.0316, 0.0316, and 0.0449 mg/kg, respectively. Relative to DDT and DDD, the observed concentrations exceeding criteria were limited to fillet samples from the area of station MT-7 at McIntosh. Concentrations of DDE exceeding criteria were detected in samples from all stations except MT-10 which was a reference station on the Alabama River near Chrysler, Alabama. The cumulative frequency distribution (CDF) of fillet samples of DDE exceeding the EPA criteria of 0.0316 mg/kg in Largemouth Bass and Channel Catfish numbered approximately 25 and 50 percent of the samples, respectively (Figures 32 and 33). Of those samples exceeding the EPA criteria, their distribution remained central to station MT-7 at McIntosh where the Olin and Ciba-Geigy NPL Sites are located (Figures 11, 12, and 13). This central tendency in sample distribution was also validated by demonstrating that the mean concentration of total DDT in the fillet samples of catfish were significantly greater at station MT-7 than all other stations (Table 29).

The greatest observed mean whole body concentration of total DDT for Largemouth Bass was from station MT-7. The concentration, however, was not significantly different from the downstream concentrations nor the background stations MT-8 and MT-9. All whole body mean concentrations for bass from the Mobile/Tombigbee River were significantly greater than samples from the reference station MT-10 of the Alabama River. Similarly for Channel Catfish, the mean whole body concentration of total DDT for station MT-7 was the largest but not significantly different from the down stream stations and reference station MT-9. The lowest mean concentrations of total DDT in whole body catfish were associated with the background station MT-8 and the reference station MT-10. The mean concentration of total DDT found in the forage fish samples was significantly greater at station MT-7 and MT-2 when compared to all other river stations. Total DDT concentrations were found at even greater levels in the forage community sampled in the inundated floodplain wetlands associated with station MT-7 and the upstream background sampling

area of station MT-8.

Based upon the above findings involving fillets and whole body levels of DDT and related metabolites DDE and DDD, the sampling area of station MT-7 at McIntosh appears to be a factor consistently associated with elevated concentrations of these compounds as indicated in Figures 11, 12, 13, 24, 25 and 30. To a lesser extent, the two background stations (MT-8 and 9) were also associated with elevated levels of these pesticides. The reference sites MT-10 on the Alabama River and MT-11 in the floodplain in the Tensaw Lake area yielded samples that consistently featured the smallest concentrations of these compounds. Since the two background stations (MT-8 and MT-9) were located about four to five river miles upstream of the NPL sites at McIntosh, the mobility of fish could be a consideration in explaining the pattern of contamination in the upper section of the study reach. Results of mark and capture studies involving Largemouth Bass in the Mobile River system may not strongly support this consideration. Bass captured from the delta area of the Mobile River were tagged and released and recaptured. The recaptured bass showed relatively little movement from their original location of capture and release (Tucker, 1994). No evidence of sediment or surface water contamination was apparent at the upstream reference stations. The only evidence of DDT and metabolite contamination occurred in sediment samples from the McIntosh floodplain wetlands and in the river where the sampling areas interface with the Olin Basin.

The movement of some fish between the river and basin is probable because of surface water connections between the two water bodies. Studies reported by Woodward and Clyde, 1994, indicate Largemouth Bass, Mosquito Fish, and other aquatic species in the Basin are excessively contaminated with mercury and DDT and its associated metabolites. The immigration of contaminated fish such as Largemouth Bass from the basin to the river and their mingling with the river population remains a plausible explanation of the fish tissue contamination. The fish fillet samples analyzed in this study were derived from a composite of five fillets. Each fillet was obtained from different fish of a similar size. Hence, a single fillet from one highly contaminated fish which may have originated from the Basin could render the composite as excessively contaminated. The composite samples represents an average concentration. An alternate and less apparent explanation of the contaminated composite fillet samples in the McIntosh area could rest with unknown sources upstream of station MT-7.

If the NPL sites at McIntosh are viewed as a source of DDT, DDE, and DDD to the river, their effects appear to be diminishing in view of the findings of a study conducted in 1990 by the U.S. Fish and Wildlife Service. In this investigation, sampling was conducted to collect samples of the Largemouth Bass population in

the area of the Tombigbee River associated with McIntosh and the Olin and Ciba-Geigy NPL Sites. In their sampling, 15 bass were collected and processed for fillet and whole body analyses. These analyses included the determination of concentrations for DDT, DDE, DDD, and mercury.

Total DDT was reported as the sum of the three compounds which in the whole body samples ranged from 0.34 to 34.53 mg/kg and averaged 8.0 mg/kg. Fillet concentrations of total DDT ranged from 0.08 to 2.22 mg/kg and averaged 0.70 mg/kg. The mean concentrations reported in the current study for total DDT in whole body and fillet samples of Largemouth Bass from MT-7 were 0.50 and 0.30 mg/kg, respectively (Table 29). A comparison of the mean values for the two studies will suggest a significant decrease in the contamination level of the Largemouth Bass has occurred over the last three years. These data when coupled with the NCBP historical data referenced in the same 1990 USFWS report suggest even a more long term decrease in pesticide concentrations (Figure 34). The referenced 1990 USFWS report also provided some historical mercury concentrations for whole body and fillet samples of Largemouth Bass from the subject area. A comparison of these data with bass results from MT-7 of the current study would also suggest a decline in mercury contamination (Figure 35).

Relative to public health considerations, concentrations of mercury in the fillet samples for both the Largemouth Bass and Channel Catfish were all less than the action level of 1 mg/kg as supported by the USFDA and EPA, respectively (Table 30). Mercury concentrations of the fillet samples of the bass correlated fairly well with fish total length; hence, the fillets of larger fish contained greater concentrations of the metal. Mercury concentrations for the fillet samples of large bass were not comparable among sampling stations because of too much variation about the means. In contrast, the range of concentrations in the fillet samples of catfish were relatively narrow and very comparable among the sampling stations except for MT-2 where the river interfaced with the lower floodplain of Cold Creek Swamp. The averaged concentration of mercury in the samples of catfish fillets from MT-2 was twice the values of the other stations and shown to be significantly different.

The mean whole body concentrations of mercury in Largemouth Bass between sampling stations were not significantly different between stations MT-8 and station MT-2. Samples from these two stations yielded mean concentrations significantly increased above all other stations. For Channel Catfish, the mean differences between the stations were not significant. Concentrations of mercury among the forage fish samples of the river were low compared to background and reference stations.

Based upon the findings for mercury, station MT-2 emerged as

the only sampling location in the study area where concentrations of this metal were found at levels significantly elevated over all other stations including both background and reference sites. This occurred in fillet samples of Channel Catfish. The mean concentration of mercury of whole body samples of Largemouth Bass from station MT-2 were also significantly increased above all other station except the background site MT-8.

Station MT-2 was established in an area of the Mobile River adjoining the floodplain wetlands of the Cold Creek Swamp and the associated Stauffer NPL site. A surface water connection occurs between the river and swamp during some periods of high river flow, thus providing a hydrologic pathway for exchange of biota and mercury contaminated surface water. Surface water concentrations of mercury in the floodplain wetland when inundated were found to exceed EPA surface water criteria. Mercury concentration reported for both the catfish and bass reflect the probable effects of this connection.

The Fish Health Index (FHI) results indicate that both the Largemouth Bass and Channel Catfish were in relatively good condition with the exception of encysted parasitic worms in the spleens, livers and kidneys which was common to all samples. Base upon the statistics of the FHI protocol, bass from station MT-5 were in the best condition. The average concentration of mercury in either the fillets of whole body samples of bass ranked least among the sampling stations. Station MT-5 was located in the Tombigbee section of the study area just upstream of the confluence of the Alabama River. In terms of the FHI, the Channel Catfish were found in better condition relative to the bass. Also, the mean concentrations of mercury in whole body samples of catfish were least when compared to the other stations.

The consequences of the reported fish tissue contamination can be considered in terms of public health and ecological effects. Regarding the former consideration, mercury did not pose a concern because the observed levels were less than the action level of the USFDA or the criteria of EPA. The same conclusion could also be reached in terms of total DDT relative to the USFDA action level of 5 mg/kg or possibly the Alabama criteria which was exceeded 10 and 7 percent of the Largemouth Bass and Channel Catfish fillet samples. The concern for public health is heighten somewhat on the basis of DDT, DDE, and DDD concentrations exceeding EPA criteria in 26 and 53 percent of the fillet samples of Largemouth Bass and Channel Catfish, respectively.

6.1 Public Health Considerations

Based upon the reported concentrations of mercury and DDT and associated metabolites DDE and DDD, a human health risk

assessment was conducted (Appendix G). A summary of the risk assessment findings are provided in Table 32. In this assessment, carcinogenic and non-carcinogenic risks are considered. The carcinogenic evaluation relates to the probability of an individual incurring incremental cancer risk due to the consumption of fish at a given frequency, quantity, and concentration of DDT contamination. For toxic or non-carcinogenic effects, a hazard quotient (HQ) is also calculated on the basis of consumption of fish with a given frequency, quantity, and concentration of DDT or mercury. The assumptions regarding these variables are given in the risk assessment of Appendix G. A HQ greater than one indicates that exposure to the contaminant will likely cause adverse effects. Tissue concentrations used in this risk assessment were based upon analyses of fish fillet samples from stations MT-2 and MT-7 because these stations yielded samples with the highest average and maximum levels of mercury and total DDT, respectively. The maximum reported concentrations actually constitute an average of five individual fillets that were composited and subsampled for analyses.

Results of this assessment indicate that a person consuming bass or catfish fillets from station MT-7 risks an additional low to moderate chance (one chance in 10,000 to 100,000) to incur a cancer. Non-carcinogenic effects from consuming catfish from non-carcinogenic are unlikely. The HQ for Largemouth Bass is higher and indicates an increased potential for adverse effects.

The consumption of Largemouth Bass or Channel Catfish fillets from station MT-2 would result in exposure to concentrations of mercury that are at or below levels shown to cause adverse toxic effects.

6.2 Preliminary Ecological Risk Evaluation

In order to determine whether data collected in this study may warrant pursuit of a full ecological risk assessment, a few exposure scenarios were compiled into a preliminary ecological risk evaluation. This evaluation draws on relevant information presented recently for other Region IV sites in an ecological risk assessment (US EPA 1994a) and another preliminary ecological risk evaluation (US EPA 1994b).

6.2.1 Assumptions

This evaluation concentrates on the dietary exposure of area wildlife to the two primary contaminants of concern for the riverine segment studied, total mercury and DDT. The exposure scenarios chosen maximize foodchain exposure through ingestion of fish; the focus of this study. The wood stork (*Mycteria americana*) and the belted kingfisher (*Ceryle alcyon*) will serve

as receptors for this evaluation. Both are upper trophic level receptors for food chain exposure pathways that may exist at this site. The diet of each species consists primarily of fish (US EPA 1993, US EPA 1994b). The wood stork is a Federally listed (June 3, 1994 amendment) endangered species statewide in Alabama. This species also serves as a representative receptor of other large fish eating wading birds sharing a similar feeding regimen. The belted kingfisher has as a permanent range Alabama and much of the southeast (Audubon 1994) and is an often seen resident within the study area.

An area use factor of 1 will be used in this evaluation. This value was chosen since the feeding range of both species could be easily contained within the 53 mile segment of the rivers studied. The range of the stork is approximately 20 miles (32 km, US EPA 1994b), and the shoreline range of the kingfisher has a mean of up to 1.4 miles (2.2 km, Brooks and Davis 1987 as cited in US EPA 1993). With these ranges, the birds could feed exclusively along the river and not extend beyond the segment studied.

Estimated dose calculations assume foraging beyond the bounds of any one sample station, and use, therefore, a mean concentration of total mercury or DDTr for all river stations (MT-0 to MT-9) other than the reference station MT-10. In determining this mean concentration, all stations for which there were either a confirmed, estimated (analytical code "J"), or presumed, (analytical code "N"), values were used in averaging. Samples below the limit of detection (analytical code "U") were used in the averaging calculations by assuming a median concentration for the reported MDL. When determining the mean for DDTr, station means were first determined, then a mean concentration was determined for all river study stations. For the purposes of this evaluation, it was assumed that the toxicities of DDT, DDE and DDD were additive. It was also assumed that mercury and DDTr were 100 percent available to the organism from their prey.

Chronically toxic levels of mercury and DDTr were not found for the species used in this evaluation, however, a No Observable Adverse Effect Level (NOAEL) for each contaminant for piscivorous birds that has been used in other recent evaluations (US EPAa,b) was used here.

6.2.2 Exposure Pathways

The exposure pathway selected to determine risk to the stork and the kingfisher is through the ingestion of contaminated forage fish. It was assumed that forage fish, defined in this study as any fish captured during electrofishing that was no longer than three inches, total length, comprised 100 percent of the diet of these piscivorous birds. An assumption of this

approach is that exposure calculated from collected biota is representative of actual exposure. Exposure from incidental water or sediment ingestion was not included here. It is expected that such additional exposure would be minimal for the kingfisher. For the stork, sediments entrained during shallow water foraging may constitute a more important source of dietary contaminants.

6.2.3 Exposure Profiles

6.2.3.1 Wood Stork (US EPA 1994b)

The wood stork is the only native stork in North America north of Mexico. It is more or less resident of Florida and Georgia, very rarely elsewhere along the coast from South Carolina to Texas (Audubon 1994). It is currently Federally listed as an endangered species for the entire state of Alabama (June 3, 1994 listing amendment). This is primarily a freshwater bird. It is, however, frequently observed in saltwater marshes (Eckert 1976). Although sightings are rare in the study area this species is used here because of its endangered status in the state, its heavy dietary reliance on fish and its upper level trophic position, all of which make it a reasonable candidate for a worst case risk scenario. Though primarily a freshwater bird, it is frequently observed in saltwater marshes.

This is a gregarious species and is rarely seen alone. Storks are usually seen in groups or with other wading birds, eating, roosting, nesting, migrating, and performing all other activities (Eckert 1976).

Adult storks weigh 2050 grams (Dunning 1993), and consume 520 grams of food per day (Kahl 1964). Dietary composition is mostly fish, however, wood storks eat a wide variety of small prey including frogs, water snakes, lizards, minnows, wood rats, fiddler crabs, turtles, tadpoles, and water beetles (Eckert 1976). Since fish comprise most of the stork diet, and since this study has provided current information on forage fish contaminant content, calculations assume forage fish constitute 100 percent of the stork diet.

6.2.3.2 Belted Kingfisher (US EPA 1994a)

The belted kingfisher is a medium-sized bird that eats primarily fish. It is one of the few species of fish-eating birds found throughout inland areas as well as coastal areas. The belted kingfisher's range includes most of the North American continent; it breeds from northern Alaska and central Labrador southward to the southern border of the United States (US EPA 1993). Alabama and essentially the entire southeast are part of its permanent range (Audubon 1994).

Adult kingfishers weigh from 113 to 178 grams (Fry and Fry 1992). Reported ingestion rates range from 0.5 (Alexander 1977) to 1.75 (White 1936) times the bodyweight per day. For this evaluation, a body weight of 113 grams and ingestion rate of 0.198 kg per day (1.75 times a bodyweight of 113 grams) will be used. The diet is predominantly fish but includes frogs crayfish and aquatic reptiles (Fry 1980). For this evaluation, it was assumed that the diet was 100 percent fish. Feeding range while nesting is 8050 acres (Cornwell 1963).

6.2.4 Effects Profiles

6.2.4.1 Mercury (US EPA 1994b)

Several studies were located that evaluated dietary mercury exposure to predatory birds, both raptors and piscivorous species. Several laboratory feeding studies conducted on goshawks and red-tailed hawks indicate that these species accumulated mercury and exhibited toxicity symptoms when fed prey containing elevated mercury levels. A field study conducted on the common loon also indicated that this species exhibits toxicity symptoms after ingesting prey with elevated mercury levels.

Goshawks were fed a diet of chickens which had been fed methyl mercury-dressed wheat (0.4 - 0.5 mg/kg/day) for five to six weeks and both chickens and goshawks were sacrificed (Borg et al., 1970). All chickens were clinically healthy at the end of the feeding period. The average mercury level in the chicken feed was 8 mg/kg, resulting in skeletal muscle concentrations of 10 mg/kg. Muscle and liver from the chickens was fed to goshawks. Intake of Hg by the goshawks was 0.7 - 1.2 mg/kg/day. Clinical symptoms of Hg poisoning appeared after two weeks. All birds were dead 47 days after the start of the experiment. Muscle Hg levels of the goshawks averaged 40 - 50 mg/kg, representing a concentration factor of 4 - 5 in the second link of the food chain. Brain mercury levels in the dead goshawks ranged from 30 to 40 mg/kg.

Red-tailed hawks were fed chickens contaminated with methyl mercury (Fimreite and Karstad, 1971). The chicks were fed diets containing Panogen 15, a commercial seed treatment containing 2.5 percent methyl mercury dicyandiamide (MMD) at rates of 6, 12, and 18 mg/kg MMD for three weeks. Mercury levels measured in chick livers were 3.9, 7.2 and 10.0 mg/kg, respectively. Mean estimated intake of mercury by the three groups of hawks over the 12-week exposure period was 0.575, 1.12 and 1.46 mg mercury per day, respectively. Mortality occurred in hawks receiving the most contaminated diet (1.12 mg/kg/day) after an exposure period of one month or more. Pathological changes noted in all hawks which received the highest mercury doses included swelling of axons of myelinated nerves in the spinal cord, and dilatation of

myelin sheaths and loss of myelin.

Barr (1986) noted decreased reproductive success and behavioral changes in common loons nesting on the Wabigoon-English River systems, areas affected by unpredictable water level fluctuations and Hg contamination. Water level fluctuations due to dams were ruled out as the cause, as the decreased nesting success observed both in lakes experiencing only natural water level changes, as well as in areas affected by dams. A strong negative correlation was found between the successful use of territories by breeding loons and mercury contamination. A reduction in egg laying, and nest site and territorial fidelity, were associated with mean mercury concentrations ranging from 0.3 to 0.4 mg/kg in prey (equivalent to 0.1 mg/kg body weight/day), and from 2 to 3 mg/kg in adult brain tissue and eggs. Loons established few territories, laid only one egg, and raised no young where mean mercury in prey species exceeded 0.4 mg/kg. Non-mercury toxicants were found in loons and prey items at low levels, and were therefore discounted as a major factor in the failure of loon reproduction.

Wood storks feed through the use of tactile response and exceptionally fast reflex action of the stork. Therefore, subtle behavioral and/or neurological effects could have substantial impacts on individual wood storks feeding at this site.

For purposes of this evaluation, dietary levels of 0.03 mg mercury per kg in prey (0.01 mg/kg/day) will be used as a NOAEL for the wood stork.

6.2.4.2 DDT_r (US EPA 1994a)

DDT_r is of particular concern in ecological systems because of its tendency to accumulate in biological tissues, posing food chain threats to higher order consumers.

To evaluate the effects of DDT_r in piscivorous birds, Anderson *et al.* (1975) studied the reproductive success of brown pelicans off the southern California coast from 1969 to 1975. Concentrations of DDT_r in anchovies (the major food source of the pelican colony) and pelican eggs were measured. Over the five year monitoring period, concentrations of DDT_r in anchovies steadily declined from 4.27 mg/kg wet weight in 1969 to 0.15 mg/kg in 1974. Eggshell thickness gradually increased over the 5-year period. Productivity at the pelican colony increased from a total of four young fledged in 1969 to 1185 fledged in 1974. At tissue levels of 0.15 mg/kg DDT_r in anchovies, the fledgling rate was 30 percent below the estimated rate necessary to maintain a stationary population.

Twelve pairs of American kestrels were fed a diet containing 2.8 mg/kg *p,p'*-DDE on a wet weight basis (Porter and Weimeyer

1972). Two of the males died after 14 and 16 months on the diet. DDE residues in brain tissue were high, and fat reserves were depleted. The kestrels died at a time when the birds lose weight and deplete fat reserves due to reproduction and molt.

With regard to the effects of DDTr on eggs and reproduction, a number of studies correlated dietary levels with levels measured in eggs. Many field studies (Greichus et al. 1973, Fox et al. 1980, and Cooke et al. 1976) have reported DDTr levels measured in eggs and observed adverse effects on reproduction such as broken eggs. However, few studies report levels of contaminants in food organisms which contribute to the levels observed in eggs. Only two studies were located that reported dietary DDTr levels and levels measured in eggs. One study was conducted with a raptor, and the second with chickens.

American kestrels were fed diets containing 2.8 mg/kg *p,p'*-DDE on a wet weight basis for 2 years (Weimeyer and Porter 1970). The DDE was dissolved in cottonseed oil and added to ground meat. The first egg laid by each pair was collected in 1968 and again in 1969. Levels of PIP'-DDE measured in eggs ranged from 1.05 to 5.89 mg/kg in 1968, and from 17.4 to 44.2 mg/kg in 1969. Average eggshell thickness was 10 percent less in 1969 than in 1968.

Smith et al., (1970) fed laying hens diets containing DDT at levels of 0, 0.05, 0.5 and 5.0 mg/kg for 2 months. DDT levels in eggs were measured before and after force molting. Levels in eggs before the molt were not elevated prior to the molt, although levels in abdominal fat were. After the forced molt, levels in eggs, for hens consuming the dietary levels reported above, were 0.1, 1.2, 4.1 and 11.9 mg/kg, respectively.

Also with regard to the effects of DDTr on eggs and reproduction, a number of studies have correlated percent shell thinning with egg loss. Several of these have correlated measured DDT residues in eggs of birds to increased thinning and egg loss due to breakage. Eggshell thinning of greater than 20 percent appears to result in decreased nesting success due to eggshell breakage (Anderson and Hickey 1972, Dilworth et al. 1972). Predatory and piscivorous birds appear to be at greatest risk for accumulating levels of DDTr which will result in this degree of eggshell thinning.

Lincer (1975) conducted laboratory feeding studies with American kestrels in which females were maintained on diets containing 0.3, 3.0, 6.0 and 10.0 mg/kg DDE (0.054, 0.55, 1.1 and 1.83 mg/kg body weight (BW) per day, respectively). Animals on the 0.3 mg/kg diet produced eggs with shells which were not significantly different in thickness from controls, and 6 percent thinner than archived eggshells collected prior to widespread use of DDT. Birds maintained on the 3.0 and 6.0 mg/kg diets produced eggshells which were 14.0 and 17.4 percent thinner than

experimental controls, and 25.5 and 28.3 percent thinner than pre-DDT eggshells, respectively. Eggshell thinning to this extent may be expected to affect breeding success. While the kestrel is not a piscivorous bird, it feeds at a similar trophic level.

A NOAEL of 0.054 mg/kgBW/day were used to evaluate the effects of DDTr on piscivorous birds for this evaluation.

6.2.5 Risk Characterization

To estimate risk to the wood stork and belted kingfisher along the Mobile River study site, implications of the exposure concentrations need to be determined. The hazard quotient method (US EPA 1989, Barnthouse *et al.*, 1986) compares exposure concentrations to ecological endpoints such as reproductive failure or reduced growth. The comparisons are expressed as ratios of potential intake values to population effect levels, or:

$$\text{Hazard Quotient} = \frac{\text{Exposure Concentration}}{\text{No Observed Adverse Effect Level (NOAEL)}}$$

A hazard quotient greater than one indicates that exposure to the contaminant will likely cause adverse effects in the organism. A hazard quotient less than one does not necessarily indicate a lack of risk, but should be interpreted based on the nature of the effect used as the denominator, and the magnitude of the calculated quotient.

6.2.6 Sources of Uncertainty

There are factors inherent in the risk assessment process which contribute to uncertainty and need to be considered when interpreting results. Major sources of uncertainty include natural variability, error, and insufficient knowledge.

Risk (hazard quotient) calculations were based on conservative values; the lowest body weight and highest ingestion rate cited for the stork and kingfisher were used in the exposure profile and the NOAELS used to determine hazard quotients were the lowest values found in the literature

An important contributor to uncertainty is the incompleteness of the data or information upon which the risk assessment is based. Literature values of life history information used in the exposure profile may not be truly representative of values for the stork and kingfisher in southern Alabama. Although the reported NOAELS used in the quotient calculations are generally for closely related species, response to mercury and DDT for the wood stork and belted kingfisher may be different than in species for which data was available. Doses

reported in toxicological studies were in units of mg contaminant/kg diet, or in units of mg contaminant/kg body weight/day. Doses were converted to units of mg/kg/day using reported average body weights and ingestion rates.

NOAELs obtained from the literature may over- or underestimate actual values for the species addressed in this evaluation. Another source of uncertainty arises because toxicity values reported in the literature are often derived in single species, single contaminant laboratory studies. Prediction of ecosystem effects from laboratory studies is difficult, as environmental factors and interactions between contaminants in field conditions can influence a toxins effects.

6.2.7 Results and Conclusions

This screening level evaluation indicates that there is reason to believe that piscivorous birds that rely on this 53 mile stretch of the Mobile River as a primary food source may be at risk from feeding on forage-size fish. In the four risk scenarios developed for the wood stork and the kingfisher exposed to mercury and DDTr individually and from food sources only, hazard quotients all ranged well within an order of magnitude of 1.0. For the wood stork, a HQ of 0.06 was calculated for exposure to mercury (Table 33), and a HQ of 0.277 was calculated for exposure to DDTr (Table 34). For the belted kingfisher, whose feeding rate per unit body weight is approximately seven times higher than that of the wood stork, therefore increasing exposure through this route proportionally, a HQ of 3.85 was calculated for exposure to mercury (Table 35), and a HQ of 1.91 was calculated for exposure to DDTr (Table 36).

With all four calculated values within an order of magnitude of 1.0, it would be advisable to develop a comprehensive ecological risk assessment for this study area. This would provide an opportunity to fully explore exposure of animals at, relative to, or suspected of inhabiting this area through a full spectrum of scenarios to determine whether a significant hazard is posed by this stretch of the river to that biota. Changes in assumptions would be expected to move HQs in either direction. Fish or mammals, having different exposure scenarios and toxic responses to mercury and DDT will have different HQ values for this geographical area. If an area use factor other than one were used, for instance, to develop a worst-case feeding scenario by centering the feeding range on the sample locations that produced fish with the highest body concentrations of mercury and DDT, the HQs calculated could increase considerably. This would be especially true in the case of the kingfisher, having a much more restricted range than the wood stork. For instance, if the kingfisher's range centered on the McIntosh sample station where mean DDTr in forage fish was 0.158 mg/kg rather than the overall river reach average 0.059 mg/kg, the

bird's hazard quotient would increase from 1.91 to 5.16, other assumptions remaining unchanged.

Exposure scenarios for raptors capable of feeding on larger fish should also be considered. A full risk assessment would consider exposure from other routes as well, probably increasing HQ values. Forage ranges that are considered radially from a nest site rather than linearly along the river, may suggest area use factors less than one, which would have an effect on the calculated Hqs. If ranges were extended away from the river, use should be made of the existing contaminant data that has been generated for various media from specific industrial floodplain and on-site locations rather than setting all non-riverine exposure to zero.

7.0 References

- Alabama. 1994. Revised Regulation 335-6-10-07. Alabama Department of Environmental Management. Montgomery, Alabama.
- Alexander, G. 1977. "Food of vertebrate predators of trout waters in north central lower Michigan." *Michigan Academician*. 10:181-195 (as cited in Newell 1987).
- Anderson, D.W. and J.J. Hickey. 1972. "Eggshell changes in certain North American birds." In: K.H. Voous, ed. *Proceedings: XV International Ornithological Congress*. The Hague. Netherlands. pp. 514-540.
- Anderson, D.W., J.R. Jehl, R.W. Risebrough, L.A. Woods, L.R. Deweese and W.G. Edgecomb. 1975. "Brown pelicans: Improved reproduction off the southern California coast." *Science*. 190:806-808.
- Barnhous, L.W., G.W. Sutor, II, S.M. Bartell, J.J. Beauchamp, R.H. Gardner, E. Linder, R.V. O'Neill and A.E. Rosen. 1986. *User's Manual for Ecological Risk Assessment*. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. Publication No. 2679, ORNL-6251.
- Barr, J.F. 1986. *Population Dynamics of the Common Loon (Gavia immer) Associated with Mercury-Contaminated Waters in Northwestern Ontario*. Canadian Wildlife Service, Occasional Paper Number 56.
- Borg, K., K. Erne, E. Hanko, and H. Wanntorp. 1970. Experimental Secondary Methylmercury Poisoning in the Goshawk (*Accipiter g. gentilis* L). *Environ. Pollut.* 1:91-104.
- Brooks, R.P.; Davis, W.J. 1987. Habitat selection by breeding belted kingfishers (*Ceryle alcyon*). *Am. Midl. Nat.* 117:63-70.
- Cooke, A.S., A.A. Bell and I. Prestt. 1976. "Eggshell characteristics and incidence of shell breakage for Grey Herons *Ardea cinerea* exposed to environmental pollutants." *Environ. Pollut.* 11:59-84.
- Cornwell, G.W. 1963. "Observations on the breeding biology and behavior of a nesting population of belted kingfishers." *Condor*. 65:426-431.
- Dilworth, T.G., J.A. Keith, P.A. Pearce and L.M. Reynolds. 1972. "DDE and eggshell thickness in New Brunswick woodcock." *J. of Wildl. Manage.* 36(4):1186-1197

- Dunning, John B. 1993. *CRC Handbook of Avian Body Masses*. CRC Press, Boca Raton, FL.
- Eckert, Allan W. 1976. *The Wading Birds of North American (North of Mexico)*. Weathervane Book, New York.
- Fimreite, M. and L. Karstad. 1971. Effects of Dietary Methyl Mercury on Red-Tailed Hawks. *J. Wildl. Manage.* 35(2):293-300.
- Fox, G.A., K.S. Yonge and S.G. Sealy. 1980. "Breeding performance, pollutant burden and eggshell thinning in Common Loons *Gavia immer* nesting on a Boreal forest lake." *Ornis Scandinavica*. 11:243-248.
- Fry, C. 1980. "The evolutionary biology of kingfishers (Alcedinidea)." In: *The Living Bird, 1979-1980*. The Laboratory of Ornithology, Cornell University, Ithaca. pp. 113-160.
- Fry, C.H. and K. Fry. 1992. *Kingfishers, Bee-eaters and Rollers. A Handbook*. Princeton University Press, Princeton, New Jersey.
- Greichus, Y.A., A. Greichus, and R.J. Emerick. 1973. "Insecticides, polychlorinated bypenyls, and mercury in wild cormorants, pelicans, their eggs, food and environment." *Bull. Environm. Contam. Toxicol.* 9(6):321-328.
- Grover, R. 1989. *Environmental Chemistry of Herbicides*. Vol.I. CRC Press.
- Kahl, M. Philip. 1964. Food Ecology of the Wood Stork (*Mycteria americana*) in Florida. *Ecological Monographs* 34(2):97-117.
- Lincer, J.L. 1975. "DDE-induced eggshell-thinning in the American kestrel: a comparison of the field situation and laboratory results." *J. Appl. Ecol.* 12:781-793.
- Long, Edward R. and Lee G. Morgan, 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. NOAA Technical Memorandum NOS0MA52. National Oceanic and Atmospheric Administration. Seattle, Washington.
- National Audubon Society. 1994. *Field Guide to North American Birds Eastern Region*. Ed. John Bell, John Farrand, Jr. Published by Alfred A. Knopf. New York.

- Noakes, Scott. 1993. Mobile River Sediment Study. Center for Applied Isotope Studies. University of Georgia, Athens, Georgia.
- Porter, R.D. and S.N. Wiemeyer. 1972. "DDE at low dietary levels kills captive American kestrels." *Bull. Environ. Contam. Toxicol.* 8(4):193-199.
- Smith, S.I., C.W. Weber and B.L. Reid. 1970. "Dietary pesticides and contamination of yolks and abdominal fat of laying hens." *Poultry Science.* 49:233-237.
- Schmitt, C.J., J.L. Zajicek, and P.H. Peterman. 1990. National Contamination Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish, 1976-1984. Archives of Environmental Contamination and Toxicology. Vol.19.
- Tucker, William. 1994. Personal communication. Alabama Division of Game and Fish, District 5, Spanish Fort, Alabama.
- U.S. EPA (United States Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund. Vol. I. Human Health Evaluation Manual (Part A).* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.
- U.S. EPA, 1993. *Wildlife Exposure Factors Handbook Volume I of II.* Office of Health and Environmental Assessment. Office of Research and Development. U.S. EPA. Washington, DC 20460. EPA/600/R-93/187a.
- U.S. EPA, 1993a. *Office of Water Guidance on Fish Sampling and Analysis, August, 1993.* Office of Water, Washington D.C.
- U.S. EPA, 1994a. *Ecological Risk Assessment Final Report Ciba-Geigy Corporation Site. McIntosh, Alabama.* U.S. EPA Office of Emergency and Remedial Response, Environmental Response Team, Edison New Jersey. Work Assignment No.: 0-022. Weston Work Order No.: 03347-040-001-0022-01. U.S. EPA Contract No.: 68-C4-0022.
- U.S. EPA, 1994b. *Preliminary Ecological Risk Evaluation for LCP Chemicals, Brunswick, GA.* Memorandum. U.S. EPA Office of Emergency and Remedial Response, Environmental Response Team. U.S. EPA. Edison, New Jersey.
- U.S. EPA. 1995. *TSC 195 Criteria Chart.* EPA Region IV. Water Quality Standards Section. Water Management Division. Atlanta, Georgia 30365.

- U.S. EPA. 1995a. Interlaboratory Quality Assurance for the Huntsville DDT Project. Analytical Support Branch, Environmental Services Division, Region 4, Athens Georgia.
- U.S. FDA, 1992. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed. Dept. Health and Environmental Services. Public Health Service. Food and Drug Administration. 200 C Street, S.W. Washington, DC 20204.
- U.S. Fish and Wildlife Service. 1992. An evaluation of mercury and DDT contamination in fish and sediments collected from the Tombigbee River near McIntosh, Alabama. July, 1992. U.S. Fish and Wildlife Enhancement. Daphne, Alabama.
- Weimeyer, S.N. and R.D. Porter. 1970. "DDE thins eggshells of captive American kestrels." *Nature*. 227:737-738.
- White, H. 1936. "the food of kingfishers and mergansers on the Margaree River, Nova Scotia." *J. Biol. Bd. Can.* 2:299-309. (as cited in: R. Palmer, 1962).
- Woodward-Clyde. 1994. Additional Ecological Studies of OU-2 McIntosh Plant Site. Vol.I and II. Olin Corporation/McIntosh Plant, McIntosh, Alabama.

TABLE 1. Potential Chemicals of Concern
Associated with Superfund Sites.
Mobile River Study
Alabama

Olin/McIntosh Site:

Alpha-BHC
Arsenic
Benzene
Beryllium
Beta-BHC
Cadmium
Chlorobenzene
Chloroform
Copper
4,4'-DDD

4,4'-DDE
4,4'-DDT
Delta-BHC
Dichlorobenzene isomers
(1,2,4,5-tetrachlorobenzene,
1,2,4-trichlorobenzene)
Gamma-BHC
Hexachlorobenzene
Lead
Mercury
Pentachlorobenzene
Pentachloronitrobenzene
Tetrachloroethylene

Ciba Geigy Site:

Alpha-BHC
Ametryn
Atrazine
Beta-BHC
Bladex
Chlorobenzilate
DDD
DDE
DDT
Delta-BHC
Diazinon
Gamma-BHC
Prometryn
Simazine

Stauffer Sites:

Carbon Disulfide
Carbon Tetrachloride
Cyanide
Mercury
Thiocyanate
Thiocarbamates including;
Molinate
Vernolate
Pebulate
Butylate

Cycloate
EPTC

Table 2. Sequence of Sampling Efforts for the Mobile River Study.

September 1993	Reconnaissance of River
October 1993	Sampling of sediments and water for screening study
November 1993	River Sampling for Fish Tissue Contamination Study
December 1993	River Sampling for Fish Tissue Contamination Study
April 1994	Floodplain sampling for Fish Tissue Contamination Study
April 1994	Floodplain sampling of sediment and surface water for Screening Study
November 1994	Sampling River for Fish Health Index Study

Table 3. Minimum detection limit ranges for Potential Chemicals of Concern* (mg/kg) for all fish tissue samples analyzed. Mobile River Study. November, 1993.

	WHOLE BODY LARGEMOUTH BASS	FILLETS LARGEMOUTH BASS	WHOLE BODY CHANNEL CATS	FILLETS CHANNEL CATS	FORAGE
ALPHA-BHC	.0025	.0025 - .003	.0025	.0025 - .003	.0025
AMETRYN	.0079 - .080	.080	.0079 - .080	.080	.080
ARSENIC	.06 - .30	.03 - 1.0	.06 - .20	.03 - 1.0	.06 - .30
ATRAZINE	.0079 - .080	.080	.0079 - .080	.080	.080
BERYLLIUM	.002 - .02	.002 - .02	.002 - .003	.002 - .02	.002 - .03
BETA-BHC	.0025 - .005	.0025 - .003	.0025 - .003	.0025 - .003	.0025 - .004
BUTYLATE	.0079 - .13	.080 - .33	.0079 .080	.080 - .15	.080
CADMIUM	.002 - .07	.002 - .10	.004 - .10	.002 - .10	.02 - .04
CHLOROBENZIATE	.0079 - .070	.040 - .33	.0079 - .040	.040 - .050	.040
COPPER	.30 - 1.0	.13 - 1.00	.20 - .60	.15 - 1.0	.60 - 2.0
CYCLOATE	.0079 - .080	.080	.0079 - .080	.080	.080 - .808?
4,4'-DDE	.007 - .080	.005 - .02	-	-	.005
4,4'-DDD	.005 - .040	.005 - .24	.005 - .070	.005 - .02	.005 - .020
4,4'-DDT	.005 - .070	.005 - .02	.005 - .040	.005 - .04	.005 - .010
DELTA-BHC	.0025	.0025 - .003	.0025	.0025 - .003	.0025
DIAZINON	.0079 - .080	.080	.0079 - .080	.080	.080
EPTC	.0079 - .080	.080	.0079 - .080	.080 - .12	.080 - .808?
GAMMA-BHC	.0025 - .005	.0025 - .003	.0025	.0025 - .003	.0025
HEXACHLOROBENZENE	.33 - 1.5	.33 - .66	.33 - 1.8	.33 - .66	.33 - 1.1

* = List excludes volatile chemicals of concerns and cyanide since they were not analyzed in tissue samples.
 - = Detected in all samples.

Table 3 cont. Minimum detection limits (mg/kg)

	WHOLE BODY LARGEMOUTH BASS	FILLETS LARGEMOUTH BASS	WHOLE BODY CHANNEL CATS	FILLETS CHANNEL CATS	FORAGE
LEAD	.03 - .06	.03 - .20	.03 - .05	.03 - .10	.04 - .2
MERCURY	-	.10	-	-	.02 - .03
MOLINATE	.0079 - .080	.080	.0079 - .080	.080	.080
PEBULATE	.0079 - .080	.080	.0079 - .080	.080	.080
PENTACHLORO- BENZENE	.33 - 1.8	.33 - .66	.33 - 1.8	.33 - .66	.33 - 1.1
PENTACHLORO- NITROBENZENE	.33 - 1.5	.33 - .66	.33 - 1.8	.33 - .66	.33 - 1.1
PROMETRYN	.0079 - .080	.080	.0079 - .080	.080	.080
SIMAZINE	.0079 - .080	.080	.0079 - .080	.080	.080
1,2,4,5- TETRACHLORO- BENZENE	.33 - 1.3	.33 - .66	.33 - 1.8	.33 - .66	.33 - 1.1
VERNOULATE	.0079 - .080	.080	.0079 - .080	.080	.080

Table 4. Organic compounds detected in river surface water samples (ug/l).
Mobile River Study. October, 1993.

STATION	WMT-0C	WMT-1C	WMT-2A	WMT-7C	WMT-8	WMT-9C
SAMPLE NUMBER	80052	80055	80066	80059	80072	80061
ATRAZINE	.050U	.050U	.050U	0.21	0.065	0.12
EPTC (EPTAM)	.038J	.046J	0.031J	.050U	.050U	.050U
BIS(2-ETHYLHEXYL) PHTHALATE	14	10U	10U	10U	10U	10U

J = Estimated value.

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

W = Water sample from screening phase.

A = Left riverbank facing upstream.

C = Right riverbank facing upstream.

Table 5. Results of inorganic analyses of river surface water samples (ug/L). Mobile River Study. October, 1993.

STATION	WMT-0C	WMT-1C	WMT-2A	WMT-7C	WMT-8	WMT-9C
STATION #	80052	80055	80067	80059	80072	80061
ALUMINUM	420	700	460	770	660	960
ANTIMONY	6.0U	6.0U	6.0U	6.0	6.0U	6.0U
BARIUM	62	68	59	130	120	130
CALCIUM	18	17	16	22	21	21
COPPER	3.3	5.1	7.4	2.0U	2.0U	2.1
IRON	0.53	0.85	0.58	0.92	0.80	1.1
MAGNESIUM	9.3	4.0	3.8	5.8	5.3	5.6
MANGANESE	71	76	46	77	67	78
MERCURY*	2.3	1.7	1.5	4.9	1.4	3.7
MOLYBDENUM	3.1	3.7	4.2	2.5	2.7	3.2
POTASSIUM	3.8	2.0	1.9	2.6	2.5	2.6
SODIUM	77	31	26	53	35	36
STRONTIUM	130	110	98	180	170	170
THALLIUM	20	20U	20U	20U	20U	20U
TITANIUM	6.7	10	6.6	8.9	8.0	12
ZINC	4.9	9.5	4.2	3.3	12	5.3

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

* = Ultra trace level mercury concentrations in ng/L.

Table 6. Results of inorganic analyses of river sediment samples (mg/kg). Mobile River Study. October, 1993.

STATION	SMT-0B	SMT-0C	SMT-2A	SMT-2A2	SMT-2A3	SMT-7C	SMT-8	SMT-9C
STATION #	80054	80053	80068	80069	80070	80060	80064	80063
ALUMINUM	510	9700	10000	11000	9000	1400	15000	1000
ARSENIC	0.70	3.6	2.9	4.6	4.0	0.98	4.5	0.52
BARIUM	3.1	99	93	100	94	20	140	14
BERYLLIUM	0.50U	1.0U	1.0U	1.0U	1.0U	0.50U	1.1	0.50U
CALCIUM	50	2000	1800	2000	1900	270	2900	200
CHROMIUM	1.2	20	20	21	18	4.2	27	3.7
COBALT	1.0U	7.5	7.0	7.7	6.8	1.3	10	1.0
COPPER	1.0U	8.5	8.6	9.6	8.1	1.0U	9.5	1.0U
IRON	1200	16000	16000	17000	16000	3000	22000	2500
LEAD	0.78	9.9	9.6	11	8.1	1.9	12	1.9
MAGNESIUM	110	1600	1500	1600	1400	260	2100	210
MANGANESE	24	540	590	670	590	140	760	86
NICKEL	2.0U	8.8	9.7	11	8.8	2.0U	13	2.0U
POTASSIUM	200U	1000	1000	1100	920	320	1400	300
SODIUM	300	230	200U	200U	200U	100U	260	100U
STRONTIUM	1.1	19	18	20	18	3.3	30	2.5
TITANIUM	13	100	110	100	110	39	110	71
VANADIUM	1.5	25	25	27	23	4.5	35	3.9
YTTORIUM	1.0U	10	9.9	10	9.8	1.6	13	1.3
ZINC	4.4	50	44	48	42	6.8	59	4.7

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

Table 7 Particle size and organic carbon content as percent dry weight of river sediments (October, 1993) and floodplain sediments (April, 1994) Mobile River Study

	medium gravel	fine gravel	coarse sand	medium sand	fine sand	very fine sand	silt	clay	totals

SMT-0B									
INORG FRAC	0 00	0 00	87 91	4 23	0 07	0 32	0 00	6 77	99 32
ORG FRACTIO	0 00	0 00	0 09	0 01	0 00	0 01	0 00	0 57	0 68

SMT-0C									
INORG FRAC	0 00	0 10	3 46	15 37	12 40	13 93	51 30	0 58	97.13
ORG FRACTIO	0 00	0 06	0 25	0 40	0 28	0 49	1 17	0 23	2.87

MT-0(C)*									
INORG FRAC	0 00	1 43	1 18	1 61	2 27	3 90	67 27	7 56	85 21
ORG FRACTIO	0 00	3 80	0 96	0 66	0 70	0 67	6 71	1 28	14 79

SMT-1C									
INORG FRAC	0 00	0 00	20 94	53 43	8 22	3 52	10 73	0 34	97 17
ORG FRACTIO	0 02	0 01	0 47	0 59	0 26	0 16	0 90	0 41	2 83

SMT-2(1)**									
INORG FRAC	0 00	0 01	5 81	3 11	23 93	6 90	9 01	0 46	49 24
ORG FRACTIO	0 01	0 00	0 22	10 38	0 50	0 32	39 30	0 02	50 76

SMT-2A(2)**									
INORG FRAC	0 01	0 32	3 61	2 84	40 60	26 85	20 61	1 25	96 08
ORG FRACTIO	0 03	0 02	0 29	0 26	0 90	0 87	1 53	0 02	3 92

SMT-2A(3)**									
INORG FRAC	0 00	0 01	21 78	19 93	26 27	9 32	18 54	0 40	96 26
ORG FRACTIO	0 00	0 02	0 59	0 49	0 67	0 38	1 48	0 12	3.74

MT-2(C)*									
INORG FRAC	0 00	2 97	2 03	1 84	2 04	4 58	63 03	4 28	80 77
ORG FRACTIO	0 00	4 62	1 85	0 99	0 90	1 44	8 78	0 65	19 23

SMT-7C									
INORG FRAC	0 00	0 02	0 38	89 33	6 46	0 58	2 78	0 03	99.53
ORG FRACTIO	0 00	0 01	0 01	0 21	0 02	0 01	0 16	0 04	0 47

MT-7N(C)*									
INORG FRAC	0 00	0 25	2 78	7 04	6 60	4 77	55 10	13 16	89 70
ORG FRACTIO	0 00	0.27	0 61	1 00	0 90	0 65	5 02	1 85	10.30

MT-7S(B)*									
INORG FRAC	0 00	0 84	1 98	2 50	3 99	3 63	66 49	9 69	89 11
ORG FRACTIO	0 00	0 78	0 72	0 61	0 70	0 59	6 04	1 45	10 89

MT-7S(C)*									
INORG FRAC	0 00	0 00	0 00	1 16	42 78	29 42	24 22	0 28	97 86
ORG FRACTIO	0.00	0 00	0 00	0 12	0 21	0 22	1 19	0 39	2.14

	medium gravel	fine gravel	coarse sand	medium sand	fine sand	very fine sand	silt	clay	totals

SMT-8									
INORG FRAC	0.01	0.08	11.81	4.57	13.01	37.73	27.69	0.16	95.04
ORG FRACTIO	0.01	0.06	0.71	0.32	0.58	1.02	1.80	0.45	4.96

MT-8(C)*									
INORG FRAC	0.00	0.00	1.75	3.32	5.38	4.72	64.54	8.62	88.33
ORG FRACTIO	0.00	0.00	1.09	0.70	0.96	0.82	6.70	1.40	11.67

MT-11(C)*									
INORG FRAC	0.00	0.00	1.75	3.00	2.74	3.19	70.99	6.05	87.72
ORG FRACTIO	0.00	0.00	1.27	0.76	0.74	0.74	7.87	0.89	12.28

* = Samples from floodplain survey
 ()** = Replicate

Table 8. Mobile River Study, August 7, 1993.

Grab Sample:	TR1 (Base)	TR78	TR2 (Base)	TR69	TR65A	TR57	TR56	TR55	TR52	TR50	TR48
Latitude N	31°19.01'	31°19.04'	31°16.26'	31°16.26'	31°15.57'	31°12.73'	31°12.35'	31°11.67'	31°10.10'	31°09.81'	31°09.66'
Longitude W	87°55.53'	87°56.39'	87°57.46'	87°58.77'	87°58.77'	87°56.58'	87°57.07'	87°56.85'	87°56.58'	87°57.08'	87°58.47'
App. R. Mile	69.3	68.5	63.4	61.8	59.5	54.3	53.7	52.7	50.8	50	48.8
Depth (ft)	14	20	11	20	17	22	28	25	23	28	13
Element	Ppm										
Al	3085	2302	4697	3463	4766	8200	9958	8810	8149	8989	4697
As	70	3101	2302	43	54	106	129	141	102	126	65
B	2.8	2.4	3.2	3.9	4.7	4.7	5.3	5.0	5.0	4.6	3.2
Ba	45	56	39	53	62	113	119	90	86	83	62
Bc	1.4	1.9	1.2	1.8	2.4	3.1	3.5	3.1	2.8	2.9	1.9
Bi	7.1	6.7	2.5	7.4	11.1	12.7	12.6	9.3	8.6	12.3	8.2
Ca	686	1210	543	771	988	1860	1927	1646	1476	1545	1012
Cd	0.4	0.8	0.5	0.6	0.6	1.0	0.5	0.9	0.8	1.1	0.3
Co	1.9	4.5	2.8	3.8	5.1	7.9	9.4	8.1	5.8	6.7	3.8
Cr	9.7	9.2	8.2	10.3	13.4	18.1	22.0	20.7	18.1	19.2	14.0
Cu	34	26	34	24	26	31	29	31	31	35	33
Fe	6672	8696	5447	8223	10214	13582	14681	13104	11539	12506	8304
K	283	213	151	473	578	758	943	866	820	831	428
Hg	0.311	0.885	1.346	1.006	1.301	1.411	1.741	1.529	1.465	2.451	1.181
Mg	579	592	434	647	832	1185	1387	1232	1088	1162	716
Mn	202	345	169	308	388	798	831	590	562	523	352
Mo	3.5	2.6	2.3	3.0	3.8	7.2	8.5	7.0	8.0	7.3	3.4
Na	58	90	41	87	131	79	85	71	100	69	85
Ni	6.5	6.1	6.0	6.6	9.8	12.1	13.2	12.4	9.9	11.6	8.6
P	184	259	169	231	284	469	465	402	359	388	237
Pb	12.6	10.8	12.1	15.6	19.2	27.0	32.8	29.1	26.3	27.9	17.6
Sb	12.4	11.6	7.0	10.5	17.1	26.7	35.1	29.5	27.5	30.1	14.3
Se	12.9	15.6	8.9	12.5	20.6	33.5	39.9	30.7	28.6	37.3	18.4
Si	197	678	95	351	487	924	965	788	1091	1609	598
Sn	13.7	45	16	26	36	59	69	65	60	65	38
Sr	8.1	9.9	6.7	9.0	11	20.2	21.8	18.6	17.4	17.2	11.2
U	N/D	N/D	N/D	N/D	0.9	N/D	N/D	N/D	N/D	N/D	N/D
V	8.4	9.0	6.6	9.2	11.6	15.0	18.6	16.2	14.2	15.0	9.4
W	11.5	6.0	5.6	15.7	11.0	18.6	33.7	24.1	19.8	25.0	11.1
Y	5.5	5.0	8.2	6.0	6.5	8.2	9.0	7.8	7.8	7.4	6.1
Zn	14.5	19.7	12.3	16.8	22.5	39.0	42.7	36.6	32.5	34.7	20.6

ICP (EPA method 6010) analysis on all elements except Hg. Sediment sample: 200 mesh or finer.
 Mercury Cold-Vapor Technique (EPA method 7471) analysis for Hg. N/D: Not Detected.

Table 8 (cont). Mobile River Study, August 7, 1993.

Grab Sample:	MR42	MR40	MR38	MR37	MR33	MR30	MR21	MR17	MR15	MR13	MR5
Latitude N	31°08.04'	31°07.47'	31°05.74'	31°05.05'	31°03.59'	31°02.62'	31°00.61'	30°59.19'	30°59.01'	30°57.15'	31°53.56'
Longitude W	87°56.74'	87°56.83'	87°58.31'	87°58.59'	87°58.76'	88°00.10'	88°00.24'	87°59.13'	87°59.13'	87°58.58'	87°58.34'
App. R. Mile	44.7	43.9	41.7	40.8	37.9	35.8	30.2	27.8	26.9	24.2	19.1
Depth (ft)	35	12	25	38	35	25	23	30	30	35	12
Element	ppm										
Al	6500	11916	7568	9571	7383	6862	6159	8474	5634	8327	6201
As	86	163	107	139	91	91	78	116	71	115	85
B	2.3	3.9	3.7	4.2	N/D	2.5	3.1	3.7	2.0	3.8	2.4
Ba	83	119	79	130	96	95	81	119	72	121	76.5
Bc	2.7	3.8	2.8	3.9	2.8	3.1	2.6	3.6	2.7	3.8	2.8
Bi	10.1	12.9	10.7	17.0	10.0	14.9	10.1	12.0	9.9	12.4	11.5
Ca	1337	1872	1548	2120	1758	1643	1523	2512	1375	1887	1401
Cd	0.7	0.9	0.7	1.1	0.7	0.1	0.7	0.8	0.5	1.0	1.1
Co	6.7	9.8	7.4	10.3	3.8	8.7	6.8	9.5	7.4	9.5	7.0
Cr	16.8	26.0	18.0	21.6	20.2	16.2	14.5	21.1	13.0	17.9	13.8
Cu	21	24	21	25	11	24	23	27	27	32	27
Fe	12061	16821	12680	17341	13129	13682	11547	15915	11767	16638	12105
K	423	939	697	713	364	473	516	681	469	546	523
Hg	0.679	1.155	0.999	1.177	0.883	0.975	0.839	1.191	0.874	1.282	0.981
Mg	927	1535	1107	1380	1044	1032	917	1177	872	1130	942
Mn	364	737	501	883	721	726	594	717	431	899	507
Mo	5.3	10.4	6.2	8.4	4.3	5.8	5.1	7.7	4.6	8.2	5.2
Na	68	120	108	153	75	74	52	74	55	125	76
Ni	10.2	15.1	12.0	14.0	12.0	10.7	9.3	13.3	10.5	13.2	9.5
P	333	477	364	507	425	395	365	497	348	596	389
Pb	23.1	36.5	27.0	33.0	28.7	24.9	22.4	31.3	21.3	29.8	23.4
Sb	20.1	41.5	25.7	33.8	32.3	23.3	20.2	29.9	20.2	29.5	23.5
Se	31.6	48.6	34.8	42.6	30.3	27.8	26.5	35.8	24.4	35.9	25.1
Si	584	1736	816	707	2707	783	742	1361	943	1220	1122
Sa	63	81	59	75	61	59	58	70	47	73	50.5
Sr	11.9	18.1	15.1	18.8	14	14.5	13.9	17.9	12.7	17.3	12.9
U	N/D	3.0	2.1	0.5	N/D	N/D	5.1	6.2	N/D	N/D	N/D
V	13.9	22.2	16.6	20.8	17.5	15.9	13.4	18.4	13.1	18.6	13.8
W	18.4	32.5	22.2	22.5	16.0	18.3	15.1	18.6	8.5	15.6	12.7
Y	7.9	11.1	11.1	11.1	10.9	9.4	8.5	10.7	7.4	11.0	7.6
Zn	29.6	49.3	34.5	47.0	38.8	36.1	29.0	44.2	31.1	60.6	34.3

ICP (EPA method 6010) analysis on all elements except Hg. Sediment sample: 200 mesh or finer.
 Mercury Cold-Vapor Technique (EPA method 7471) analysis for Hg. N/D: Not Detected.

Table 9. Results of organic analyses of surface water samples (ug/L) from the floodplain wetland. Mobile River Study, October, 1993.

STATION	MT-0 (A)	MT-0 (B)	MT-0 (C)	MT-2 (A)	MT-2 (B)	MT-2 (C)	MT-7N (A)	MT-7N (B)	MT-7N (C)
SAMPLE #	85054	85055	85056	85057	85058	85046	85051	85052	85053
ATRAZINE	0.20	.069J	0.23	0.36	0.34	0.30	0.48	0.26	0.42
SIMAZINE	0.12U	0.12U	0.12U	0.040JN	0.037JN	0.060U	0.046JN	0.12U	.039JN

STATION	MT-7S (A)	MT-7S (B)	MT-7S (C)	MT-8 (A)	MT-8 (B)	MT-8 (C)
SAMPLE #	85063	85064	85065	85047	85048	85049
ATRAZINE	0.55	0.45	0.41	0.29	0.44	0.40
SIMAZINE	.040JN	.041JN	.038JN	0.12U	.045JN	.039JN

STATION	MT-11 (A)	MT-11 (B)	MT-11 (C)	MT-11 (D)
SAMPLE #	85059	85060	85061	85062
ATRAZINE	.023J	.024J	.024J	.024J
SIMAZINE	.058JN	.058JN	.060JN	.059JN

J = Estimated value.

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

() = Floodplain sample.

Table 10. Results of inorganic analyses of surface water samples (ug/L) from the floodplain wetlands. Mobile River Study. April, 1994.

STATION	MT- 0 (A)	MT- 0 (B)	MT- 0 (C)	MT- 2 (A)	MT- 2 (B)	MT- 2 (C)	MT- 7N (A)	MT- 7N (B)	MT- 7N (C)
STATION #	85054	85055	85056	85057	85058	85046	85051	85052	85053
ALUMINUM	570	440	660	1400	1500	1700	1700	1800	1800
BARIUM	30	28	31	41	42	43	42	43	44
CALCIUM	12	10	12	12	12	12	12	12	12
CHROMIUM	2.5U	2.5U	2.5U	2.5U	2.5U	2.5U	2.7	2.5	2.6
COPPER	2.5U	2.5U	2.5U	6.0	6.6	7.0	2.5U	2.5U	2.5U
IRON	2.0	2.9	2.0	2.4	2.4	2.7	2.4	2.5	2.6
LEAD	10U	10U	10	10U	10U	10U	10U	10U	10U
MAGNESIUM	2.9	3.0	2.8	2.4	2.4	2.5	2.4	2.5	2.6
MANGANESE	84	180	78	54	49	66	67	68	70
UTL MERCURY*	4.9	5.8	4.8	54	63	37	5.9	5.3	5.3
POTASSIUM	1.6	1.4	1.4	1.5	1.6	1.5	1.3	1.4	1.5
SODIUM	14	18	13	5.6	5.7	5.3	4.7	4.8	4.9
STRONTIUM	70	65	72	72	73	73	74	77	77
TITANIUM	7.4	6.2	8.2	17	18	19	19	20	21
VANADIUM	2.5U	2.5U	2.5U	3.7	3.9	4.2	4.1	4.2	4.4
ZINC	4.1	4.0	4.7	7.8	11	7.9	6.2	7.0	7.5

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

* = Exception, ultra-trace level mercury is reported in ng/L.
 Stations - A,B,C,N, and S denote specific sites within designated station area, further explanation is in text.

() = Floodplain sample.

Table 10 cont. Inorganic surface water floodplain (ug/L)

STATION	MT- 7S(A)	MT- 7S(B)	MT- 7S(C)	MT- 8(A)	MT- 8(B)	MT- 8(C)	MT- 11(A)	MT- 11(B)	MT- 11(C)	MT- 11(D)
STATION #	85063	85064	85065	85047	85048	85049	85059	85060	85061	85062
ALUMINUM	1400	1800	1700	1500	1300	1500	580	520	610	530
BARIUM	44	44	43	40	39	44	27	26	27	26
CALCIUM	13	13	12	11	11	12	11	10	11	11
CHROMIUM	2.5U	3.0	2.5U	2.5U	2.5U	2.7	2.5U	2.5U	2.5U	2.5U
COPPER	2.5U	2.5U	2.5U	2.5U	2.5U	3.2	2.5U	2.5U	2.5U	2.5U
IRON	2.1	2.6	2.5	2.0	1.9	2.1	0.90	0.86	0.92	0.90
LEAD	10U	10U	10U	10U	10U	10U	10U	10U	10U	10U
MAGNESIUM	2.5	2.6	2.6	2.4	2.3	2.4	2.2	2.2	2.2	2.2
MANGANESE	54	67	65	59	59	62	36	36	36	36
UTL MERCURY*	6.4	9.4	9.6	5.2	4.7	4.8	2.8	3.1	2.8	3.3
POTASSIUM	1.6	1.6	1.4	1.5	1.3	1.5	1.2	1.1	1.3	1.4
SODIUM	5.8	5.2	5.2	4.7	4.7	5.2	5.4	5.4	5.7	5.4
STRONTIUM	82	79	78	71	70	75	46	45	46	46
TITANIUM	16	20	19	16	14	18	8.6	8.2	9.4	8.6
VANADIUM	3.7	4.6	4.4	3.6	2.8	3.6	2.5U	2.5U	2.5U	2.5U
ZINC	4.6	5.8	7.3	5.8	4.7	6.3	2.9	2.8	3.1	3.6

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

* = Exception ultra-trace level mercury is reported in ng/L. Stations - A,B,C,N, and S denote specific sites within designated station area, further explanation is in text. () = Floodplain sample.

Table 11. Results of inorganic analyses of sediment from the floodplain wetlands (mg/kg). Mobile River Study, April 1994.

STATION	MT- 0 (A)	MT- 0 (B)	MT- 0 (C)	MT- 2 (A)	MT- 2 (B)	MT- 2 (C)	MT- 7S (A)	MT- 7S (B)	MT- 7S (C)
STATION #	85076	85077	85078	85079	85080	85081	85070	85071	85072
ALUMINUM	28000	31000	38000	30000	29000	30000	28000	29000	9000
ARSENIC	13	12	9.1	6.7	13	7.2	8.4	12	6.0U
BARIUM	130	160	190	180	210	220	130	140	70
BERYLLIUM	2.0U	2.0U	2.0U	1.6	1.5U	1.6	1.5U	2.0U	1.0U
CALCIUM	3000	3500	6200	4700	3200	3100	4500	2600	1800
CHROMIUM	45	50	66	53	60	62	48	46	19
COBALT	13	18	15	15	12	7.5	17	9.0	5.7
COPPER	20	16	21	16	42	41	17	17	4.7
IRON	43000	42000	36000	33000	24000	19000	29000	36000	13000
LEAD	24	34	26	19	23	30	29	26	8.7
MAGNESIUM	3000	3400	3900	3600	2200	2600	2400	2900	1400
MANGANESE	570	940	970	1500	180	150	420	240	360
MERCURY	0.19	0.20	3.3	0.84	30	18	32	0.17	0.05U
MOLBDENIUM	4.0U	4.0U	4.0U	3.0U	3.4	3.3	3.0U	4.0U	2.0U
NICKEL	20	24	28	23	25	22	18	18	9.1
POTASSIUM	1900	2000	2600	2300	1200	1800	1700	1900	1200
SODIUM	480	640	580	340	410	360	500	620	260
STRONTIUM	32	37	54	44	32	35	36	31	17
TITANIUM	65	63	29	74	63	100	70	130	110
VANADIUM	59	65	73	61	63	63	60	63	24
YTTRIUM	20	22	20	18	19	19	15	20	7.3
ZINC	100	120	130	100	130	110	86	92	34

U = Material was analyzed for but not detected, number is minimum quantitation limit.

Table 11 cont. Inorganic sediments floodplain (mg/kg)

STATION	MT- 7N(A)	MT- 7N(B)	MT- 7N(C)	MT- 8(A)	MT- 8(B)	MT- 8(C)	MT- 11(A)	MT- 11(B)	MT- 11(C)	MT- 11(D)
STATION #	85073	85074	85075	85042	85043	85044	85066	85067	85068	85069
ALUMINUM	43000	39000	25000	34000	23000	36000	32000	33000	36000	36000
ARSENIC	15U	8.5	9.0	12U	9.0U	12U	12U	13	12	13
BARIUM	240	220	200	160	190	210	210	220	220	210
BERYLLIUM	2.5U	2.1	2.0U	2.0U	1.9	2.0U	2.0U	2.0U	2.0U	2.0U
CALCIUM	4600	4400	4300	2700	4500	4700	3600	4100	3500	3400
CHROMIUM	70	65	44	53	44	61	50	55	56	56
COBALT	20	18	16	16	15	13	17	15	11	11
COPPER	18	16	15	12	16	13	15	16	22	21
IRON	41000	38000	35000	31000	33000	36000	38000	38000	40000	40000
LEAD	29	30	19	20	23	22	24	22	28	30
MAGNESIUM	4200	3900	2700	3200	2600	3700	2900	3300	3200	3200
MANGANESE	2000	1600	1600	710	1200	960	1400	1000	420	410
MERCURY	0.33	0.23	0.26	0.16	0.21	0.20	0.20	0.19	0.17	0.18
MOLBDENIUM	5.0U	4.0U	4.0U	4.0U	3.0U	4.0U	4.0U	4.0U	4.0U	4.0U
NICKEL	32	30	22	20	21	28	21	23	21	18
POTASSIUM	2600	2400	1700	2100	1500	2200	1700	2100	2000	2000
SODIUM	500U	780	400U	410	300U	440	420	490	420	430
STRONTIUM	52	48	44	38	42	49	28	32	28	28
TITANIUM	49	51	72	45	81	94	180	130	130	98
VANADIUM	82	78	58	66	54	73	66	67	72	71
YTRIUM	22	21	20	14	20	22	21	22	25	24
ZINC	140	120	90	99	100	120	110	130	120	120

U = Material was analyzed for but not detected, number is minimum quantitation limit.

Table 12. Results of organic analyses of floodplain sediments (ug/kg). Mobile River Study. April, 1994.

STATION	MT-2 (A)	MT-0 (B)	MT-0 (C)	MT-2 (A)	MT-2 (B)	MT-2 (C)	MT-7N(A)	MT-7N(B)	MT-7N(C)	MT-7S (A)	MT-7S (B)	MT-7S (C)
SAMPLE #	85076	85077	85078	85079	85080	85081	85073	85074	85075	85070	85071	85072
CYANIDE*	.64U	.54U	.53U	.33U	1.2U	.74U	.37	.36U	.38U	.33U	.40U	.30U
4,4'-DDT	99U	30J	78U	50U	200U	110U	51U	51U	50U	41	35	12J
4,4'-DDE	40U	64U	63U	50U	80U	43U	50U	50U	50U	270	35	11J
4,4'-DDD	99U	64U	63U	50U	160U	86U	50U	50U	50U	27	50U	6.8J
HEXADECANOL	-	-	-	-	-	-	-	-	-	-	-	-
OP-DDT	-	-	-	-	-	-	-	-	-	31	-	5.9J
OP-DDE	-	-	-	-	-	-	-	-	-	190	16J	9.5J
OP-DDD	-	-	-	-	-	-	-	-	-	61	-	-
TOLUENE	160U	130U	150U	83U	560U	270U	73U	150U	96U	66U	90U	75U

STATION	MT-8 (A)	MT-8 (B)	MT-8 (C)	MT-11 (A)	MT-11 (B)	MT-11 (C)	MT-11 (D)
SAMPLE #	85042	85043	85044	85066	85067	85068	85069
CYANIDE	.38U	.39U	.41U	.38U	.40U	.48U	.48U
4,4'-DDT	56U	50U	68U	55U	54U	68U	79U
4,4'-DDE	50U	50U	50U	50U	50U	55U	32U
4,4'-DDD	50U	50U	50U	50U	50U	55U	64U
HEXADECANOL	4000JN	-	-	-	-	-	-
OP-DDT	-	-	-	-	-	-	-
OP-DDE	-	-	-	-	-	-	-
OP-DDD	-	-	-	-	-	-	-
TOLUENE	76U	83U	85U	75U	84U	21J	120U

* = except cyanide mg/kg.
 J = Estimated value.
 U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 N = Presumptive evidence of presence of material.
 - = No data reported.

Table 13. Results of organic analyses of Largemouth Bass fillet composite samples (mg/kg).
Mobile River Study. November, 1993.

STATION MT-0	SL	SL	SL	ML	ML	ML	LL	LL	LL
D NUMBER	2414	2418	2409	2417	2416	2407	2412	2410	2405
TAG NUMBER	42745	42804	42614	42739	44517	42737	44912	42609	44525
% LIPIDS	0.48	0.33	0.37	0.50	0.43	0.44	0.60	0.40	0.56
ENDRIN	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj
METHOXYCHLOR	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	-	.025Uj	.025Uj
BUTYLATE	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj
4,4'-DDE	.011j	.015j	.010j	.009j	.011j	.020Uj	.027j	.013Nj	.028j
4,4'-DDD	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.006Uj (.003)	.005Uj (.0025)	.006Uj (.003)
4,4'-DDT	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.006Uj (.003)	.005Uj (.0025)	.007Uj (.008U)
SUM OF DDE, DDD AND DDT	0.016	0.020	0.015	0.014	0.016	0.015	0.030	0.018	0.287

j = Samples received thawed; a second value represents a replicate sample continuously frozen from preparation to analysis.
 N = Difference between columns.
 U = Material was analyzed for but not detected. The number is the minimum quantitation limit
 SL = Small Largemouth Bass composite.
 ML = Medium Largemouth Bass composite.
 LL = Large Largemouth Bass composite.
 - = No numbers reported.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass fillets (mg/kg)

STATION MT-2	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2507	2506	2422	2423	2421	2517	2514	2801	2802	2512
TAG NUMBER	44562	44560	44572	42583	42724	44557	42729	44557	42729	42585
% LIPIDS	0.41	0.40	0.30	0.43	0.65	0.52	1.13	0.52	1.13	0.45
ENDRIN	.005Uj									
METHOXYCHLOR	.025Uj									
BUTYLATE	.080Uj									
4,4'-DDE	.013j	.012j	.011j	.016j	.017j	.008j	.024j	.015	.030	.021Nj
4,4'-DDD	.005Uj (.0025)	.007Uj (.0035)	.005Uj (.0025)							
4,4'-DDT	.005Uj (.0025)									
SUM OF DDE, DDD AND DDT	0.018	0.017	0.016	0.021	0.022	0.013	0.030	0.013	0.030	0.026

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

() = Assumed median value of reported MDL for the purpose of calculating total DDT.

Table 13 cont. Organics analyses bass fillets (mg/kg)

STATION MT-3	SL	SL	SL	ML	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2627	2544	2541	2545	2542	2540	2546	2543	2536		
TAG NUMBER	44739	44783	44785	44791	42639	44797	44741	44787	44789		
% LIPIDS	0.21	0.25	0.63	0.47	0.41	0.87	1.53	0.62	1.60		
ENDRIN	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	0.014j	.005Uj	.005Uj	.006Uj		
METHOXYCHLOR	.025Uj										
BUTYLATE	.080Uj										
4,4'-DDE	.008j	.009j	.010j	.020Uj (.010)	.014j	.005Uj (.0025)	.046j	.021j	.032j		
4,4'-DDD	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.020Uj (.010)	.008Uj (.004)	.008j		
4,4'-DDT	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.009Uj (.0045)	.005Uj (.0025)	.009Uj (.0045)		
SUM OF DDE, DDD AND DDT	0.013	0.014	0.015	0.025	0.019	0.008	0.061	0.028	0.041		

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

() = Assumed median value of reported MDL for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass fillets (mg/kg)

STATION MT-4	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2721	2717	2716	2725	2724	2720	2731	2729	2715			
TAG NUMBER	44814	44808	42651	44812	44825	42649	44810	44799	44816			
% LIPIDS	0.70	0.62	0.56	0.91	1.06	0.70	1.52	0.78	1.57			
ENDRIN	.005U	.005U										
METHOXYCHLOR	.025U	.025U	.025U	.025U	.025U	.025	.025U	.025U	.025U			
BUTYLATE	.080U	.080U										
4,4' -DDE	.005U (.0025)	.005U (.0025)	.005	.009	.010	.017	.021	.013	.039			
4,4' -DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.008U (.004)	.005U (.0025)	.009 (.0045)			
4,4' -DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.008U (.004)	.005U (.0025)	.005U (.0025)	.020U (.010)			
SUM OF DDE, DDD AND DDT	0.008	0.008	0.008	0.014	0.015	0.024	0.028	0.018	0.054			

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass fillets (mg/kg)

STATION MT-5	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2628	2633	2640	2632	2637	2634	2631	2629	2642	
TAG NUMBER	42694	42618	42616	42621	44589	44586	42635	42634	44580	
% LIPIDS	0.67	0.70	0.63	0.85	0.71	0.85	1.67	1.34	1.25	
ENDRIN	.005U	.005U								
METHOXYCHLOR	.025U	.025U								
BUTYLATE	.080U	.080U								
4,4'-DDE	.009	.008	.009	.010	.013	.012	.048	.022	.030	
4,4'-DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.026N (.0025)	.010U (.005)	.010N	
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.006U (.003)	.005U (.0025)	.010U (.005)	.005U (.0025)	.008U (.004)	
SUM OF DDE, DDD AND DDT	0.014	0.013	0.014	0.015	0.019	0.017	0.079	0.030	0.044	

N = Difference between columns.
 U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass filelets (mg/kg)

STATION MT-7	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL	LL
D NUMBER	2524	2523	2521	2530	2526	2525	2533	2532	2809	2811	2518
TAG NUMBER	44714	44710	44829	44708	44863	44706	44726	44859	44724		44724
% LIPIDS	0.49	0.32	0.61	0.43	0.46	0.40	0.76	0.85	0.60	0.57	2.73
ENDRIN	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005Uj	.005U	.005U	.005Uj
METHOXYCHLOR	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025U	.025U	.025Uj
BUTYLATE	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080Uj	.080U	.080U	.13j
4,4'-DDE	.009j	.023j	.44j	.019j	.15j	.014j	.071j	.87j	.097	.89C	.064j
4,4'-DDD	.005Uj (.0025)	.006Uj (.003)	.24Uj (.12)	.007Uj (.0035)	.057Nj	.006Uj (.003)	.027j .052	.35j .25			.020j
4,4'-DDT	.005Uj (.0025)	.005Uj (.0025)	.007j	.005Uj (.0025)	.020Uj (.010)	.005Uj (.0025)	.012Nj .020U	.13j .10			.008Nj
SUM OF DDE, DDD AND DDT	0.014	0.029	0.564	0.025	0.217	0.020	0.110	1.350			0.092

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.

C = Confirmed by GCMS.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass fillets (mg/kg)

STATION MT-8	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2738	2737	2736	2735	2734	2732	2747	2745	2742			
TAG NUMBER	42819	42835	44613	44626	42813	44609	44638	44640	42809			
% LIPIDS	0.34	0.51	0.53	0.45	0.61	0.42	0.98	1.08	0.54			
ENDRIN	.005U	.005U										
METHOXYCHLOR	.025U	.025U										
BUTYLATE	.080U	.080U										
4,4'-DDE	.010	.008	.041	.009	.025	.010	.048	.082	.063			
4,4'-DDD	.005U (.0025)	.005U (.0025)	.020	.005U (.0025)	.005U (.0025)	.005U (.0025)	.009U (.0045)	.025	.012			
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.007U (.0035)	.009U (.0045)	.008U (.004)			
SUM OF DDE, DDD, AND DDT	0.015	0.013	0.064	0.014	0.030	0.015	0.056	0.112	0.079			

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass filelets (mg/kg)

STATION MT-9	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2593	2591	2592	2582	2585	2581	2579	2578	2575			
TAG NUMBER	42915	42720	44545	44849	44541	42714	44663	44653	44851			
% LIPIDS	0.75	0.70	0.80	0.76	0.92	0.74	0.95	0.90	0.88			
ENDRIN	.005U											
METHOXYCHLOR	.025U	.025U	.025U	.025U	.025U	.025	.025U	.025U	.025U			
BUTYLATE	.080U											
4,4'-DDE	.008	.010	.005U (.0025)	.014	.018	.010	.035	.050	.059			
4,4'-DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.009N	.020U (.010)	.020U (.010)			
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.007U (.0035)	.005U (.0025)	.009U (.0045)			
SUM OF DDE, DDD, AND DDT	0.013	0.015	0.008	0.019	0.023	0.015	0.048	0.063	0.074			

N = Difference between columns.
 U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 13 cont. Organic analyses bass filets (mg/kg)

STATION MT-10	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
D NUMBER	2688	2693	2690	2685	2682	2794	2684	2683	2754			
TAG NUMBER	42853	42881	42867	42879	42871	42877	42865	42869	42849			
% LIPIDS	0.64	0.80	0.64	0.80	1.0	0.53	1.04	1.2	0.64			
ENDRIN	.005U											
METHOXYCHLOR	.025U											
BUTYLATE	.080U											
4,4'-DDE	.005U (.0025)	.0084	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.0058	.0072	.022			
4,4'-DDD	.005U (.0025)											
4,4'-DDT	.005U (.0025)											
SUM OF DDE, DDD, AND DDT	0.008	0.013	0.008	0.008	0.008	0.008	0.011	0.012	0.027			

U = Material was analyzed for but not detected. The number is the minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14. Results of organic analyses of Channel Catfish composite fillet samples (mg/kg).
Mobile River Study. November, 1993.

STATION MT-0	SC	SC	SC	MC	MC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2404	2403	2401	2411	2408	2406	2413	2415	2402	2805		
TAG NUMBER	42964	42998	44509	42996	43023	43004	42743	31857	43045			
% LIPIDS	1.08	1.39	.87	1.85	4.47	2.98	2.15	3.66	3.66			
METHOXYCHLOR	.25Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj
ALPHA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj
GAMMA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj
PCB 1260	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj
4,4'-DDE	.027j	.027j	.013j	.046j	.039j	.29j	.064j	.062j	.066j	.051		
4,4'-DDD	.007Uj (.0035)	.006Nj (.003)	.005Uj (.0025)	.010Nj	.012Nj	.008Uj (.004)	.013Nj	.020Uj (.010)	.020Nj	.015		
4,4'-DDT	.007Uj (.0035)	.006Uj (.003)	.005Uj (.0025)	.009Uj (.0045)	.008Uj (.004)	.020Uj (.010)	.020Uj (.010)	.020Uj (.010)	.020Uj (.010)	.020Uj (.010)	.009U	
SUM OF DDE, DDD, AND DDT	0.034	0.036	0.018	0.061	0.055	0.304	0.087	0.082	0.096			

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

SC = Small Channel Catfish composite.

MC = Medium Channel Catfish composite.

LC = Large Channel Catfish composite.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic Analyses catfish fillets (mg/kg)

STATION MT-2	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2510	2420	2419	2505	2513	2509	2515 2803	2511 2804	2508	
TAG NUMBER	42972	42968	42970	44525	42743	42597	42982	44946	43056	
% LIPIDS	0.90	1.38	0.72	0.36	1.92	0.63	3.18 1.97	3.28 1.87	2.39	
METHOXYCHLOR	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj .025U	.025Uj .025U	.025Uj	
ALPHA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj .0025U	.003Uj .0025U	.003uJ	
GAMMA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj .0025U	.003Uj .0025U	.003Uj	
PCB 1260	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj .070U	.050Uj .050U	.050Uj	
4,4'-DDE	0.043j	0.021j	.028j	.024j	.046j	.037j	.054j .063	.051j .045	.049j	
4,4'-DDD	.008Uj (.004)	.006Nj (.003)	.005Uj (.0025)	.006Uj (.003)	.020Uj (.010)	.007Nj	.020Uj (.010) .017	.020Uj (.010) .015N	.014Nj	
4,4'-DDT	.008Uj (.004)	.005Uj (.0025)	.005Uj (.0025)	.006Uj (.003)	.010Uj (.005)	.007Uj (.0035)	.020Uj (.010) .020U	.020Uj (.010) .020U	.010Uj (.005)	
SUM OF DDE, DDD, AND DDT	0.051	0.030	0.033	0.030	0.061	0.048	0.074	0.071	0.068	

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish filets (mg/kg)

STATION MT-3	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2626	2539	2538	2547	2548	2550	2551	2549	2537	2814	2816
TAG NUMBER	42660	43008	43021	43027	43019	43014	42664	44845	44827		
% LIPIDS	0.24	0.64	0.91	0.88	1.43	1.38	1.01	0.86	1.60	0.87	1.17
METHOXYCHLOR	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj
ALPHA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj
GAMMA CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.006Uj	.0025U	.0025U
PCB 1260	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj
4,4'-DDE	.025j	.009j	.012j	.048j	.055j	.032j	.068j	.041j	.090j	.044	.047
4,4'-DDD	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.020Uj (.010)	.010j	.020Uj (.010)	.020Uj (.010)	.008Uj (.004)	.032j	.0079	.011N
4,4'-DDT	.005Uj (.0025)	.005Uj (.0025)	.005Uj (.0025)	.020Uj (.010)	.006Uj (.003)	.007Uj (.0035)	.020Uj (.010)	.010Uj (.005)	.030Uj (.015)	.010U	.020U
SUM OF DDE, DDD, AND DDT	0.030	0.014	0.017	0.068	0.068	0.046	0.088	0.050	0.137	0.050	0.088

j = Samples received thawed; a second value represents a replicate sample continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-4	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2723	2722	2719	2727	2726	2793	2730	2728	2718	
TAG NUMBER	43072	43050	43070	43068	43033	43041	43035	43031	43037	
% LIPIDS	1.31	0.89	0.79	2.28	3.40	1.70	2.79	2.86	2.58	
METHOXYCHLOR	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U	
ALPHA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.0025U	.003U	.003U	.003U	
GAMMA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.0025U	.003U	.004U	.003U	
PCB 1260	.050U	.050U	.050U	.060U	.060U	.050U	.060U	.070U	.050U	
4,4'-DDE	.019	.025	.020	.048	.054	.038	.050	.062	.039	
4,4'-DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.020U (.010)	.017N	.011	.020U (.010)	.020U (.010)	.013	
4,4'-DDT	.005U (.0025)	.005U (.0025)	.006U (.003)	.010U (.005)	.020U (.010)	.008U (.004)	.010U (.005)	.020U (.010)	.010U (.005)	
SUM OF DDD, DDE, AND DDT	0.024	0.030	0.026	0.063	0.081	0.053	0.065	0.082	0.057	

N = Difference between columns.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-5	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2638	2641	2644	2635	2636	2639	2630	2643	2680		
TAG NUMBER	43094	43102	43106	43098	43103	42668	42676	43087	43090		
% LIPIDS	1.17	1.34	1.55	1.71	1.79	1.30	2.65	2.82	3.19		
METHOXYCHLOR	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U		
ALPHA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U		
GAMMA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U		
PCB 1260	.050U	.050U	.050U	.050U	.050U	.050U	.050U	.080U	.080U		
4,4'-DDE	.039	.028	.027	.040	.034	.025	.063	.054	.058		
4,4'-DDD	.011N	.006	.008N	.009	.010N	.009N	.025N	.014	.017		
4,4'-DDT	.020U (.010)	.007U (.0035)	.008U (.004)	.010U (.005)	.008U (.004)	.007U (.0035)	.020U (.010)	.020U (.010)	.020U (.010)		
SUM OF DDE, DDD, AND DDT	0.060	0.038	0.039	0.054	0.048	0.038	0.098	0.078	0.085		

N = Difference between columns.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-7	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2531	2522	2520	2529	2528	2527	2535	2534	2519	2519
TAG NUMBER	42954	44877	42952	44865	44755	42942	44753	44764	44873	44873
% LIPIDS	0.99	0.41	1.98	2.21	2.40	1.90	3.53	2.98	2.73	2.77
METHOXYCHLOR	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj	.025Uj
ALPHA-CHLORDANE	.003Uj	.004Nj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj
GAMMA-CHLORDANE	.003Uj	.003Uj	.003Uj	.003Uj	.003Uj	.003j	.003Nj	.003j	.003Uj	.003Uj
PCB 1260	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj	.050Uj
4,4'-DDE	.023j	.054j	.040j	.18j	.036j	.14j	.089j	.20j	.29j	.29j
4,4'-DDD	.007j	.006j	.009Uj (.0045)	.058j	.013j	.067j	.046j	.071j	.091j	.091j
4,4'-DDT	.005Uj (.0025)	.007Uj (.0035)	.006Uj (.003)	.020Uj (.010)	.006j	.030j	.021j	.048Nj	.038j	.038j
SUM OF DDE, DDD, AND DDT	0.033	0.064	0.048	0.248	0.055	0.237	0.156	0.319	0.419	0.419

j = Samples received thawed; a second value represents a replicate sample, continuously frozen from preparation to analysis.

N = Difference between columns.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-8	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2744	2743	2733	2741	2740	2739	2748	2749	2746	2746
TAG NUMBER	42944	42946	42920	42837	42841	44628	44619	44615	44630	44630
% LIPIDS	1.67	1.14	1.16	1.07	1.07	1.14	1.59	1.82	1.47	1.47
METHOXYCHLOR	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U	.025U
ALPHA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U
GAMMA CHLORDANE	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U	.003U
PCB 1260	.050U	.050U	.050U	.050U	.050U	.050U	.050U	.050U	.050U	.050U
4,4'-DDE	.027	.015	.029	.046	.016	.080	.040	.040	.018	.018
4,4'-DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.010N (.0025)	.005U (.0025)	.027	.006N (.0025)	.006N	.005U (.0025)	.005U (.0025)
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.008U (.004)	.005U (.0025)	.008U (.004)	.007U (.0035)	.008U (.004)	.005U (.0025)	.005U (.0025)
SUM OF DDE, DDD AND DDT	0.032	0.020	0.034	0.060	0.021	0.111	0.050	0.050	0.023	0.023

N = Difference between columns.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-9	SC	SC	SC	MC	MC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2584	2589	2587	2588	2586	2583	2580	2751	2590			
TAG NUMBER	44670	42914	44905	44898	44672	44908	44894	44665	44896			
% LIPIDS	0.73	0.68	0.85	1.45	1.25	1.01	0.24	2.26	1.09			
METHOXYCHLOR	.025U	.025	.025U									
ALPHA CHLORDANE	.003U	.003U	.003U									
GAMMA CHLORDANE	.003U	.003U	.003U									
PCB 1260	.050U	.050U	.050U									
4, 4' -DDE	.007	.010	.007	.024	.012	.019	.021	.052	.030			
4, 4' -DDD	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005N (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.020U (.010)	.005U (.0025)			
4, 4' -DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.006U (.003)	.006U (.003)	.020U (.010)	.007U (.0035)			
SUM OF DDE, DDD, AND DDT	0.012	0.015	0.012	0.032	0.017	0.025	0.027	0.072	0.036			

N = Difference between columns.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 14 cont. Organic analyses catfish fillets (mg/kg)

STATION MT-10	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC
D NUMBER	2694	2692	2691	2689	2687	2686	2679	2678	2755	
TAG NUMBER	42895	42899	42897	42889	42884	42883	42928	42933	42893	
% LIPIDS	0.88	0.80	1.12	1.0	0.56	1.2	1.76	1.68	1.44	
METHOXYCHLOR	.025U									
ALPHA CHLORDANE	.0025U									
GAMMA CHLORDANE	.0025U									
PCB-1260	.050U	.050	.050U	.050U						
4,4'-DDE	.0053	.0055	.015	.011	.0072	.0089	.017	.017	.013	
4,4'-DDD	.005U (.0025)									
4,4'-DDT	.005U (.0025)									
SUM OF DDE, DDD, AND DDT	0.010	0.011	0.020	0.016	0.012	0.014	0.022	0.022	0.018	

U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 15. Mean and Range of Lipid Content for Largemouth Bass and Channel Catfish Fillet and Whole Body Samples. Mobile River Study, 1993 - 94.

Species**	Station - Percent Lipids										NCBP*
	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10		
LMB-F	0.5	0.5	0.7	0.9	1.0	0.8	0.6	0.8	0.8	0.8	
	0.3-0.6	0.3-1.1	0.2-1.6	0.6-1.5	0.6-1.8	0.3-0.8	0.3-1.1	0.7-1.0	0.6-1.0		
LMB-WB	1.3	2.3	4.9	5.0	3.6	2.9	6.9	3.4	4.1	4.1	
	1.0-1.9	1.5-3.1	1.0-7.9	1.4-8.0	1.5-5.9	0.8-5.5	0.9-11.2	2.0-5.6	0.6-7.7	1.1-8.9	
CC-F	2.6	1.6	1.0	2.1	2.0	2.1	1.4	1.1	1.2		
	0.8-4.5	0.9-3.3	0.2-1.6	0.9-2.9	1.2-3.2	0.4-3.5	1.1-1.8	0.7-2.3	0.6-1.8		
CC-WB	5.2	5.2	6.6	5.7	3.0	4.3	4.8	3.6	4.8	4.7	
	2.3-7.5	1.1-8.4	3.9-9.2	2.8-7.8	0.9-5.6	0.8-5.5	1.6-7.3	2.1-9.3	0.9-7.2	1.5-10.8	

* From National Contamination Biomonitoring Program (NCBP), U.S. Fish and Wildlife Service, 1976-1984.

LMB = Largemouth Bass
 CC = Channel Catfish
 F = Fillet Composite Sample
 WB = Whole body sample

Table 16. Results of inorganic analyses of Largemouth Bass fillet samples (mg/kg).
Mobile River Study. November, 1993.

STATION MT-0	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2342	2337	2331	2333	2343	2339	2329	2334	2345	2345	2345
TAG NUMBER	42744	42746	42803	42736	42738	44516	44911	44524	42608	42608	42608
BARIUM	0.17U	0.15U	0.16U	0.17U	0.16U	0.17U	0.17U	0.17U	0.17U	0.17U	0.15U
CALCIUM	340	800	560	420	230	240	200	160	440	440	440
COBALT	0.22U	0.19U	0.20U	0.21U	0.21U	0.22U	0.22U	0.21U	0.18U	0.18U	0.18U
COPPER	0.15U	1U	0.13U	0.13U	0.13U						
IRON	3U	2U	3U								
LEAD	0.04U										
MAGNESIUM	330	340	340	300	300	330	300	320	300	300	300
MANGANESE	0.12J	0.15J	0.15J	0.10J	0.14J	0.11J	0.08J	0.12J	0.13J	0.13J	0.13J
MERCURY	0.05J	0.06J	0.09J	0.12J	0.08J	0.09J	0.22J	0.19J	0.16J	0.16J	0.16J
NICKEL	0.20U	0.17U	0.86J	0.19U	0.19U	0.20U	0.25J	0.21J	0.22J	0.22J	0.22J
POTASSIUM	4500	4500	4600	4300	4400	4400	4200	4300	4200	4200	4200
SELENIUM	0.51	0.43	0.48	0.46	0.47	0.55	0.39	0.42	0.37	0.37	0.37
SILVER	0.21U	0.18U	0.19U	0.20U	0.20U	0.21U	0.21U	0.20U	0.17U	0.17U	0.17U
SODIUM	420	460	590	410	410	520	500	530	590	590	590
THALLIUM	0.06U	0.05U	0.06U	1U	0.06U	0.06U	0.06U	0.06U	0.05U	0.05U	0.05U
VANADIUM	0.18U	0.16U	0.17U	0.18U	0.17U	0.18U	0.18U	0.17U	0.15U	0.15U	0.15U
ZINC	12.0	12.0	14.0	9.6	12.0	13.0	12.0	9.3	9.2	9.2	9.2

J = Estimated value.
U = Material was analyzed for but not detected; number is minimum quantitation limit.
SL = Small Largemouth Bass; ML = Medium Largemouth Bass; LL = Large Largemouth Bass.

Table 16 cont. Inorganic analyses bass fillet (mg/kg)

STATION MT-2	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2368	2367	2661	2377	2376	2375	2380	2373	2366			
TAG NUMBER	44563	44573	44561	42582	42723	44568	42584	44556	42728			
BARIUM	0.17U	0.15U	0.2U	0.17U	0.17U	0.18U	0.14U	0.16U	0.17U			
CALCIUM	1200	370	960	260	260	560	480	400	530			
COBALT	0.22U	0.19U	0.03U	0.21U	0.21U	0.22U	0.18U	0.21U	0.22U			
COPPER	1U	1U	0.3U	1U	1U	14	2.3	1U	1U			
IRON	15U	3U	4U	4U	4U	3U	3U	3U	6U			
LEAD	0.04U	0.04U	0.05U	0.04U	0.04U	0.51	0.04U	0.04U	0.04U			
MAGNESIUM	360	320	320	300	320	320	290	310	320			
MANGANESE	0.44J	0.16J	0.19	0.09J	0.11J	0.12J	0.10J	0.13J	0.12J			
MERCURY	0.03J	0.07J	0.04J	0.12J	0.16J	0.21J	0.39J	0.27J	0.41J			
NICKEL	0.23J	0.17U	0.03U	0.31J	0.19U	1.3	0.16U	0.19U	0.20U			
POTASSIUM	4500	4500	3700J	4300	4500	4400	4000	4200	4600			
SELENIUM	0.49	0.45	0.53	0.49	0.90	0.46	0.45	1.4	0.40			
SILVER	0.21U	0.18U	0.03UJ	0.20U	0.20U	0.21U	0.17U	0.20U	0.21U			
SODIUM	520	520	480J	470	420	480	490	480	470			
THALLIUM	0.07	0.05U	0.07U	0.06U	0.06U	0.03U	0.05U	0.03U	0.06U			
VANADIUM	0.18U	0.16U	0.03U	0.17U	0.18U	0.18U	0.15U	0.17U	0.18U			
ZINC	13.0	13.0	12.0	11.0	11.0	18.0	12.0	8.6	8.6			

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-3	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2387	2385	2384	2392	2391	2389	2398	2397	2394		
TAG NUMBER	44782	44784	44738	44790	44796	42638	44788	44786	44740		
BARIUM	0.16U	0.17U	0.15U	0.16U	0.16U	0.16U	0.17U	0.16U	0.15U		
CALCIUM	310	930	500	330	280	210	870	390	220		
COBALT	0.20U	0.21U	0.19U	0.21U	0.21U	0.20U	0.21U	0.21U	0.19U		
COPPER	1U	1U	1U	1U	1U	1U	1U	0.14U	1U		
IRON	3U	3U	3U	3U	3U	3U	3U	3U	2U		
LEAD	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U		
MAGNESIUM	320	320	320	320	300	310	320	310	300		
MANGANESE	0.12J	0.12J	0.11J	1U	0.10J	0.07J	1U	0.09J	0.10J		
MERCURY	0.10J (0.05)	0.04J	0.03J	0.16	0.19	0.11J	0.34	0.27	0.25		
NICKEL	0.18U	0.19U	0.17U	0.19U	0.19U	0.18U	0.19U	0.19U	0.22J		
POTASSIUM	4100	3900	4100	4300	4000	4300	4100	4100	4100		
SELENIUM	0.48	0.45	0.43	0.50	0.41	0.36	0.41	0.47	0.45		
SILVER	0.19U	0.20U	0.18U	0.20U	0.20U	0.19U	0.20U	0.20U	0.18U		
SODIUM	450	450	460	490	430	500	490	450	450		
THALLIUM	0.05U	0.06U	0.05U	0.06U	0.06U	0.05U	0.06U	0.06U	0.05U		
VANADIUM	0.17U	0.18U	0.16U	0.17U	0.17U	0.17U	0.17U	0.17U	1U		
ZINC	9.7	10.0	11.0	11.0	8.1	9.0	7.7	8.3	7.8		

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating mercury.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-4	SL	SL	SL	ML	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2609	2608	2601	2662	2607	2606	2598	2596	2594			
TAG NUMBER	44807	44813	42650	44823	44811	42648	44809	44815	44798			
BARIUM	0.11U	0.10U	0.11U	0.11U	0.10U	0.11U	0.11U	0.11U	0.10U	0.11U	0.11U	0.10U
CALCIUM	710	360	380	370	370	340	520	300	450			
COBALT	0.03U											
COPPER	0.3U	7.1	0.3U	0.8U	0.3U	0.4U	0.3U	0.3U	0.3U	0.3U	0.3U	0.3U
IRON	3U	3U	3U	3U	3U	4U	3U	3U	3U	3U	3U	3U
LEAD	0.04U	0.40	0.04U	0.2U	0.04U	0.06U	0.04U	0.1U	0.1U	0.04U	0.1U	0.1U
MAGNESIUM	310	300	300	290	290	300	290	280	280	290	280	280
MANGANESE	0.15	0.16	0.13	0.10	0.11	0.14	0.09	0.08	0.09	0.09	0.08	0.09
MERCURY	0.03	0.04	0.09	0.10J	0.08	0.07	0.30	0.40	0.33	0.30	0.40	0.33
NICKEL	0.03U	0.65	0.03U	0.03U	0.03U	0.03	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3400J	3400J	3300J	3300J	3500J	3500J	3500J	3300J	3400J	3500J	3300J	3400J
SELENIUM	0.61J	0.61J	0.56	0.46	0.63J	0.63J	0.46J	0.50J	0.54J	0.46J	0.50J	0.54J
SILVER	0.03UJ											
SODIUM	390	420	390	370J	390	400	410	390	380	410	390	380
THALLIUM	0.08U	0.07U	0.08U	0.08U	0.07U	0.08U	0.08U	0.08U	0.07U	0.08U	0.08U	0.07U
VANADIUM	0.03U											
ZINC	9.4	13.0	9.9	9.5	8.5	9.7	7.8	6.9	7.2	7.8	6.9	7.2

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-5	SL	SL	SL	ML	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2655	2656	2658	2651	2652	2653	2645	2646	2697			
TAG NUMBER	42693	42617	42615	44587	44588	42622	42633	42636	44581			
BARIUM	0.2U	0.2U	0.2U	0.2U	0.2U	0.10U	0.10U	0.11U	0.09U			
CALCIUM	550	380	170	770	450	580	160	350	470			
COBALT	0.03U											
COPPER	0.3U	0.3U	0.3U	0.4U	0.3U	0.3U	0.3U	0.5U	0.3U			
IRON	4U	3U	3U	3U	3U	3U	3U	4U	3U			
LEAD	0.07U	0.09U	0.1U	0.06U	0.07U	0.06U	0.06U	0.04U	0.09U			
MAGNESIUM	310	300	300	310	280	290	290	280	290			
MANGANESE	0.39	0.14	0.11	0.13	0.13	0.20	0.09	0.11	0.13			
MERCURY	0.04J	0.04J	0.03J	0.11J	0.11J	0.10J	0.13J	0.23J	0.15J			
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.10	0.03U	0.36	0.03U			
POTASSIUM	3600J	3400J	3500J	3400J	3400J	3400J	3500	3300	3600J			
SELENIUM	0.47	0.44	0.42	0.46	0.43	0.48	0.33	0.34	0.43			
SILVER	0.03UJ											
SODIUM	390J	500J	400J	370J	400J	520J	420J	380J	450J			
THALLIUM	0.08U	0.08U	0.08U	0.09U	0.08U	0.07U	0.2U	0.2U	0.07U			
VANADIUM	0.03U											
ZINC	9.4	8.9	9.0	8.5J	7.9	8.6	8.6J	7.5J	8.7			

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 16 cont. Inorganic analyses bass filets (mg/kg)

STATION MT-7	SL	SL	SL	ML	ML	ML	ML	ML	LL	LL	LL	LL
MD NUMBER	2353	2363	2350	2356	2349	2348	2359	2355	2347			
TAG NUMBER	44713	44828	44709	44707	44705	44862	44725	44858	44723			
BARIIUM	0.17U	0.17U	0.17U	0.16U	0.17U	0.15U	0.16U	0.17U	0.17U	0.17U	0.17U	0.17U
CALCIUM	360	480	520	520	520	320	340	280	270			
COBALT	0.21U	0.21U	0.21U	0.20U	0.22U	0.19U	0.20U	0.21U	0.22U			
COPPER	1U	1U	1U	2.5	1U	1U	1.7	2U	0.15U			
IRON	3U	3U	3U	3U	3U	2U	3U	3U	3U			
LEAD	0.04U											
MAGNESIUM	330	330	320	320	310	310	300	320	320			
MANGANESE	0.16J	0.14J	0.14J	0.14J	0.13J	0.13J	0.12J	0.10J	0.12J			
MERCURY	0.04J	0.06J	0.06J	0.07J	0.10J	0.18J	0.20J	0.21J	0.22J			
NICKEL	0.19J	0.19U	0.19U	0.36	0.36	0.17U	0.61	0.19U	0.20U			
POTASSIUM	4300	4200	4300	4300	4200	4400	4100	4400	4900			
SELENIUM	0.42	0.44	0.41	0.41	0.37	0.36	0.34	0.35	0.36			
SILVER	0.20U	0.20U	0.20U	0.19U	0.21U	0.18U	0.19U	0.20U	0.21U			
SODIUM	460	530	440	460	450	500	490	550	550			
THALLIUM	0.06U	0.06U	0.06U	0.06U	0.06U	0.05U	0.05U	0.06U	1U			
VANADIUM	0.18U	0.18U	0.18U	0.17U	0.18U	0.16U	0.17U	0.18U	0.18U			
ZINC	11.0	10.0	11.0	14.0	10.0	9.6	9.9	12.0	8.3			

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-8	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
MD NUMBER	2623	2561	2560	2618	2615	2555	2616	2558	2557			
TAG NUMBER	42818	42826	44612	44608	44625	42810	44639	42808	44637			
BARIUM	0.11U	0.10U	0.10U	0.10U	0.11U	0.10U	0.11U	0.10U	0.10U	0.10U	0.10U	0.10U
CALCIUM	630	680	280	890	270	550	450	250	330			
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.3U	0.3U	0.5U	0.4U	0.3U	0.3U	0.3U	0.3U	0.3U	0.3U	0.3U
IRON	2U	0.43U	0.45U	4U	5U	1U	3U	0.45U	1U			
LEAD	0.1U	0.04UJ	0.04UJ	0.06U	0.04U	0.19J	0.04U	0.04UJ	0.04UJ			
MAGNESIUM	290	300	270	330	290	280	270	280	270			
MANGANESE	0.14	0.13	0.14	0.20	0.17	0.13	0.14	0.10	0.17			
MERCURY	0.11J	0.09J	0.10J	0.21J	0.14J	0.20J	0.39J	0.25J	0.22J			
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3000	3300	3200	3600	3400	3200	3300	3300	3300			
SELENIUM	0.46	0.48J	0.41J	0.41	0.33	0.44J	0.30	0.43J	0.37J			
SILVER	0.04UJ	0.03U	0.03U	0.03UJ	0.03UJ	0.03U	0.03UJ	0.03U	0.03U	0.03U	0.03U	0.03U
SODIUM	340J	400	360	390J	340J	420	370J	390	440			
THALLIUM	0.2U	0.07U	0.2U	0.2U	0.2U	0.07U	0.2U	0.1	0.2U			
VANADIUM	0.04U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
ZINC	9.6J	11.0	8.6	14.0J	9.6J	9.1	6.9J	7.7	7.2			

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-9	SL	SL	SL	ML	ML	ML	ML	ML	ML	LL	LL	LL
MD NUMBER	2577	2573	2570	2572	2569	2565	2562	2563	2625			
TAG NUMBER	44544	42916	42719	44848	44540	42713	44652	44662	44850			
BARIUM	.2U	0.11U	0.09U	0.11U	0.10U	0.10U	0.11U	0.10U	0.2U			
CALCIUM	670	510	650	230	360	860	270	550	350			
COBALT	0.03U											
COPPER	0.5U	0.3U	0.3U	0.3U	0.3U	0.3U	0.4U	0.2U	1U			
IRON	3U	0.5U	0.5U	0.5U	0.5U	0.46U	0.47U	0.46U	2U			
LEAD	0.08U	0.04UJ	0.03UJ	0.04UJ	0.04UJ	0.04UJ	0.04UJ	0.04UJ	0.2U			
MAGNESIUM	310	300	300	280	290	290	280	280	280			
MANGANESE	0.13	0.12	0.11	0.10	0.11	0.12	0.09	0.08	0.10			
MERCURY	0.06	0.07J	0.05J	0.14J	0.11J	0.09J	0.13J	0.14J	0.23J			
NICKEL	0.03U	0.65										
POTASSIUM	3400J	3300	3300	3400	3300	3400	3400	3200	3300			
SELENIUM	0.58J	0.38J	0.43J	0.40J	0.39J	0.43J	0.41J	0.39J	0.38			
SILVER	0.03UJ	0.03U	0.03UJ									
SODIUM	420	430	300	370	390	390	380	370	340J			
THALLIUM	0.08U	0.08U	0.2U	0.2U	0.08U	0.08U	0.08U	0.08U	0.2U			
VANADIUM	0.03U											
ZINC	9.3	8.6	8.4	7.6	8.0	7.7	7.0	7.1	7.6J			

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17. Results of inorganic analyses of Channel Catfish fillet samples (mg/kg).
Mobile River Study. November, 1993.

STATION MT-0	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC
MD NUMBER	2332	2346	2344	2341	2340	2335	2330	2338	2336		
TAG NUMBER	44508	42963	42997	43003	42995	43022	43024	42742	43044		
BARIUM	0.16U	0.15U	0.17U	0.17U	0.17U	0.17U	0.15U	0.17U	0.15U		
CALCIUM	190	130	110	120	96	110	93	88	100		
COBALT	0.20U	0.19U	0.22U	0.21U	0.22U	0.21J	0.19U	0.21U	0.19U		
COPPER	1U	0.15U	1U								
IRON	3U	8U	6U	7U	27	4U	4U	6U	3U		
LEAD	0.04U										
MAGNESIUM	330	260	270	270	260	260	260	280	300		
MANGANESE	0.16J	0.38J	0.25J	0.31J	0.33J	0.15J	0.14J	0.23J	0.12J		
MERCURY	0.05J	0.03J	0.04J	0.05J	0.05J	0.04J	0.09J	0.06J	0.05J		
NICKEL	0.19U	0.18U	0.22J	0.21J	0.40J	0.36J	0.17U	0.19U	0.72		
POTASSIUM	4900	4200	4200	4300	4200	4100	4400	4600	5100		
SELENIUM	0.24	0.23	0.25	1U	1U	1U	1U	0.24	0.23		
SILVER	0.19U	0.18U	0.21U	0.20U	0.21U	0.20U	0.18U	0.20U	0.18U		
SODIUM	710	660	640	460	450	460	420	430	370		
THALLIUM	0.06U	0.05U	0.06U	0.06U	0.06U	0.06U	0.05U	0.06U	0.05U		
VANADIUM	0.17U	0.16U	0.18U	0.18U	0.18U	0.18U	0.16U	0.18U	0.16U		
ZINC	9.4	9.9	9.4	7.8	9.0	8.6	7.3	7.3	6.5		

J = Estimated value.
U = Material was analyzed for but not detected; number is minimum quantitation limit.
SC = Small Catfish, MC = Medium Catfish; LC = Large Catfish.

Table 16 cont. Inorganic analyses bass fillets (mg/kg)

STATION MT-10	SL	SL	SL	ML	ML	ML	ML	LL	LL	LL
MD NUMBER	2665	2669	2674	2795	2667	2668	2752	2666	2675	
TAG NUMBER	42866	42852	42880	42872	42878	42870	42848	42864	42868	
BARIUM	0.09U	0.10U	0.11U	0.09U	0.11U	0.10U	0.10U	0.10U	0.11U	
CALCIUM	210	180	340	250	170	160	140	290	120	
COBALT	0.03U									
COPPER	0.4U	0.4U	0.34	0.3U	0.3U	1U	0.3U	0.3U	0.3U	
IRON	6U	4U								
LEAD	0.06U	0.07U	0.07U	0.03U	0.04U	0.07U	0.05U	0.05U	0.08U	
MAGNESIUM	340	340	310	300	320	300	300	300	280	
MANGANESE	0.15	0.10	0.11	0.10	0.11	0.09	0.08	0.10	0.08	
MERCURY	0.03	0.14	0.03	0.25J	0.29	0.20	0.23	0.35	0.22	
NICKEL	0.03U	0.03U	0.03U	0.05U	0.03U	0.03U	0.03U	0.03U	0.03U	
POTASSIUM	3900J	3800J	3300J	3800J	3700J	3600J	3800J	3700J	3500J	
SELENIUM	0.29	0.42	0.25	0.33	0.47	0.35	0.53	0.36	0.31	
SILVER	0.03U									
SODIUM	520J	470J	440J	550J	470J	440J	420J	470J	440J	
THALLIUM	0.07U	0.07U	0.08U	0.07U	0.08U	0.08U	0.07U	0.07U	0.08U	
VANADIUM	0.03U	0.03J	0.03U							
ZINC	11.0	13.0	12.0	9.4	8.2	8.4	7.3	8.0	7.6	

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish fillets (mg/kg)

STATION MT-3	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC
MD NUMBER	2388	2383	2663	2393	2390	2386	2399	2396	2395		
TAG NUMBER	43020	43007	42659	43026	43018	43013	44826	42663	44844		
BARIUM	0.15U	0.16U	0.2U	0.18U	0.17U	0.15U	0.16U	0.17U	0.17U	0.17U	0.17U
CALCIUM	120	160	120	110	130	110	120	92	88		
COBALT	0.19U	0.20U	0.03U	0.22U	0.22U	0.19U	0.21U	0.22U	0.21U	0.21U	0.21U
COPPER	1U	1U	0.3U	1U							
IRON	5U	4U	4U	4U	5U	5U	3U	3U	3U	3U	3U
LEAD	0.04U	0.04U	0.07U	0.04U							
MAGNESIUM	260	250	260	280	250	270	280	270	270	270	270
MANGANESE	0.21J	0.25J	0.15	0.17J	0.18J	0.14J	0.07J	0.11J	0.08J	0.08J	0.08J
MERCURY	0.06J	0.06J	0.06J	0.16	0.11	0.06J	0.11	0.15	0.19	0.19	0.19
NICKEL	0.17U	0.18U	0.03U	0.20U	0.20U	0.17U	0.19U	0.20U	0.19U	0.19U	0.19U
POTASSIUM	4000	4000	3600J	4500	4100	4300	4400	4400	4300	4300	4300
SELENIUM	0.30	1U	0.25	0.26	1U	0.27	0.24	0.33	1U	1U	1U
SILVER	0.18U	0.19U	0.04UJ	0.21U	0.21U	0.18U	0.20U	0.21U	0.20U	0.20U	0.20U
SODIUM	620	580	550J	470	410	450	480	370	560	560	560
THALLIUM	0.05U	0.05U	0.08U	0.06U	0.06U	0.05U	0.06U	0.06U	0.06U	0.06U	0.06U
VANADIUM	0.16U	0.17U	0.04U	0.18U	0.18U	0.16U	0.17U	0.18U	0.18U	0.18U	0.18U
ZINC	9.2	8.4	8.3	6.6	7.9	8.6	6.7	6.7	6.8	6.8	6.8

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish fillets (mg/kg)

STATION MT-2	SC	SC	SC	MC	MC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2372	2370	2369	2381	2378	2371	2379	2374	2365				
TAG NUMBER	42971	42967	42969	44943	42973	42596	43055	44945	42981				
BARIUM	0.17U	0.17U	0.17U	0.16U	0.17U	0.16U	0.17U						
CALCIUM	120	120	150	100	110	120	87	86	170				
COBALT	0.21U	0.22U	0.22U	0.20U	0.22U	0.20U	0.21U	0.22U	0.21U	0.22U	0.22U	0.21U	0.21U
COPPER	1U												
IRON	5U	4U	5U	5U	4U	3U	4U						
LEAD	0.04U												
MAGNESIUM	260	250	270	270	270	260	260	270	270	270	270	270	270
MANGANESE	0.22J	0.20J	0.18J	0.08J	0.13J	0.10J	0.16J	0.08J	0.21J				
MERCURY	0.22J	0.06J	0.23J	0.33J	0.22J	0.20J	0.54J	0.16J	0.13J				
NICKEL	0.20U	0.20U	0.20U	0.18U	0.20U	0.18U	0.19U	0.20U	0.19U	0.20U	0.20U	0.19U	0.19U
POTASSIUM	4200	4000	4200	4600	4300	4400	4300	4400	4600				
SELENIUM	0.31	1U	0.29	0.27	0.39	0.28	0.34J	0.33	1U				
SILVER	0.20U	0.21U	0.21U	0.19U	0.21U	0.19U	0.20U	0.23	0.20U	0.23	0.23	0.20U	0.20U
SODIUM	550	610	640	470	510	510	370	430	400				
THALLIUM	0.03U	0.03U	0.03U	0.05U	0.06U	0.03U	0.06U	0.03U	0.06U	0.03U	0.03U	0.06U	0.06U
VANADIUM	0.18U	0.18U	0.18U	0.17U	0.18U	0.17U	0.18U	0.18U	0.17U	0.18U	0.18U	0.17U	0.17U
ZINC	11.0	9.4	10.0	7.5	7.5	7.1	6.6	6.8	6.8	6.6	6.8	6.8	6.8

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish fillets (mg/kg)

STATION MT-4	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC
MD NUMBER	2610	2603	2600	2602	2597	2595	2605	2604	2599		
TAG NUMBER	43071	43069	43049	43067	43032	43040	43030	42655	43036		
BARIUM	0.10U	0.10U	0.10U	0.10U	0.11U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U
CALCIUM	98	150	120	100	110	95	100	86	110		
COBALT	0.03U										
COPPER	0.4U	0.3U	0.3U	0.4U	0.6U	0.3U	0.3U	0.3U	0.3U	0.3U	0.3U
IRON	4U	4U	4U	5U	4U	3U	5U	3U	4U		
LEAD	0.04U	0.04U	0.04U	0.06U	0.04U	0.1U	0.1U	0.04U	0.04U	0.04U	0.04U
MAGNESIUM	250	240	250	250	250	250	240	260	240		
MANGANESE	0.13	0.20	0.20	0.17	0.14	0.13	0.12	0.11	0.11	0.11	0.11
MERCURY	0.04	0.08	0.10	0.09	0.11	0.13	0.11	0.09	0.12		
NICKEL	0.03U	0.04									
POTASSIUM	3500J	3100J	3400J	3300J	3500J	3700J	3500J	3700J	3500J	3500J	3500J
SELENIUM	0.32J	0.45J	0.38J	0.36J	0.38J	0.37J	0.36	0.40J	0.46J		
SILVER	0.03UJ										
SODIUM	340	310	400	320	290	280	260	290	260	260	260
THALLIUM	0.07U	0.08U	0.07U	0.07U	0.08U	0.08U	0.07U	0.07U	0.07U	0.07U	0.07U
VANADIUM	0.03U										
ZINC	5.9	6.5	7.8	6.7	6.6	7.5	5.9	6.3	5.6		

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish fillets (mg/kg)

STATION MT-5	SC	SC	SC	MC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2657	2659	2660	2648	2649	2650	2647	2654	2698			
TAG NUMBER	43105	43101	43093	43104	42667	43097	42675	43089	43088			
BARIUM	0.11	0.2U	0.10U	0.10U	0.2U	0.10U	0.2U	0.2U	0.10U	0.2U	0.2U	0.10U
CALCIUM	210	120	170	110	140	96	100	150	88			
COBALT	0.03U											
COPPER	0.3U	0.3U	0.3U	0.4U	0.3U							
IRON	5.5	4U	5U	4U	3U	4U	5U	5.7	5.3			
LEAD	0.08U	0.06U	0.07U	0.04U	0.09U	0.04U	0.04U	0.09U	0.09U	0.04U	0.09U	0.09U
MAGNESIUM	240	240	250	240	250	230	250	240	240	250	240	240
MANGANESE	0.43	0.20	0.24	0.16	0.11	0.22	0.15	0.31	0.15	0.15	0.31	0.15
MERCURY	0.06J	0.05J	0.06J	0.05J	0.06J	0.07J	0.07J	0.10J	0.07J	0.07J	0.10J	0.07J
NICKEL	0.03U	0.03J	0.03U									
POTASSIUM	3400J	3400J	3600J	3400	3300	3300	3600	3400J	3500J	3600	3400J	3500J
SELENIUM	0.25	0.25	0.24	0.3U	0.27	0.24	0.28	0.64	0.3U	0.28	0.64	0.3U
SILVER	0.03UJ	0.04UJ	0.03UJ	0.03UJ	0.04UJ	0.03UJ						
SODIUM	370	400J	430J	340J	490J	300J	320J	360J	300J	320J	360J	300J
THALLIUM	0.08U	0.08U	0.07U	0.09U	0.08U	0.1U	0.2U	0.08U	0.07U	0.2U	0.08U	0.07U
VANADIUM	0.03U	0.04U	0.03U	0.03U	0.04U	0.03U						
ZINC	8.8	7.7	7.9	6.1J	6.1J	6.3J	5.4J	5.8	5.8	5.4J	5.8	5.8

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish filets (mg/kg)

STATION MT-7	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2360	2357	2351	2362	2361	2358	2352	2364	2354		
TAG NUMBER	44870	42951	42953	42983	44868	44754	44752	44872	44763		
BARIUM	0.16U	0.17U	0.16U	0.17U	0.17U	0.17U	0.17U	0.16U	0.16U		
CALCIUM	160	160	120	120	100	110	99	96	87		
COBALT	0.20U	0.22U	0.20U	0.21U	0.22U	0.22U	0.22U	0.20U	0.21U		
COPPER	1U	1U	1U	5.6	1U	1U	1U	1U	1U		
IRON	4U	3U	3U	4U	3U	3U	3U	4U	3U		
LEAD	0.04U	0.04U	0.04U	0.21	0.04U	0.04U	0.04U	0.04U	0.04U		
MAGNESIUM	260	260	260	250	260	300	270	280	260		
MANGANESE	0.19J	0.18J	0.16J	0.14J	0.11J	0.14J	0.11J	0.09J	0.10J		
MERCURY	0.09J	0.03J	0.04J	0.08J	0.08J	0.07J	0.08J	0.08J	0.11J		
NICKEL	0.18J	0.20U	0.19U	0.19U	0.20U	0.20U	0.36	0.18U	0.19U		
POTASSIUM	4100	4200	4000	4400	4300	4600	4400	4600	4400		
SELENIUM	0.25	1U	1U	1U	1U	1U	0.31	1U	1U		
SILVER	0.19U	0.21U	0.20U	0.20U	0.21U	0.21U	0.21U	0.19U	0.20U		
SODIUM	730	630	600	340	430	540	480	540	490		
THALLIUM	0.05U	0.06U	0.06U	0.06U	0.06U	0.06U	0.06U	0.07	0.06U		
VANADIUM	0.17U	0.18U	0.17U	0.18U	0.18U	0.18U	0.18U	0.17U	0.17U		
ZINC	11.0	11.0	8.5	10.0	6.7	8.1	6.6	6.4	7.1		

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish filets (mg/kg)

STATION MT-8	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2622	2620	2612	2621	2617	2613	2614	2559	2556		
TAG NUMBER	42945	42919	42943	42836	42840	44627	44614	44629	44618		
BARIUM	0.10U	0.10U	0.09U	0.11U	0.10U	0.11	0.10U	0.11U	0.10U	0.11U	0.10U
CALCIUM	110	120	120	110	93	160	160	74	87		
COBALT	0.03U	0.03U	0.03U								
COPPER	0.4U	0.4U	0.4U	0.6U	0.4U	0.3U	0.4U	0.3U	0.34		
IRON	4U	3U	3U	5U	4U	4U	4U	1U	2U		
LEAD	0.05U	0.05U	0.03U	0.1U	0.05U	0.04U	0.10U	0.04UJ	0.04UJ		
MAGNESIUM	240	230	250	230	230	250	240	230	230		
MANGANESE	0.15	0.18	0.16	0.14	0.14	0.29	0.22	0.07	0.11		
MERCURY	0.07J	0.07J	0.06J	0.04J	0.07J	0.16J	0.15J	0.08J	0.15J		
NICKEL	0.03U	0.03U	0.03U								
POTASSIUM	3200	3100	3200	3200	3200	3500	3400	3300	3400		
SELENIUM	0.2U	0.3U	0.2U	0.2U	0.2U	0.2U	0.3U	0.3UJ	1UJ		
SILVER	0.03UJ	0.03UJ	0.03UJ	0.04UJ	0.03UJ	0.03UJ	0.03UJ	0.03U	0.03U	0.03U	0.03U
SODIUM	440J	540J	480J	460J	390J	460J	390J	440	400		
THALLIUM	0.2U	0.2U	0.07U	0.08U	0.24	0.2U	0.1U	0.08U	0.08U		
VANADIUM	0.03U	0.03U	0.03U	0.04U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
ZINC	7.8J	6.9J	7.6J	13J	7.1J	7.2J	5.8J	6.2	6.1		

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish fillets (mg/kg)

STATION MT-9	SC	SC	SC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2575	2574	2568	2564	2571	2566	2624	2576	2624	2576	2567
TAG NUMBER	44906	44669	42913	44671	44897	44907	44664	44895	44664	44895	44893
BARIUM	0.10U	0.10U	0.10U	0.11U	0.09U	0.11U	0.10U	0.10U	0.10U	0.10U	0.09U
CALCIUM	98	240	92	80	110	84	140	100	140	100	78
COBALT	0.03U										
COPPER	0.4U	0.8U	0.3U								
IRON	3U	0.5U	0.5U	0.48U	0.6U	0.47U	4U	4U	4U	4U	0.5U
LEAD	0.15	0.04UJ	0.04UJ	0.04UJ	0.03UJ	0.04UJ	0.05U	0.20	0.05U	0.20	0.03UJ
MAGNESIUM	260	260	230	250	250	240	240	240	240	240	250
MANGANESE	0.10	0.14	0.21	0.06	0.09	0.07	0.09	0.10	0.09	0.10	0.07
MERCURY	0.06	0.06J	0.07J	0.05J	0.05J	0.05J	0.09J	0.15	0.09J	0.15	0.06J
NICKEL	0.03U	0.08	0.03U								
POTASSIUM	3500J	3400	3300	3400	3500	3500	3400	3500J	3400	3500J	3500
SELENIUM	0.42J	0.3UJ	0.25J	0.29J	0.3U	0.28J	0.3U	0.39J	0.3U	0.39J	0.21J
SILVER	0.03UJ	0.03U	0.03U	0.03U	0.03U	0.03U	0.03UJ	0.03UJ	0.03UJ	0.03UJ	0.03U
SODIUM	470	530	420	400	410	430	380J	420	380J	420	420
THALLIUM	0.07U	0.07U	0.11	0.08U	0.07U	0.08U	0.2U	0.07U	0.2U	0.07U	0.1U
VANADIUM	0.03U	0.03									
ZINC	6.6	7.6	6.9	6.0	6.0	5.5	6.7J	5.7	6.7J	5.7	5.6

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 17 cont. Inorganic analyses Channel Catfish filets (mg/kg)

STATION MT-10	SC	SC	SC	MC	MC	MC	MC	MC	MC	LC	LC	LC	LC
MD NUMBER	2670	2672	2677	2664	2673	2756	2753	2671	2676				
TAG NUMBER	42894	42898	42896	42882	42888	42885	42892	42927	42932				
BARIUM	0.10U	0.11U	0.11U	0.10U	0.11U	0.09U	0.11	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U
CALCIUM	110	120	110	100	100	100	160	89	100	100	100	100	100
COBALT	0.03U												
COPPER	0.8U	0.4U	0.3U	1U	0.4U	0.3U	0.5U	0.3U	0.3U	0.3U	0.3U	0.3U	0.3U
IRON	6U	5U	5U	4U	6U	5U	32	5U	6U	5U	5U	6U	6U
LEAD	0.09U	0.07U	0.07U	0.07U	0.06U	0.03U	0.07U	0.08U	0.04U	0.08U	0.08U	0.04U	0.04U
MAGNESIUM	240	250	240	260	260	240	240	260	230	240	260	230	230
MANGANESE	0.25	0.17	0.18	0.29	0.16	0.14	1.1	0.24	0.45	1.1	0.24	0.45	0.45
MERCURY	0.07	0.05	0.06	0.08	0.12	0.08	0.07	0.08	0.06	0.07	0.08	0.06	0.06
NICKEL	0.03U												
POTASSIUM	3400J	3500J	3300J	3800J	3400J	3700J	3700J	3400J	2600J	3700J	3400J	2600J	2600J
SELENIUM	0.26	0.3U	0.3U	0.23	0.3U	0.42	0.39	0.3U	0.2U	0.39	0.3U	0.2U	0.2U
SILVER	0.03U												
SODIUM	480J	580J	570J	490J	500J	520J	580J	320J	380J	580J	320J	380J	380J
THALLIUM	0.08U	0.08U	0.08U	0.07U	0.08U	0.07U	0.08U	0.07U	0.07U	0.08U	0.07U	0.07U	0.07U
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.05	0.03U	0.03U	0.05	0.03U	0.03U	0.03U
ZINC	8.7	8.2	7.7	7.4	7.7	6.6	7.2	7.2	5.4	7.2	7.2	5.4	5.4

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.

Table 18. Results of organic analyses of Largemouth Bass whole body samples (mg/kg). Mobile River Study. November, 1993.

STATION	MT-0SL	MT-0ML	MT-0LL	MT-0LL	MT-0LL	MT-0LL	MT-2SL	MT-2SL	MT-2ML	MT-2LL	MT-2LL	MT-2LL	MT-2LL
D NUMBER	3360	3368	3358	2867	2865	3332	3400	3331	3329	3325	2849	3327	
TAG NUMBER	44916	44919	44915	44918	44914	42601	42603	44936	43753	44949	44937	44938	
WEIGHT	**	312	481	919	1050	**	**	340	W	647	577	959	
LENGTH (mm)	<226	293	333	389	437	<226	<226	293	<401	365	372	405	
% LIPIDS	0.97	1.1	0.82	1.46	1.94	2.88	1.53	2.62	2.58	1.66	1.66	3.13	
CHLORO-BENZILATE	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.080U	.080U	.040U	.050U	
ENDOSULFAN I (ALPHA)	.0025U	.010U	.0025U	.006U	.008U	.0025U	.009U	.0025U	.0025U	.020U	.020U	.020U	
4,4'-DDE	.052	.066	.070	.071	.077	.054	.050	.077	.13	.16	.065	.11	
4,4'-DDD	.007N	.010N	.020U (.010)	.013	.017	.012N	.020U (.010)	.013N	.025N	.030U (.015)	.020U (.010)	.020N	
4,4'-DDT	.005U (.0025)	.020U (.010)	.020U (.010)	.005U (.0025)	.030U (.015)	.008U (.004)	.008U (.004)	.020U (.010)	.030U (.015)	.030U (.015)	.020U (.010)	.020U (.010)	
SUM OF DDE, DDD, AND DDT	0.062	0.086	0.090	0.087	0.109	0.070	0.064	0.100	0.170	0.190	0.085	0.140	

N = Presumptive evidence of presence of material.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 ** = Compositd sample of small fish to meet mass needs.
 W = Weight not reported.
 SL = Small Largemouth Bass.
 ML = Medium Largemouth Bass.
 LL = Large Largemouth Bass.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 18 cont. Organic analyses whole body Largemouth Bass (mg/kg)

STATION	MT-3ML	MT-3ML	MT-3LL	MT-3LL	MT-3LL	MT-4SL	MT-4ML	MT-4LL	MT-4LL	MT-4LL
D NUMBER	3321	3323	3319	3317	3305	3263	3259	3261	2879	3362
TAG NUMBER	44778	44779	44776	44777	44775	42685	44821	44820	42683	44819
WEIGHT (g)	144	302	620	870	1582	**	325	501	570	1102
LENGTH (mm)	230	280	333	372	463	<226	288	320	352	419
% LIPIDS	0.95	4.68	3.06	7.88	8.11	1.43	8.75	3.29	8.04	3.4
CHLORO BENZILATE	.040U	.040U	.041N	.040U	.083	.040U	.050	.040U	.040U	.040U
ENDOSULFAN I (ALPHA)	.0025U	.0025U	.0025U	.020U	.0025U	.0025U	.0025U	.020U	.0025U	.020U
4,4'-DDE	.029	.029N	.097	.12	.22	.023	.080U (.040)	.13	.11	.11
4,4'-DDD	.008U (.004)	.009U (.0045)	.020N	.023N	.046	.0053	.030N	.032	.047N	.022
4,4'-DDT	.006U (.003)	.009U (.0045)	.020U (.010)	.020U (.010)	.050U (.025)	.006U (.003)	.012N	.030U (.015)	.040U (.020)	.030U (.015)
SUM OF DDE, DDD, AND DDT	0.036	0.038	0.127	0.153	0.291	0.031	0.082	0.177	0.177	0.147

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositated sample of small fish to meet mass needs.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 18 cont. Organic analyses whole body Largemouth Bass (mg/kg)

STATION	MT-5SL	MT-5ML	MT-5LL	MT-5LL	MT-5LL	MT-7SL	MT-7ML	MT-7ML	MT-7LL	MT-7LL
D NUMBER	3366	2877	2875	2873	2871	3355	3353	3351	3349	3347
TAG NUMBER	42705	42701	42702	42706	42637	44734	44735	44733	44736	44737
WEIGHT (g)	**	288	373	508	1080	108	208	380	670	W
LENGTH (mm)	<226	271	304	330	410	206	240	290	345	440
% LIPIDS	1.5	3.05	2.65	4.98	5.88	0.77	1.16	2.82	4.17	5.46
CHLOROBENZILATE	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.050N	.055	.16U
ENDOSULFAN I (ALPHA)	.0025U	.0025U	.020U	.0025U	.0025U	.0025U	.030U	.0025U	.050U	.18U
4,4'-DDE	.035	.049	.064	.082	.16	.056	.10	.14	.30	1.3C
4,4'-DDD	.020U (.010)	.022N	.029N	.040U (.020)	.062	.030U (.015)	.040U (.020)	.045	.089	.26
4,4'-DDT	.009U (.0045)	.020U (.010)	.030U (.015)	.030U (.015)	.050U (.025)	.007U (.0035)	.020U (.010)	.016	.029	.066
SUM OF DDE, DDD, AND DDT	0.050	0.081	0.108	0.117	0.247	0.075	0.130	0.201	0.418	1.630

N = Presumptive evidence of presence of material.
 U = Material analyzed for but not detected; number is minimum quantitation limit.
 f = Compositd sample of small fish to meet mass needs.
 W = weight not reported.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 18 cont. Organic analyses whole body Largemouth Bass (mg/kg)

STATION	MT-8ML	MT-8LL	MT-8LL	MT-8LL	MT-8LL	MT-8LL	MT-9SL	MT-9LL	MT-9LL	MT-9LL	MT-9LL
D NUMBER	2833	2837	2834	2831	2829	3293	3297	3287	3301	3299	
TAG NUMBER	44603	44605	44604	44606	44607	44925	44931	44651	44929	44655	
WEIGHT (g)	164	542	582	1310	2052	**	379	552	1160	1562	
LENGTH (mm)	240	323	344	440	508	<226	310	340	430	460	
% LIPIDS	.90	4.54	6.47	11.15	10.73	1.96	2.21	2.84	4.59	5.59	
CHLORO BENZILATE	.040U	.040U	.040U	.040U	.040U	.040U	.054	.040U	.080U	.040U	
ENDOSULFAN I (ALPHA)	.0025U	.009U	.006U	.020U	.020U	.0025U	.0025U	.004U	.0025U	.0025U	
4,4'-DDE	.055	.16	.12	.19	.17	.025	.18	.087	.45	.89	
4,4'-DDD	.005U (.0025)	.030	.029	.033	.054	.005U (.0025)	.059	.0068	.063	.14	
4,4'-DDT	.005U (.0025)	.030U (.015)	.020U (.010)	.030U (.015)	.025N	.005U (.0025)	.030U (.015)	.020U (.010)	.040U (.020)	.053	
SUM OF DDE, DDD, AND DDT	0.060	0.205	0.159	0.238	0.249	0.030	0.254	0.104	0.533	1.083	

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositd sample of small fish to meet mass needs.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 19. Results of organic analyses of Channel Catfish whole body samples (mg/kg). Mobile River Study. November 1993.

STATION	MT-0SC	MT-0MC	MT-0MC	MT-0MC	MT-0LC	MT-2SC	MT-2SC	MT-2MC	MT-2MC	MT-2LC
D NUMBER	3279	3277	3273	3271	2869	2855	2821	2825	2823	2827
TAG NUMBER	43002	44503	44505	44504	44506	42904	44575	44575	44575	44575
WEIGHT (g)	**	280	288	380	621	**	W	237	296	955
LENGTH (mm)	<276	345	345	355	420	<276	170	333	334	474
% LIPIDS	2.59	5.59	3.88	7.53	6.39	1.10	1.20	5.51	9.99	8.36
CHLORO BENZYLATE	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U
4,4'-DDE	.055	.044	.066	.054	.093	.0061	.057	.021	.093	.052
4,4'-DDD	.017N	.0097	.030	.016	.050U (.025)	.005U (.0025)	.007U (.0035)	.007U (.0035)	.026N	.014N
4,4'-DDT	.020U (.010)	.005U (.0025)	.030U (.015)	.020U (.010)	.030U (.015)	.005U (.0025)	.005U (.0025)	.006U (.003)	.030U (.015)	.020U (.010)
SUM OF DDE, DDD, AND DDT	0.082	0.056	0.111	0.080	0.133	0.011	0.063	0.028	0.134	0.076
STATION	MT-3MC	MT-3MC	MT-3LC	MT-3LC	MT-3LC	MT-4SC	MT-4MC	MT-4MC	MT-4LC	MT-4LC
D NUMBER	3315	3313	3311	3309	3307	3165	3168	3169	3166	3167
TAG NUMBER	44831	44832	44833	44834	44835	43057	43062	43061	43060	43059
WEIGHT (g)	205	337	559	1333	1937	**	139	358	445	840
LENGTH (mm)	316	358	398	500	582	<276	280	357	385	462
% LIPIDS	3.86	6.36	4.85	8.88	9.17	2.8	7.8	6.6	7.4	3.8
CHLORO BENZYLATE	.040U	.050	.040U	.047	.049	.040U	.040U	.040U	.040U	.040U
4,4'-DDE	.072	.12	.025	.12	.11	.029	.061	.032	.099	.23
4,4'-DDD	.013	.031	.006U (.003)	.036N (.025)	.050U (.025)	.007U (.0035)	.014	.030U (.015)	.050U (.025)	.070U (.035)
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.020U (.010)	.030U (.015)	.009U (.0045)	.010U (.005)	.007U (.0035)	.020U (.010)	.040U (.020)
SUM OF DDE, DDD, AND DDT	0.088	0.154	0.031	0.166	0.150	0.037	0.080	0.051	0.134	0.285

W = Weight not reported.

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Composite sample of small fish to meet mass needs.

SC = Small Channel Catfish; MC = Medium Channel Catfish; LC = Large Channel Catfish.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 18 cont. Organic analyses whole body Largemouth Bass (mg/kg)

STATION	MT-10SL	MT-10ML	MT-10ML	MT-10LL	MT-10LL	MT-10LL
D NUMBER	2857	2863	2859	3335	3303	3281
TAG NUMBER	42860	42859	42861	42857	42575	42574
WEIGHT (g)	**	140	275	557	1204	1934
LENGTH (mm)	<226	227	292	357	432	510
% LIPIDS	1.86	0.61	1.26	7.72	7.05	6.35
CHLOROBENZILIATE	.040U	.040U	.040U	.065	.040U	.040U
ENDOSULFAN I (ALPHA)	.0025U	.0025U	.003U	.0025U	.005	.004U
4,4'-DDE	.027	.007U (.0035)	.071	.045N	.078	.15
4,4'-DDD	.0066N	.005U (.0025)	.005U (.0025)	.006U (.003)	.009U (.0045)	.030U (.015)
4,4'-DDT	.008U (.004)	.005U (.0025)	.005U (.0025)	.020U (.010)	.005U (.0025)	.070U (.035)
SUM OF DDE, DDD, AND DDT	0.038	0.009	0.076	0.058	0.085	0.200

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositd sample of small fish to meet mass needs.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 19 cont. Organic analyses whole body Channel Catfish (mg/kg)

STATION	MT-5SC	MT-5SC	MT-5MC	MT-5MC	MT-5LC	MT-7SC	MT-7MC	MT-7MC	MT-7LC	MT-7LC
D NUMBER	3275	3364	3268	3267	3265	3345	3343	3341	3339	3337
TAG NUMBER	43497	43112	43113	43114	43109	44759	44760	44761	44758	42930
WEIGHT (g)	W	**	230	416	922	**	263	448	718	1020
LENGTH (mm)	<276	<276	307	361	470	<276	320	350	430	500
% LIPIDS	.86	3.3	.98	5.64	4.38	.81	1.74	10.1	3.13	5.51
CHLOROENZILATE	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U
4,4'-DDE	.062	.065	.048	.067	.079	.073	.14	.058	.22	.25
4,4'-DDD	.025N	.026	.017N	.037N	.047N	.017	.028	.014	.043	.065
4,4'-DDT	.020U (.010)	.020U (.010)	.010U (.005)	.020U (.010)	.030U (.015)	.010	.010N	.009U (.0045)	.019	.021
SUM OF DDE, DDD, AND DDT	0.097	0.101	0.070	0.114	0.141	0.100	0.178	0.077	0.282	0.336
STATION	MT-8SC	MT-8MC	MT-8MC	MT-8LC	MT-8LC	MT-9MC	MT-9MC	MT-9MC	MT-9LC	MT-9LC
D NUMBER	2845	2847	2843	2841	2839	3291	3295	3285	3289	3283
TAG NUMBER	42938	44602	44599	44601	44598	42721	43718	43709	43713	43707
WEIGHT (g)	**	219	431	548	960	**	**	W	W	W
LENGTH (mm)	<276	318	370	417	486	<376	<376	<376	<501	<501
% LIPIDS	3.00	1.61	7.29	7.17	7.46	2.13	1.86	9.18	0.71	3.95
CHLOROENZILATE	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U	.040U
4,4'-DDE	.019	.028	.055	.044	.042	.029	.058	.016	.30	1.1C
4,4'-DDD	.005U (.0025)	.005U (.0025)	.0072	.005U (.0025)	.0055	.005U (.0025)	.005U (.0025)	.005U (.0025)	.019	.13
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.010U (.005)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)
SUM OF DDE, DDD, AND DDT	0.024	0.033	0.065	0.049	0.053	0.034	0.063	0.021	0.322	1.230

** = Compositd sample of small fish to meet sample mass needs.
 N = Presumptive evidence of presence of material.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 C = Confirmed by GCMS.
 W = Weight not reported.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 19 cont. Organic analyses whole body Channel Catfish (mg/kg)

STATION	MT-10MC	MT-10MC	MT-10LC
D NUMBER	2861	2853	2851
TAG NUMBER	42902	42903	43001
WEIGHT (g)	253	385	629
LENGTH (mm)	335	374	421
% LIPIDS	.86	6.43	7.15
CHLORO BENZILATE	.040U	.040U	.040U
4,4'-DDE	.014	.069	.027
4,4'-DDD	.005U (.0025)	.0068	.005U (.0025)
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)
SUM OF DDE, DDD, AND DDT	0.019	0.078	0.032

U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 20. Mean and range for DDE, DDD and DDT concentrations* in fillet and whole body samples (mg/kg) of Largemouth Bass and Channel Catfish. Mobile River Study. November, 1993.

Pesticide	Largemouth Bass		Channel Catfish	
	fillets	whole body	fillets	whole body
DDE	.035 .002 - .87	.143 .004 - 1.3	.042 .002 - .290	.100 .006 - 1.1
DDD	.011 .002 - .35	.030 .001 - .26	.008 .002 - .09	.019 .002 - .13
DDT	.005 .002 - .35	.016 .002 - .066	.007 .002 - .048	.005 .002 - .021

* Mean values subtended by range. MDL included as median value.

Table 21. Results of inorganic analyses of Largemouth Bass whole body samples (mg/kg). Mobile River Study. November, 1993.

STATION MT-0	SL	ML	LL	LL	LL
MD NUMBER	3359	3367	3357	2864	2866
TAG NUMBER	44916	44919	44915	44918	44914
WEIGHT (g)	**	312	481	919	1050
LENGTH (mm)	<226	293	333	389	437
ALUMINUM	4U	5U	9.2	6U	5.5
BARIUM	2.3	1.3	9.6	3.0	3.4
CALCIUM	13,000J	9600J	16,000	17,000	14,000
COBALT	0.03U	0.03U	0.03U	0.03U	0.02U
COPPER	0.5U	0.5U	0.8U	1U	0.9U
IRON	55J	45J	56	30	28
MAGNESIUM	480J	390J	500	560	490
MANGANESE	1.4	0.92	7.1	3.0	4.0
MERCURY	0.08	0.08	0.06	0.16	0.32
NICKEL	35	18	3.7	0.03U	0.02U
POTASSIUM	3100J	3100J	3000J	3000J	2800J
SELENIUM	0.60	0.58	0.58J	0.33	0.30
SODIUM	1000	1000	1200J	1300J	1200J
VANADIUM	0.03U	0.03U	0.05J	0.03U	0.08
ZINC	17J	15J	14	18	15

J = Estimated value.
 ** = Compositd sample of small fish to meet mass needs.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 SL = Small Largemouth Bass.
 ML = Medium Largemouth Bass.
 LL = Large Largemouth Bass.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATION MT-2	SL	SL	ML	LL	LL	LL	LL	LL
MD NUMBER	3333	3399	3330	3324	2848	3326	3328	
TAG NUMBER	42601	42603	44936	44949	44937	44938	43753	
WEIGHT (g)	**	**	340	647	577	959	W	
LENGTH (mm)	<226	<226	293	365	372	405	<401	
ALUMINUM	9.8	8UJ	6U	5U	9.1	9.6	5U	
BARIUM	1.1	1.1	1.4	3.0	1.4	8.1	1.1	
CALCIUM	12,000	14,000J	14,000	17,000	14,000J	17,000	12,000	
COBALT	0.03U	0.02U	0.03U	0.03U	0.03U	0.08J	0.03U	
COPPER	0.4U	3.5	0.7U	0.5U	0.5U	1U	0.7U	
IRON	25	14J	46	30	34	87	25	
MAGNESIUM	470	540J	500	530	480J	530	450	
MANGANESE	1.1	1.0	0.97	1.1	0.62	8.0	0.61	
MERCURY	0.33	0.12	0.15	0.64	2.5	0.32	1.2	
NICKEL	0.03U	2.5	0.03U	0.03U	0.03U	0.03U	0.03U	
POTASSIUM	3100J	3600J	3000J	3100J	2900	2700J	3000J	
SELENIUM	0.59J	0.70	0.81J	0.39J	0.60	0.59J	1.1J	
SODIUM	1100J	1100	1100J	1400J	1300	1500J	1100J	
VANADIUM	0.03U	0.03U	0.03	0.04J	0.08	0.15	0.07J	
ZINC	20	21J	17	17	17J	15	16	

J = Estimated value.
W = Weight not reported.
U = Material was analyzed for but not detected; number is minimum quantitation limit.
** = Compositated sample of small fish to meet mass needs.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATIONS MT-3 AND 4	3ML	3ML	3LL	3LL	3LL	3LL	4SL	4ML	4LL	4LL	4LL
MD NUMBER	3320	3322	3318	3316	3304	3262	3258	3260	2878	3361	
TAG NUMBER	44778	44779	44776	44777	44775	42685	44821	44820	42683	44819	
WEIGHT (g)	144	302	620	870	1582	**	325	501	570	1102	
LENGTH (mm)	230	280	333	372	463	<226	288	320	352	419	
ALUMINUM	5U	4U	6U	3U	2U	5U	3U	5U	3U	5U	
BARIUM	1.4	0.85	1.7	0.81	1.6	0.68	0.61	0.85	0.41	4.5	
CALCIUM	17,000	9200	12,000	12,000	14,000	11,000	15,000	13,000	9500	11,000J	
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.05J	
COPPER	0.5U	0.3U	1.3	0.3U	0.3U	0.4U	0.3U	0.4U	0.3U	0.7U	
IRON	26	15	20	14	16	23	12	22	13	1600J	
MAGNESIUM	570	380	450	410	440	440	470	430	360	440J	
MANGANESE	1.1	0.47	0.90	0.49	0.49	1.4	0.50	0.95	0.42	8.7	
MERCURY	0.04	0.08	0.09	0.08	0.24	0.04	0.16	0.12	0.13	0.63	
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	13	
POTASSIUM	3300J	2900J	3200J	2900J	2800J	3300J	3100J	2800J	2900J	3600J	
SELENIUM	0.38J	0.40J	0.58J	0.68	0.35	0.44	0.34	0.39	0.34	0.63	
SODIUM	1200J	940J	1100J	1000J	1100J	970J	1100J	1100J	940J	1200	
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.17	
ZINC	20	14	18	13J	13J	19	15	16	12	14J	

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositd sample of small fish to meet mass needs.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATIONS MT-5 AND 7	5SL	5ML	5LL	5LL	5LL	7SL	7ML	7ML	7LL	7LL
MD NUMBER	3365	2876	2874	2872	2870	3354	3352	3350	3348	3346
TAG NUMBER	42705	42701	42702	42706	42637	44734	44735	44733	44736	44737
WEIGHT (g)	**	288	373	508	1080	108	188	380	670	56
LENGTH (mm)	<226	271	304	330	410	206	240	290	345	440
ALUMINUM	7.3	5U	4U	3U	3U	4U	4U	6.8	1U	0.8U
BARIUM	0.89	1.2	1.1	0.79	0.65	1.1	1.5	1.7	1.5	1.1
CALCIUM	6900J	12,000	13,000	12,000	14,000	13,000	12,000	13,000	13,000	15,000
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.3U
IRON	37J	24	18	18	18	8.6	23	20	14	14
MAGNESIUM	370J	460	470	430	450	480	460	460	430	460
MANGANESE	1.5	2.4	0.68	0.61	0.69	0.86	1.6	2.0	0.47	0.54
MERCURY	0.07	0.07	0.10	0.09	0.18	0.10	0.03	0.13	0.13	0.44
NICKEL	22	0.03U	0.03U	0.03U	0.03U	0.12	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3200J	2900J	3100J	2800J	2900J	3300J	3100J	3000J	2900J	2700J
SELENIUM	0.55	0.49	0.37	0.49	0.33	0.68J	0.30J	0.62J	0.30J	0.30J
SODIUM	930	1000J	1100J	1100J	1100J	1100J	1100J	1000J	1100J	1100J
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03	0.03U	0.03U	0.03U
ZINC	16J	17	17	16	13	14	18	18	13	12

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.
** = Compositd sample of small fish to meet mass needs.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATION MT-8	ML	LL	LL	LL	LL
MD NUMBER	2832	2836	2835	2830	2828
TAG NUMBER	44603	44605	44604	44606	44607
WEIGHT (g)	164	542	582	1310	2052
LENGTH (mm)	240	323	344	440	508
ALUMINUM	11	5U	3U	3U	4U
BARIUM	1.0	1.3	1.1	0.99	0.62
CALCIUM	14,000J	16,000J	13,000J	15,000J	12,000J
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.5U	0.4U	0.4U	0.3U	0.3U
IRON	47	24	24	22	24
MAGNESIUM	500J	500J	450J	470J	410J
MANGANESE	1.9	0.84	0.97	0.69	0.50
MERCURY	0.17	0.20	0.20	0.29	0.46
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3300	3000	2900	2800	3000
SELENIUM	0.41	0.35	0.45	0.35	0.35
SODIUM	1200	1200	1100	1200	1100
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U
ZINC	21	15J	15J	13J	12

J = Estimated value.

U = Material was analyzed for but not detected.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATION MT-9	SL	LL	LL	LL	LL
MD NUMBER	3292	3296	3286	3300	3298
TAG NUMBER	44925	44931	44651	44929	44655
WEIGHT (g)	**	379	552	1160	1562
LENGTH (mm)	<226	310	340	430	460
ALUMINUM	4U	3U	3U	3U	2U
BARIUM	1.5	1.2	1.0	1.5	0.91
CALCIUM	15,000	15,000	16,000	13,000	15,000
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.3U	0.4U	0.3U	0.3U
IRON	17	25	19	18	21
MAGNESIUM	500	500	490	470	460
MANGANESE	1.7	1.1	1.2	0.65	0.86
MERCURY	0.03	0.15	0.15	0.37	0.28
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3400J	3300J	3100J	3200J	3000J
SELENIUM	0.49	0.66	0.53	0.38	0.35
SODIUM	1100J	1200J	1100J	1100J	1200J
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U
ZINC	20J	21	17J	13J	12J

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.
 ** = Composite sample of small fish to meet mass needs.

Table 21 cont. Inorganic analyses whole body Largemouth Bass (mg/kg)

STATION MT-10	SL	ML	ML	LL	LL	LL
MD NUMBER	2856	2862	2858	3334	3302	3280
TAG NUMBER	42860	42859	42861	42857	42575	42574
WEIGHT (g)	**	140	275	557	1204	1934
LENGTH (mm)	<226	227	292	357	432	510
ALUMINUM	5U	3U	3U	0.55U	2U	3U
BARIUM	0.62	2.0	0.68	0.57	0.67	1.7
CALCIUM	11,000	10,000	17,000J	14,000	12,000	15,000
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.8U	0.3U	0.3U	0.3U	0.3U
IRON	24	32	23	23	13	16
MAGNESIUM	430J	430	530J	470	430	480
MANGANESE	1.7	0.92	0.71	0.47	0.49	0.80
MERCURY	0.03	0.46	0.14	0.10	0.23	0.34
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	3200	3400J	3100	2900J	3000J	3200J
SELENIUM	0.33	0.54	0.36	0.3UJ	0.60	0.31
SODIUM	1000	1000J	1300	1000J	930J	1200J
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
ZINC	25J	22	21J	16	13J	14J

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.
 ** = Compositd sample of small fish to meet mass needs.

Table 22. Results of inorganic analyses of Channel Catfish whole body samples (mg/kg). Mobile River Study. November, 1993.

STATION MT-	OSC	OMC	OMC	OMC	OLC	2SC	2SC	2MC	2MC	2LC
MD NUMBER	3278	3272	3276	3270	2868	2854	2820	2824	2822	2826
TAG NUMBER	43002	44505	44503	44504	44506	42904	44575	44575	44575	44575
WEIGHT (g)	**	288	298	380	621	**	22	237	296	955
LENGTH (mm)	<276	345	345	355	420	<276	170	333	334	474
ALUMINUM	9.5	4U	2U	14	2U	17	14	6.4	8.0	9.6
ARSENIC	0.07U	0.07U	0.07U	0.2U	0.07U	0.07U	0.09U	0.07U	0.2U	0.2U
BARIUM	0.59	1.0	0.99	0.78	1.0	1.8	1.2	1.5	1.7	1.5
CALCIUM	4800	7000	7400	7800	9400	5900J	7900J	9300J	13,000J	11,000J
CHROMIUM	0.2U	0.2U	0.2U	0.2U	0.20	0.2U	0.3U	0.3U	0.4U	0.3U
COBALT	0.03U	0.03U	0.03U	0.04	0.03U	0.04	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.3U	0.3U	0.4U	0.3U	0.4U	0.6U	0.4U	0.4U	0.5U
IRON	39	27	22	23	22	57	73	31	45	46
LEAD	0.04U	0.04U								
MAGNESIUM	250	310	310	300	330	290J	350J	400J	460J	390
MANGANESE	1.8	1.6	7.0	9.9	5.3	4.5	2.7	3.2	2.8	6.8
MERCURY	0.03	0.08	0.04	0.04	0.05	0.04	0.08	0.09	0.14	0.13
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.04	0.03U	0.03J	0.03U
POTASSIUM	2500J	2500J	2600J	2600J	2600J	2700	2800	3100	3300	3000
SELENIUM	0.27	0.63	0.3U	0.3U	0.28	0.38	0.32	0.37	0.34	0.37
SODIUM	860J	620J	910J	940J	940J	860	1200	1200	1200	1100
VANADIUM	0.10	0.08	0.07	0.13	0.12	0.10	0.15	0.08J	0.16	0.19
ZINC	23J	19	21	20	18	30J	32J	29J	32J	19J

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositated sample of small fish to meet mass needs.

SC = Small Channel Catfish.

MC = Medium Channel Catfish.

LL = Large Channel Catfish.

Table 22 cont. Inorganic analyses whole body Channel Catfish (mg/kg)

STATION MT-	3MC	3MC	3LC	3LC	3LC	4SC	4MC	4MC	4LC	4LC
MD NUMBER	3314	3312	3310	3308	3306	3165	3168	3169	3166	3167
TAG NUMBER	44831	44832	44833	44834	44835	43057	43062	43061	43060	43059
WEIGHT (g)	205	337	559	1333	1937	**	139	358	445	840
LENGTH (mm)	316	358	398	500	582	<276	280	357	385	462
ALUMINUM	6.7	5U	12	3U	3U	10	32	6U	12	5U
ARSENIC	0.07U	0.07U	0.07U	0.07U	0.2U	0.07U	0.07U	0.07U	0.07U	0.07U
BARIUM	2.6	1.0	2.3	0.93	0.65	3.0	1.1	1.5	1.0	2.0
CALCIUM	6500	4400	8500	8300	7900	19,000	6400	15,000	6400	9500
CHROMIUM	0.2U	0.2U	0.3U	0.2U	0.2U	0.5U	0.2U	0.3U	0.2U	0.3U
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.3U	0.4U	0.2U	0.2U	0.6U	0.5U	0.4U	0.4U	0.4U
IRON	30	19	29	15	16	61	140	17	40	82
LEAD	0.04U	0.04U	0.04U	0.04U	0.80	0.04U	0.05U	0.04U	0.05U	0.04U
MAGNESIUM	300	250	330	320	310	550	310	440	300	370
MANGANESE	1.8	4.4	8.9	1.3	1.1	6.2	7.9	4.7	1.4	2.6
MERCURY	0.04	0.04	0.12	0.12	0.05	0.04	0.07	0.36	0.12	0.06
NICKEL	0.03U	0.03U	0.03U	0.03U	0.04J	6.6J	14J	0.03UJ	21J	32J
POTASSIUM	2800J	2700J	2800J	2800J	2800J	3300J	2900J	3100J	2800J	2900J
SELENIUM	0.2U	0.2U	0.2U	0.3U	0.22	0.44	0.56	0.45	0.37	0.42
SODIUM	940J	790J	980J	930J	930J	1200J	750J	940J	650J	890J
VANADIUM	0.12	0.10	0.10	0.10	0.07	0.17	0.15	0.13	0.11	0.09
ZINC	27J	17J	21J	19J	18J	39	29	38	20	22

J = Estimated value.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

** = Compositd sample of small fish to meet mass needs.

Table 22 cont. Inorganic analyses whole body Channel Catfish (mg/kg)

STATION MT-	SSC	SSC	SMC	SMC	SLC
MD NUMBER	3274	3363	3269	3266	3264
TAG NUMBER	43496	43112	43113	43114	43109
WEIGHT (g)	W	**	230	416	922
LENGTH (mm)	<276	<276	307	361	470
ALUMINUM	2U	5U	9.7	6U	4U
ARSENIC	0.07U	0.07U	0.07U	0.07U	0.07U
BARIUM	1.3	1.6	1.3	1.0	1.1
CALCIUM	7300	15,000J	5500	7500	9700
CHROMIUM	0.2U	0.3U	0.2U	0.2U	0.3U
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.3U	0.3U	0.4U	0.4U	0.3U
IRON	21	47J	42	29	22
LEAD	0.04U	0.04U	0.05U	0.04U	0.04U
MAGNESIUM	330	420J	300	330	360
MANGANESE	1.3	3.0	2.4	1.8	3.5
MERCURY	0.03	0.03	0.04	0.05	0.04
NICKEL	0.03U	4.9	0.03U	0.03U	0.03U
POTASSIUM	2700J	2900J	2700J	2800J	2900J
SELENIUM	0.27	0.43	0.31	0.31	0.27
SODIUM	1000J	1000	910J	750J	750J
VANADIUM	0.09	0.27	0.08	0.05	0.11
ZINC	25	22J	21	20	21

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 W = Weight not reported.
 ** = Compositd sample of small fish to meet mass needs.

Table 22 cont. Inorganic analyses whole body Channel Catfish (mg/kg)

STATION MT-	7SC	7MC	7MC	7LC	7LC	8SC	8MC	8MC	8LC	8LC
MD NUMBER	3344	3342	3340	3338	3336	2844	2846	2842	2840	2838
TAG NUMBER	44759	44760	44761	44758	42930	42938	44602	44599	44601	44598
WEIGHT (g)	**	263	448	718	1020	**	219	431	548	960
LENGTH (mm)	<276	320	350	430	500	<276	318	370	417	486
ALUMINUM	7.7	0.63U	8.5	6.0	2U	16	4U	0.8U	29	6U
ARSENIC	0.07U	0.07U	0.06U	0.06U	0.06U	0.06U	0.07U	0.07U	0.07U	0.07U
BARIUM	3.0	0.41	0.51	0.85	1.1	1.6	0.86	1.8	2.3	0.98
CALCIUM	13,000	6400	6700	8200	8600	8600J	9700J	8300J	12,000J	9800J
CHROMIUM	0.4U	0.2U	0.2U	0.2U	0.2U	0.2U	0.3U	0.2U	0.3U	0.2U
COBALT	0.03U	0.03U	0.03U	0.03U	0.02U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.4U	0.2U	0.3U	0.3U	0.6U	0.4U	0.3U	0.5U	0.4U	0.4U
IRON	30	16	27	29	26	42	34	26	52	34
LEAD	0.15	0.04U	0.03U	0.03U	0.03U	0.03U	0.04U	0.04U	0.04U	0.04U
MAGNESIUM	430	300	310	330	330	340J	350J	310J	390J	350J
MANGANESE	3.9	2.2	9.8	1.9	1.6	3.4	3.3	2.1	6.4	4.3
MERCURY	0.07	0.04	0.05	0.04	0.06	0.05	0.07	0.17	0.09	0.10
NICKEL	0.03U	0.03U	0.03U	0.03U	0.02U	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	2700J	2800J	2700J	2800J	2900J	2800	2700	2700	2800	2900
SELENIUM	0.23J	0.27J	0.27J	0.38J	0.36J	0.27	0.42	0.27	0.27	0.3U
SODIUM	1300J	980J	840J	1000J	810J	1100	1200	90	1200	1100
VANADIUM	0.09	0.03U	0.11	0.04J	0.03J	0.12	0.12	0.07J	0.11	0.04
ZINC	31	21	20	20	19	24J	23J	21J	23J	18J

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 ** = Compositated sample of small fish to meet mass needs.

Table 22 cont. Inorganic analyses whole body Channel Catfish (mg/kg)

STATION MT-	9MC	9MC	9MC	9LC	9LC	10MC	10MC	10LC
MD NUMBER	3284	3290	3294	3282	3288	2852	2860	2850
TAG NUMBER	43708	42721	43719	43706	43712	42903	42902	43001
WEIGHT (g)	W	W	W	W	W	385	253	629
LENGTH (mm)	<376	<376	<376	<501	<501	374	335	421
ALUMINUM	2U	6U	3U	2U	7.6	2U	13	3U
ARSENIC	0.07U	0.07U	0.07U	0.07U	0.07U	0.07U	0.07U	0.09U
BARIUM	0.67	1.9	1.7	1.1	4.4	0.71	0.86	0.88
CALCIUM	4900	8700	10,000	11,000	9200	9300J	6300	7800J
CHROMIUM	0.2U	0.3U	0.3U	0.3U	0.3U	0.3U	0.2U	0.2U
COBALT	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
COPPER	0.2U	0.3U	0.3U	0.2U	0.5U	0.4U	0.4U	0.4U
IRON	11	20	17	20	30	27	28	23
LEAD	0.04U	0.04U	0.04U	0.04U	0.04U	0.04U	0.03U	0.04U
MAGNESIUM	260	340	370	350	330	340J	290	310J
MANGANESE	0.89	1.6	4.2	7.7	8.7	3.3	3.1	1.6
MERCURY	0.04	0.04	0.04	0.21	0.09	0.06	0.03	0.04
NICKEL	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
POTASSIUM	2600J	2700J	2800J	2700J	2700J	2800	2700J	2600
SELENIUM	0.2U	0.28	0.23	0.2U	0.31	0.36	0.31	0.33
SODIUM	730J	1000J	1100J	1200J	1200J	940	1100J	720
VANADIUM	0.04J	0.07	0.09	0.03U	0.06J	0.08	0.04	0.04
ZINC	19J	24J	23J	21J	21J	22J	29	17J

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 ** = Compositd sample of small fish to meet mass needs.
 W = Weight not reported.

Table 23. Results of inorganic analyses of whole body forage fish composite samples (mg/kg). Mobile River Study. November, 1993.

STATION	MT-0F	MT-0F	MT-0F	MT-2F	MT-2F	MT-2F	MT-3F	MT-3F	MT-3F
MD NUMBER	2699	2700	2701	2703	2704	2705	2764	2710	2709
TAG NUMBER	44920	42748	44922	44947	42605	42732	42642	42646	42644
ALUMINUM	66	59	67	210J	72J	190J	75	100	52
ARSENIC	0.2U	0.2U	0.1U	0.09U	0.07U	0.2U	0.2U	0.3U	0.2U
BARIUM	7.6	6.3	7.0	11	6.5	8.8	7.7	8.8	8.5
CALCIUM	9700	9300	9600	12,000	9600	9800	9600	10,000	11,000
CHROMIUM	0.4U	0.3U	0.4U	0.53	0.4U	0.5U	0.5U	0.5U	0.4U
COBALT	0.09	0.07	0.08	0.12	0.06J	0.14	0.08	0.09J	0.05
COPPER	0.7U	0.7U	0.7U	2.9	0.8U	2U	0.8U	1U	0.9U
IRON	120	110	120	220	100	220	87	140	74
LEAD	0.2U	0.2U	0.2U	0.20J	0.04U	0.2U	0.05U	0.2U	0.05U
MAGNESIUM	400	390	400	460	390	380	400	410	440
MANGANESE	26	15	16	24	14	29	13	18	11
MERCURY	0.02J	0.02J	0.03J	0.03J	0.03J	0.02J	0.02J	0.02U (0.01)	0.03
NICKEL	0.11J	0.04J	0.08	0.52	0.20	1.6	0.3U	0.2U	0.1U
POTASSIUM	2900J	3000J	3000J	3100J	3100J	2900J	3200J	3100J	3200J
SELENIUM	0.44	0.44	0.41	0.48	0.47	0.51	0.40	0.77	0.45
SODIUM	810J	750J	770J	850J	790J	830J	840J	860J	890J
VANADIUM	0.26	0.21	0.27	0.44	0.22	0.42	0.19	0.29	0.18
ZINC	42	40	36	45	38	36	38	41	39

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 F = Forage.
 () = Assumed median of reported MDL value for the purpose of calculating mercury.

Table 23 cont. Inorganic analyses forage fish (mg/Kg)

STATION	MT-4F	MT-4F	MT-4F	MT-5F	MT-5F	MT-5F	MT-5F	MT-5F	MT-7F	MT-7F	MT-7F
MD NUMBER	2713	2714	2712	2708	2706	2707	2790	2695	2696	2702	
TAG NUMBER	42657	44806	44802	44590	42627	42625	42624	44773	44771	44780	
ALUMINUM	110	190J	130J	37J	47J	52J	200	53	43	52	
ARSENIC	0.06U	0.2U	0.09J	0.07U	0.07U	0.07U	0.2U	0.1U	0.07U	0.2U	
BARIUM	6.6	7.5	6.8	7	7.5	6.6	9.5	6.3	8	7.9	
CALCIUM	9200	9100	8800	9100	10,000	9900	10,000	13,000	12,000	13,000	
CHROMIUM	0.4U	0.51	0.5U	0.3U	0.3U	0.3U	0.60	0.4U	0.4U	0.4U	
COBALT	0.09	0.16	0.12	0.03U	0.06	0.05	0.16	0.06	0.04	0.07	
COPPER	0.9U	1.3	2U	0.6U	2U	2U	2U	0.6U	0.9U	0.8U	
IRON	130	240	170	52	74	65	230	73	6.9	74	
LEAD	0.09U	0.2U	0.2U	0.06U	0.07U	0.05U	0.2U	0.08U	0.1U	0.1U	
MAGNESIUM	340	340	350	360	360	350	370	440	410	450	
MANGANESE	22	35	29	10	26	25	31	13	15	14	
MERCURY	0.02UJ (0.01)	0.03J	0.02J	0.02J	0.02UJ (0.01)	0.03UJ (0.015)	0.03UJ (0.015)	0.05J	0.03J	0.02J	
NICKEL	0.17	0.12	0.36	0.03U	0.23	0.67	0.2U	0.10	0.19	0.07	
POTASSIUM	2800J	3000J	3000J	2700J	2900J	3100J	3000J	2700J	2900J	3200J	
SELENIUM	0.47	0.48	0.51	0.47	0.55	0.50	0.52	0.48	0.51	0.51	
SODIUM	840J	960J	860J	700J	970J	990J	1000J	900J	930J	1000J	
VANADIUM	0.27	0.43	0.33	0.11	0.14	0.11	0.43	0.20	0.14	0.19	
ZINC	27	26	27	35	27	27	32	28	32	31	

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating mercury

Table 23 cont. Inorganic analyses forage fish (mg/Kg)

STATION	MT-8F	MT-8F	MT-8F	MT-9F	MT-9F	MT-9F	MT-9F	MT-9F	MT-10F	MT-10F	MT-10F
MD NUMBER	2798	2761	2760	2759	2757	2758	2799	2767	2765	2766	
TAG NUMBER	43117	44596	44909	44534	44666	44535	43119	42948	42845	42844	
ALUMINUM	200	170	230	57	45	76	70	92	63	130	
ARSENIC	0.3U	0.3U	0.3U	0.2U	0.06U	0.2U	0.2U	0.2U	0.1U	0.2U	
BARIUM	10	9.1	12	7.5	7.1	9.5	7.6	3.5	6.3	5.8	
CALCIUM	11,000	16,000	12,000	11,000	9,900	12,000	11,000	8600	11,000	12,000	
CHROMIUM	0.65	0.69	0.69	0.5U	0.4U	0.5U	1U	0.5U	0.5U	0.52	
COBALT	0.43	0.17	0.44	0.08	0.07	0.14	0.09J	0.10	0.06J	0.09J	
COPPER	2U	2.7	1.3	2U	2U	2U	2U	1.3	0.8U	0.8U	
IRON	300	260	350	76	80	120	89	130	78	140	
LEAD	0.2U	0.15	0.13	0.08U	0.08U	0.08U	0.04U	0.1U	0.04U	0.04U	
MAGNESIUM	370	510	390	380	350	400	380	350	420	440	
MANGANESE	44	26	48	24	22	27	24	19	16	18	
MERCURY	0.02UJ (0.01)	0.07J	0.02UJ (0.01)	0.03UJ (0.015)	0.01	0.03UJ (0.015)	0.02UJ (0.01)	0.02UJ (0.01)	0.03UJ (0.015)	0.03UJ (0.015)	
NICKEL	0.3U	1U	1U	0.1U	0.06U	0.1U	0.1U	2.5	0.05U	0.1U	
POTASSIUM	2900J	2900J	3000J	3100J	2700J	3100J	3200J	3000J	3100J	2900J	
SELENIUM	0.55	0.54	0.51	0.34	0.52	0.52	0.35	0.35	0.38	0.42	
SODIUM	1000J	1200J	1100J	1100J	840J	1100J	1100J	890J	990J	910J	
VANADIUM	0.48	0.47	0.55	0.16	0.13	0.23	0.19	0.25	0.15	0.27	
ZINC	26	33	29	29	31	32	30	30	49	51	

J = Estimated value.
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 () = Assumed median of reported MDL value for the purpose of calculating mercury.

Table 24. Results of organic analyses of whole body forage fish composite samples (mg/kg).
Mobile River Study. November, 1993.

STATION	MT-0F	MT-0F	MT-0F	MT-2F	MT-2F	MT-2F	MT-2F	MT-3F	MT-3F	MT-3F	MT-3F	MT-3F
D NUMBER	2774	2775	2776	2780	2781	2782	2771	2772	2773	2773	2773	2789
TAG NUMBER	42751	44923	44921	44948	42604	44574	42645	42647	44822	44822	44822	44824
% LIPIDS	3.07	3.17	3.1	4.77	3.57	4.27	3.53	3.67	4.63	4.63	4.63	3.33
PCB-1260	.050U	.060U	.053	.060U	.070U	.070U	.060U	.060U	.060U	.070U	.070U	.090U
4,4'-DDE	0.032	.043	.044	.053	.045	.063	.056	.052	.030	.030	.030	.035
4,4'-DDD	.0091N	.012	.013	.020U (.010)	.020U (.010)	.020U (.010)	.020U (.010)	.020U (.010)	.0083N	.0083N	.0083N	.020U (.010)
4,4'-DDT	.005U (.0025)	.010U (.005)										
SUM OF DDE,DDD AND DDT	0.044	0.058	0.060	0.066	0.058	0.076	0.069	0.065	0.041	0.041	0.041	0.050

U = Material was analyzed for but not detected; number is minimum quantitation limit.
 N = Presumptive evidence of presence of material.
 F = Forage.
 () = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 24 cont. Organic analyses forage fish (mg/kg)

STATION	MT-4F	MT-4F	MT-4F	MT-5F	MT-5F	MT-5F	MT-7F	MT-7F	MT-7F
D NUMBER	2777	2778	2779	2786	2787	2788	2783	2784	2785
TAG NUMBER	42689	44805	44804	42697	42699	42626	44774	44781	44772
% LIPIDS	4.2	2.17	2.73	2.23	1.90	3.17	2.27	2.37	2.87
PCB-1260	.070U	.050U	.050U	.050U	.050U	.050U	.050U	.050U	.050U
4,4'-DDE	.050	.008	.0094	.021	.016	.0083	.25	.089	.047
4,4'-DDD	.020U (.010)	.005U (.0025)	.005U (.0025)	.007U (.0035)	.007U (.0035)	.005U (.0025)	.031N	.020U (.010)	.020U (.010)
4,4'-DDT	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.006U (.003)	.029N	.0009U (.00045)	.0073N
SUM OF DDE, DDD AND DDT	0.063	0.013	0.014	0.027	0.022	0.014	0.31	0.10	0.064

U = Material was analyzed for but not detected; number is minimum quantitation limit.

N = Presumptive evidence of presence of material.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 24 cont. Organic analyses forage fish (mg/kg)

STATION	MT-8F	MT-8F	MT-8F	MT-9F	MT-9F	MT-9F	MT-9F	MT-10F	MT-10F	MT-10F
D NUMBER	2762	2763	2800	2759	2796	2797	2768	2769	2770	
TAG NUMBER	44910	44597	43118	44534	43116	43115	42846	42846	42573	
% LIPIDS	1.76	1.36	1.43	NA	1.47	1.27	3.60	4.0	5.27	
PCB-1260	.050U	.050U	.050U	NA	.050U	.050U	.16U	.050U	.11	
4,4'-DDE	.012	.052	.076	NA	.005U (.0025)	.005U (.0025)	.017	.0082	.026	
4,4'-DDD	.005U (.0025)	.005U (.0025)	.012N	NA	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	.005U (.0025)	
4,4'-DDT	.009U (.0045)	.020U (.010)	.005U (.0025)	NA	.005U (.0025)	.005U (.0025)	.025	.005U (.0025)	.005U (.0025)	
SUM OF DDE, DDD AND DDT	0.019	0.065	0.091	NA	0.008	0.008	0.045	0.013	0.031	

N = Presumptive evidence of presence of material.

NA = Not analyzed.

U = Material was analyzed for but not detected; number is the minimum quantitation limit.

() = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 25.

Results of inorganic analyses of whole body samples (mg/kg) of fish collected from the floodplain wetlands. Mobile River Study. April, 1994.

STATION	DLML MT-0ML	CCML MT-2ML	CCML MT-2ML	CCLL MT-2LL	FP8SL MT-8SL	FP8LL MT-8LL	TRSL MT-11SL	TRSL MT-11SL	TRSL MT-11SL
MD NUMBER	3369	3377	3373	3371	3387	3385	3393	3395	3397
ALUMINUM	2U	2U	2U	2U	2U	2U	1U	2U	2U
BARIUM	0.10U	0.10U	0.10U	0.11U	0.24	0.10	0.09U	0.09U	0.10U
CALCIUM	680J	300J	530J	1000J	1400J	710J	160J	240J	430J
CHROMIUM	0.09U	0.08U	0.07U	0.09U	0.1U	0.09U	0.09U	0.07U	0.08U
COBALT	0.03U	0.03U	0.03U	0.03U	0.04U	0.03U	0.02U	0.02U	0.03U
COPPER	0.3U	0.4U	0.3U	0.3U	0.4U	0.3U	0.3U	0.4U	0.3U
IRON	4UJ	3UJ	3UJ	3UJ	3UJ	4UJ	3UJ	3UJ	3UJ
LEAD	0.04U	0.04U	0.04U	0.04U	0.05U	0.03U	0.03U	0.05U	0.04U
MAGNESIUM	300J	310J	340J	310J	340J	300J	300J	310J	320J
MANGANESE	0.19	0.14	0.10	0.09	0.32	0.17	0.13	0.17	0.19
MERCURY	0.26	0.18	0.16	0.65	0.09	0.13	0.18	0.25	0.24
NICKEL	0.03U	0.03U	0.03U	0.65U	0.04U	0.03U	0.02U	0.02U	0.03U
POTASSIUM	3300J	3700J	3500J	3500J	3400J	3400J	3400J	3500J	3400J
SELENIUM	0.41	0.38	0.46	0.42	0.68	0.48	0.33	0.31	0.36
SODIUM	610	5500	460	460	580	530	470	500	470
VANADIUM	0.03U	0.03U	0.03U	0.03U	0.04U	0.03U	0.03U	0.03U	0.03U
ZINC	11J	12J	9.5J	8.6J	14J	7.8J	12J	12J	14J

FP = Floodplain

SL = Small Largemouth Bass

ML = Medium Largemouth Bass

DL = Dead Lake

J = Estimated Value.

LL = Large Largemouth Bass

TR = Tensas River

CC = Cold Creek

U = Material analyzed for but not detected; number is minimum quantitation limit.

Table 25 cont. Inorganic analyses floodplain fish (mg/kg)

STATION	CCSC MT-2SC	LCFOR MT-0 FOR	CCFOR MT-2 FOR	OBFOR MT-7 FOR	FP8FOR MT-8 FOR	TRFOR MT-11 FOR
MD NUMBER	3376	3381	3379	3383	3389	3391
ALUMINUM	3U	88	27	58	13	24
BARIUM	0.11U	3.4	3.1	3.6	1.8	2.5
CALCIUM	160J	8700J	9100J	15,0000J	9200J	9300J
CHROMIUM	0.1U	0.4U	0.3U	0.47	0.3U	0.3U
COBALT	0.03U	0.11	0.04J	0.09	0.03U	0.05
COPPER	0.3U	1.3	2U	0.9U	1.2	0.8U
IRON	9.8J	120J	53J	81J	32J	44J
LEAD	0.04U	0.04U	0.04U	0.03U	0.04U	0.04U
MAGNESIUM	280J	340J	340J	470J	350J	350J
MANGANESE	0.35	26	15	34	9.6	14
MERCURY	0.03	0.05	0.23	0.21	0.05	0.10
NICKEL	0.03U	0.05	0.03U	0.08	0.03U	0.36
POTASSIUM	3600J	3000J	2800J	3000J	2900J	3000J
SELENIUM	0.3U	0.58	0.59	0.55	0.58	0.50
SODIUM	500	1000	1000	1100	870	970
VANADIUM	0.03U	0.27	0.13	0.22	0.19	0.09
ZINC	11J	20J	20J	21J	20J	23J

CC = Cold Creek
 LC = Lizard Creek
 U = Material was analyzed for but not detected; number is minimum quantitation limit.
 J = Estimated value.
 OB = Floodplain area between Olin Basin and the Mobile River.
 FOR = Forage fish SC = Small Channel Catfish

Table 26. Results of organic analyses of whole body fish from the floodplain wetlands (mg/kg).
Mobile River Study, April 1994.

STATION	MT-0 ML	MT-2 SC	MT-2 ML	MT-2 ML	MT-2 LL	MT-8 SL	MT-8 LL	MT-11 SL	MT-11 SL	MT-11 SL
D NUMBER	3370	3375	3378	3374	3372	3388	3386	3398	3394	3396
% LIPIDS	1.27	7.6	0.53	1.19	0.82	1.4	0.21	1.63	1.1	1.02
METHOXYCHLOR	.025U	.025U	.025U							
4,4'-DDE	.012	.0066	.0054	.0078	.037	.008U	.079	.005U	.005U	.005U
4,4'-DDD	.005	.005U	.005U	.005U	.008U	.005U	.030U	.005U	.005U	.005U
4,4'-DDT	.005	.005U	.005U	.005U	.010U	.005U	.009U	.005U	.005U	.005U

SL = Small Largemouth Bass SC = Small Channel Catfish

ML = Medium Largemouth Bass FOR = Forage

LL = Large Largemouth Bass

STATION	MT-0 FOR	MT-2 FOR	MT-7* FOR	MT-8 FOR	MT-11 FOR
D NUMBER	3382	3380	3384	3390	3392
LIPIDS	10.3	3.1	3.23	8.68	7.31
METHOXYCHLOR	.025U	.025U	.042N	.025U	.025U
4,4'-DDE	.030	.027	1.2C	.85	.022
4,4'-DDD	.005U	.066N	.47	.24	.005U
4,4'-DDT	.010U	.008U	.12	.053N	.009U

N = Presumptive evidence of presence of material.

U = Material was analyzed for but not detected; number is minimum quantitation limit.

C = Confirmed by GCMS.

* = Floodplain area between Olin Basin and river.

Table 27. Fish Health Index scores for largemouth bass. Mobile River study. October 1994.

Fish #	Station Identification								
	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10
1	90	90	60	30	90	130	90	30	120
2	90	90	90	70	120	90	90	120	90
3	120	60	30	100	60	60	90	90	90
4	60	60	60	60	60	60	60	140	60
5	30	90	30	30	30	120	30	30	90
6	90	30	60	90	0	90	120	90	60
7	90	30	90	60	60	60	90	60	60
8	60	120	60	0	0	90	60	60	60
9	120	100	90	100	60	30	30	90	30
10	60	60	90	0	0	60	60	120	30
11	30	90	30	60	60		30	90	90
12	0	90	90	120	0			90	90
13	30	40	150	90	0			90	90
14	90		60	60					90
15	60		60	8					90
16			90						90
Mean Score	68.0	73.1	71.2	63.3	41.5	79.0	68.2	84.6	76.9
Standard Deviation	34.9	28.4	30.7	35.8	39.8	30.7	30.3	32.8	24.4

Table 28. Fish Health Index Scores for channel catfish. Mobile River study. October 1994.

Fish #	Station Identification								
	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10
1	0	30	30	30	30	30	30	30	N O F I S H W E R E C O L L E C T E D
2	0	30	60	0	30	30	30	0	
3	30	30	60	60	30	60	30	30	
4	0	30	60	30	30	0	30	30	
5	50	30	60		30	30	30	30	
6	30	30	60		30	30	30	60	
7	60	30	60		30	30	30	60	
8	30	30	30		30	60	60	60	
9	30	30	60		30	30	30	30	
10	30	30	30		30	30	30	60	
11	30	60	60		30		30	30	
12	30	30	60		30		30	60	
13	30				30		30	60	
14					60		30	60	
15							30	30	
16							30	60	
Mean Score	26.9	32.5	52.5	30.0	32.1	33.0	31.9	43.1	
Standard Deviation	18.0	8.7	13.6	24.5	8.0	17.0	7.5	18.9	

Table 29. Mean and Range of TOTAL DDT concentrations in fillet and whole body samples (mg/kg)* of Largemouth Bass and Channel Catfish. Mobile River Study. April, 1994.

	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10
LMB FILLETS	0.048 .014 - .287	0.020 .013 - .030	0.025 .008 - .061	0.020 .008 - .054	0.027 .013 - .079	0.269 .014 - 1.35	0.044 .013 - .112	0.031 .008 - .074	0.011 .008 - .027
CC FILLETS	0.086 .018 - .304	0.052 .030 - .074	0.058 .014 - .137	0.053 .024 - .082	0.060 .038 - .098	0.175 .033 - .419	0.045 .020 - .111	0.028 .012 - .072	0.016 .010 - .022
LMB WHOLE BODY	0.087 .062 - .109	0.117 .064 - .190	0.129 .036 - .291	0.123 .031 - .177	0.121 .050 - .247	0.491 .075 - 1.63	0.182 .060 - .249	0.401 .030 - 1.083	0.078 .009 - .200
CC WHOLE BODY	0.092 .056 - .133	0.062 .011 - .134	0.118 .031 - .166	0.117 .037 - .285	0.105 .070 - .141	0.195 .077 - .336	0.045 .024 - .065	0.334 .021 - 1.23	0.043 .019 - .078

LMB = Largemouth Bass

CC = Channel Catfish

* = Assumed median of reported MDL value for the purpose of calculating total DDT.

Table 30. Mean and Range of mercury concentrations in fillet samples (mg/kg). Mobile River Study. November, 1993.

STATIONS										
	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10	
SC	0.03 - 0.05	0.06 - 0.23	0.06 - 0.06	0.04 - 0.10	0.05 - 0.06	0.03 - 0.09	0.06 - 0.07	0.06 - 0.07	0.05 - 0.06	0.06
MC	0.04 - 0.05	0.20 - 0.33	0.06 - 0.16	0.09 - 0.13	0.05 - 0.07	0.07 - 0.08	0.04 - 0.16	0.05 - 0.05	0.08 - 0.12	0.09
LC	0.05 - 0.07	0.13 - 0.54	0.11 - 0.19	0.09 - 0.12	0.07 - 0.10	0.08 - 0.11	0.08 - 0.15	0.06 - 0.15	0.06 - 0.08	0.07
SL	0.05 - 0.09	0.03 - 0.07	0.04	0.03 - 0.09	0.03 - 0.04	0.04 - 0.06	0.09 - 0.11	0.05 - 0.07	0.03 - 0.14	0.07
ML	0.08 - 0.12	0.12 - 0.21	0.11 - 0.19	0.07 - 0.10	0.10 - 0.11	0.07 - 0.18	0.14 - 0.21	0.09 - 0.14	0.20 - 0.29	0.25
LL	0.16 - 0.22	0.27 - 0.41	0.25 - 0.34	0.30 - 0.40	0.13 - 0.23	0.20 - 0.22	0.22 - 0.39	0.13 - 0.23	0.22 - 0.35	0.27

ND = No Detection.
 -- = One detected concentration among samples.
 SC = Small Channel Catfish
 MC = Medium Channel Catfish
 LC = Large Channel Catfish
 SL = Small Largemouth Bass
 ML = Medium Largemouth Bass
 LL = Large Largemouth Bass

Table 31. Mean and Range of mercury concentrations in whole body samples (mg/kg). Mobile River Study, November, 1993.

STATION	MT-0	MT-2	MT-3	MT-4	MT-5	MT-7	MT-8	MT-9	MT-10
FORAGE	.023 .02 - .03	.027 .02 - .03	.025 ND - .03	.025 ND - .03	.025 ND - .02	.033 .02 - .05	.033 ND - .07	.033 ND - .01	.033 ND
LMB	.14 .06 - .32	.751 .12 - 2.5	.106 .04 - .24	.216 .04 - .63	.102 .07 - .18	.166 .03 - .44	.264 .17 - .46	.196 .03 - .37	.217 .03 - .46
CC	.048 .03 - .08	.096 .04 - .14	.074 .04 - .12	.13 .04 - .36	.038 .03 - .05	.052 .04 - .07	.096 .05 - .17	.084 .04 - .21	.043 .03 - .06

LMB = Largemouth Bass
 CC = Channel Catfish
 ND = No detection and excluded from the calculation of the mean.
 Average based only on measured values.

Table 32. Summary of Human Risk Level by a finding Provided in Appendix G

<u>Contaminant</u>	<u>Station</u>	<u>Risk Type</u>	<u>Bass</u>		<u>Catfish</u>		<u>Tissue Concentration</u>
DDTr	7	carcinogenic	1E-5 < risk < 1E-4		1E-5 < risk < 1E-4		mean
			risk ≈ 1E-4		1E-5 < risk < 1E-4		max
		toxic (non-carcinogenic)	0.1 < HQ < 1.0		0.1 < HQ < 1.0		mean
			1.0 < HQ < 10.0		0.1 < HQ < 1.0		max
Mercury	2	toxic (non-carcinogenic)	0.1 < HQ < 1.0		0.1 < HQ < 1.0		mean
			0.1 < HQ < 1.0		HQ < 1.0		max

Above calculations based on these fillet concentrations (mg/kg)

DDTr	Station 7	average	0.517	0.302
		max	1.35	0.0409
Mercury	Station 2	average	0.36	0.28
		max	0.41	0.54

Table 33.
Hazard Quotient Calculations with Supporting
Documentation for the Wood Stork (*Mycteria americana*)
ingesting Mercury-contaminated prey within the 53-mile
Mobile River Study Area, 1993-94.

LIFE HISTORY INFORMATION

Home range	32 km (794,193 acres)	US EPA, 1994b
Ingestion Rate	0.52 kg/day	US EPA, 1994b
Body Weight	2050 g	US EPA, 1994b

PREY

Forage Fish	0.022 mg/kg	Table 23
-------------	-------------	----------

NO OBSERVABLE ADVERSE EFFECT LEVEL (NOAEL)

0.01 mg/kg body weight/day	US EPA, 1994a,b
----------------------------	-----------------

DOSE CALCULATIONS (Diet (mg/kg) X Ingestion Rate (kg/day) X Area Use Factor X 1/body weight (kg))

$$0.022 \text{ mg/kg} \times 0.52 \text{ kg/day} \times 1 \times 1/2.05 \text{ kg} = 0.006 \text{ mg/kg body weight/day}$$

HAZARD QUOTIENT CALCULATIONS (Exposure concentration/NOAEL)

$$\frac{0.006 \text{ mg/kg body weight/day}}{0.01 \text{ mg/kg body weight/day}} = 0.60$$

**Table 34.
Hazard Quotient Calculations with Supporting
Documentation for the Wood Stork (*Mycteria americana*)
ingesting DDT-contaminated prey within the 53-mile
Mobile River Study Area, 1993-94.**

LIFE HISTORY INFORMATION

Home range	32 km (794,193 acres)	US EPA, 1994b
Ingestion Rate	0.52 kg/day	US EPA, 1994b
Body Weight	2050 g	US EPA, 1994b

PREY

Forage Fish	0.059 mg/kg	Table 24
-------------	-------------	----------

NO OBSERVABLE ADVERSE EFFECT LEVEL (NOAEL)

0.054 mg/kg body weight/day	US EPA, 1994a,b
-----------------------------	-----------------

DOSE CALCULATIONS (Diet (mg/kg) X Ingestion Rate (kg/day) X Area Use Factor X 1/body weight (kg))

$$0.059 \text{ mg/kg} \times 0.52 \text{ kg/day} \times 1 \times 1/2.05 \text{ kg} = 0.015 \text{ mg/kg body weight/day}$$

HAZARD QUOTIENT CALCULATIONS (Exposure concentration/NOAEL)

$$\frac{0.015 \text{ mg/kg body weight/day}}{0.054 \text{ mg/kg body weight/day}} = 0.277$$

Table 35.
Hazard Quotient Calculations with Supporting
Documentation for the Belted Kingfisher (*Ceryle alcyon*)
ingesting Mercury-contaminated prey within the 53-mile
Mobile River Study Area, 1993-94.

LIFE HISTORY INFORMATION

Home range	8041 acres	US EPA, 1994a
	2.2 km shoreline	US EPA, 1993
Ingestion Rate	0.198 kg/day	US EPA, 1994a
Body Weight	113 g	US EPA, 1994a

PREY

Forage Fish	0.022 mg/kg	Table 23
-------------	-------------	----------

NO OBSERVABLE ADVERSE EFFECT LEVEL (NOAEL)

0.01 mg/kg body weight/day	US EPA, 1994a,b
----------------------------	-----------------

DOSE CALCULATIONS (Diet (mg/kg) X Ingestion Rate (kg/day) X Area Use Factor X 1/body weight (kg))

$$0.022 \text{ mg/kg} \times 0.198 \text{ kg/day} \times 1 \times 1/0.113 \text{ kg} = 0.039 \text{ mg/kg body weight/day}$$

HAZARD QUOTIENT CALCULATIONS (Exposure concentration/NOAEL)

$$\frac{0.039 \text{ mg/kg body weight/day}}{0.01 \text{ mg/kg body weight/day}} = 3.85$$

Table 36.
Hazard Quotient Calculations with Supporting
Documentation for the Belted Kingfisher (*Ceryle alcyon*)
ingesting DDT-contaminated prey within the 53-mile
Mobile River Study Area, 1993-94.

LIFE HISTORY INFORMATION

Home range	640 acres/mi, 8041 acres	US EPA, 1994a
	2.2 km shoreline	US EPA, 1993
Ingestion Rate	0.198 kg/day	US EPA, 1994a
Body Weight	113 g	US EPA, 1994a

PREY

Forage Fish	0.059 mg/kg	Table 24
-------------	-------------	----------

NO OBSERVABLE ADVERSE EFFECT LEVEL (NOAEL)

0.054 mg/kg body weight/day	US EPA, 1994a,b
-----------------------------	-----------------

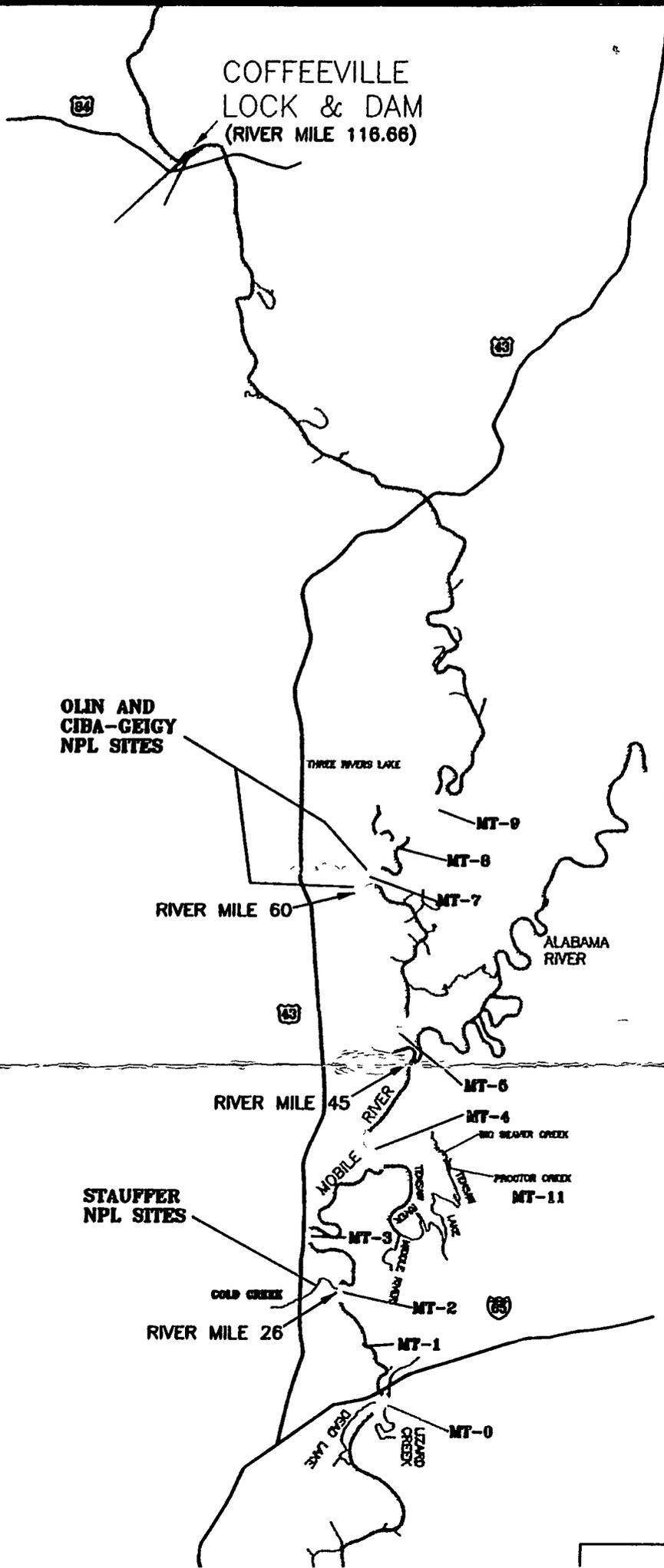
DOSE CALCULATIONS (Diet (mg/kg) X Ingestion Rate (kg/day) X Area Use Factor X 1/body weight (kg))

$$0.059 \text{ mg/kg} \times 0.198 \text{ kg/day} \times 1 \times 1/0.113 \text{ kg} = 0.103 \text{ mg/kg body weight/day}$$

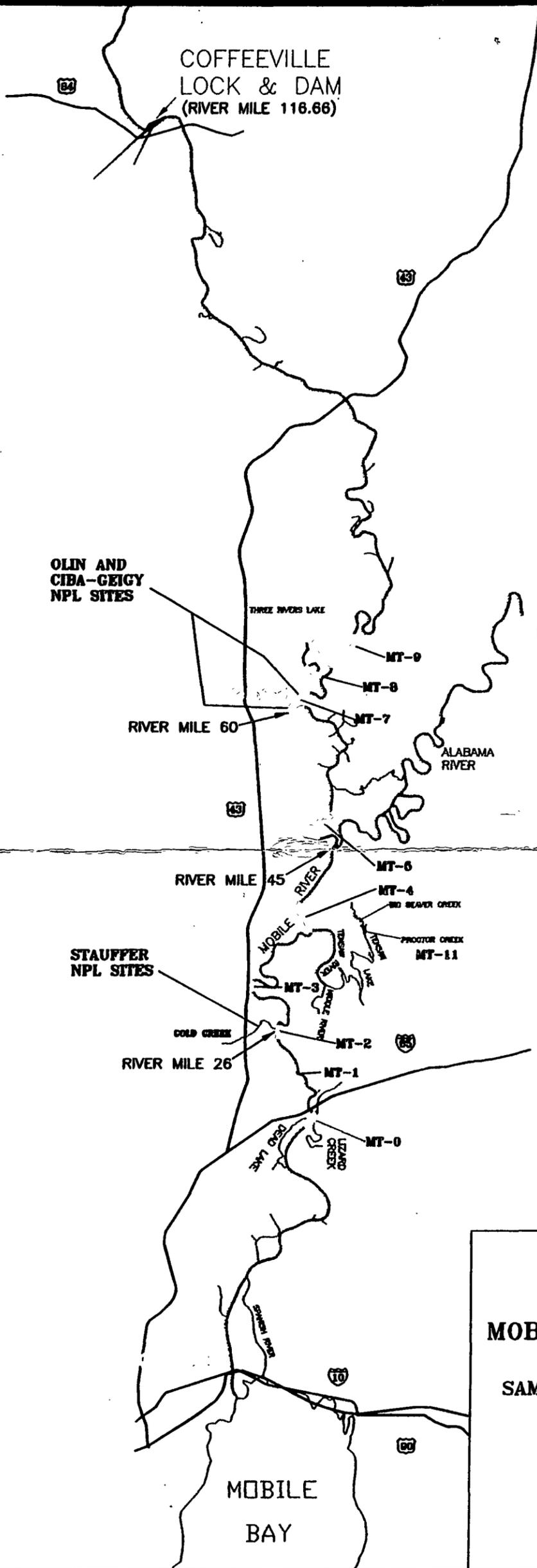
HAZARD QUOTIENT CALCULATIONS (Exposure concentration/NOAEL)

$$\frac{0.103 \text{ mg/kg body weight/day}}{0.054 \text{ mg/kg body weight/day}} = 1.91$$

FIGURES



AREA OF RIVER SAMPLED
FOR FISH



AREA OF RIVER SAMPLED FOR FISH

OLIN AND CIBA-GEIGY NPL SITES

THREE RIVERS LAKE

MT-9

MT-8

MT-7

RIVER MILE 60

43

MT-10

DIXIE LANDING NEAR CHRYSLER, AL

ALABAMA RIVER

RIVER MILE 45

MT-6

MT-4

WIL BEAVER CREEK

PROCTOR CREEK

MT-11

STAUFFER NPL SITES

MOBILE RIVER

MT-3

COLD CREEK

MT-2

RIVER MILE 26

95

MT-1

MOBILE BAY

MT-0

WIL CREEK

LIZARD CREEK

MOBILE BAY

10

90

FIGURE 1

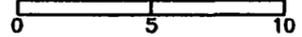
MOBILE/TOMBIGBEE RIVERS

SAMPLING STATIONS AND AREAS

MOBILE RIVER STUDY

1993-1994

SCALE IN MILES



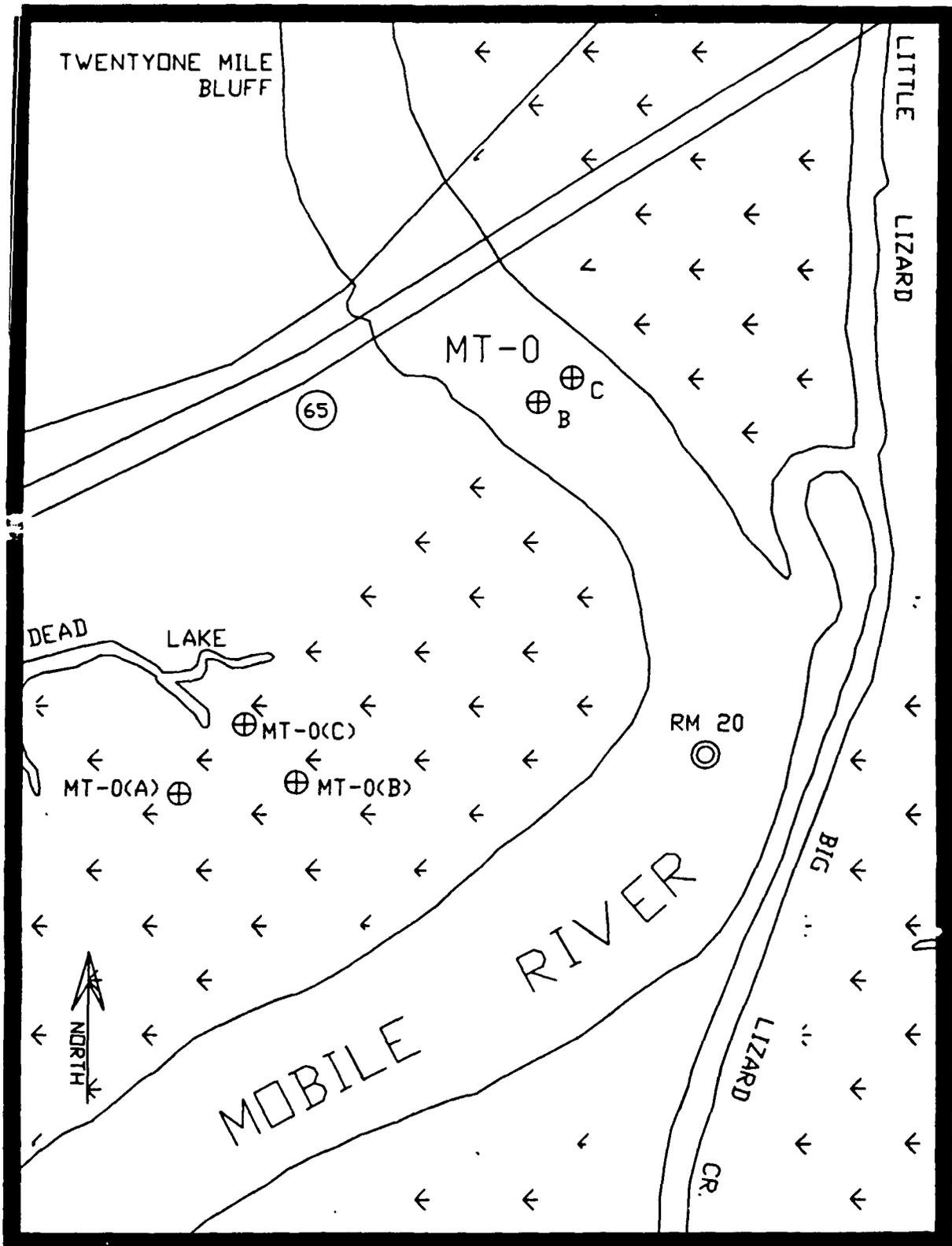


FIGURE 2

Site locations for water quality and sediment sampling in river and floodplain wetlands, station MT-0 October, 1993 and April 1994 respectively. MOBILE RIVER STUDY

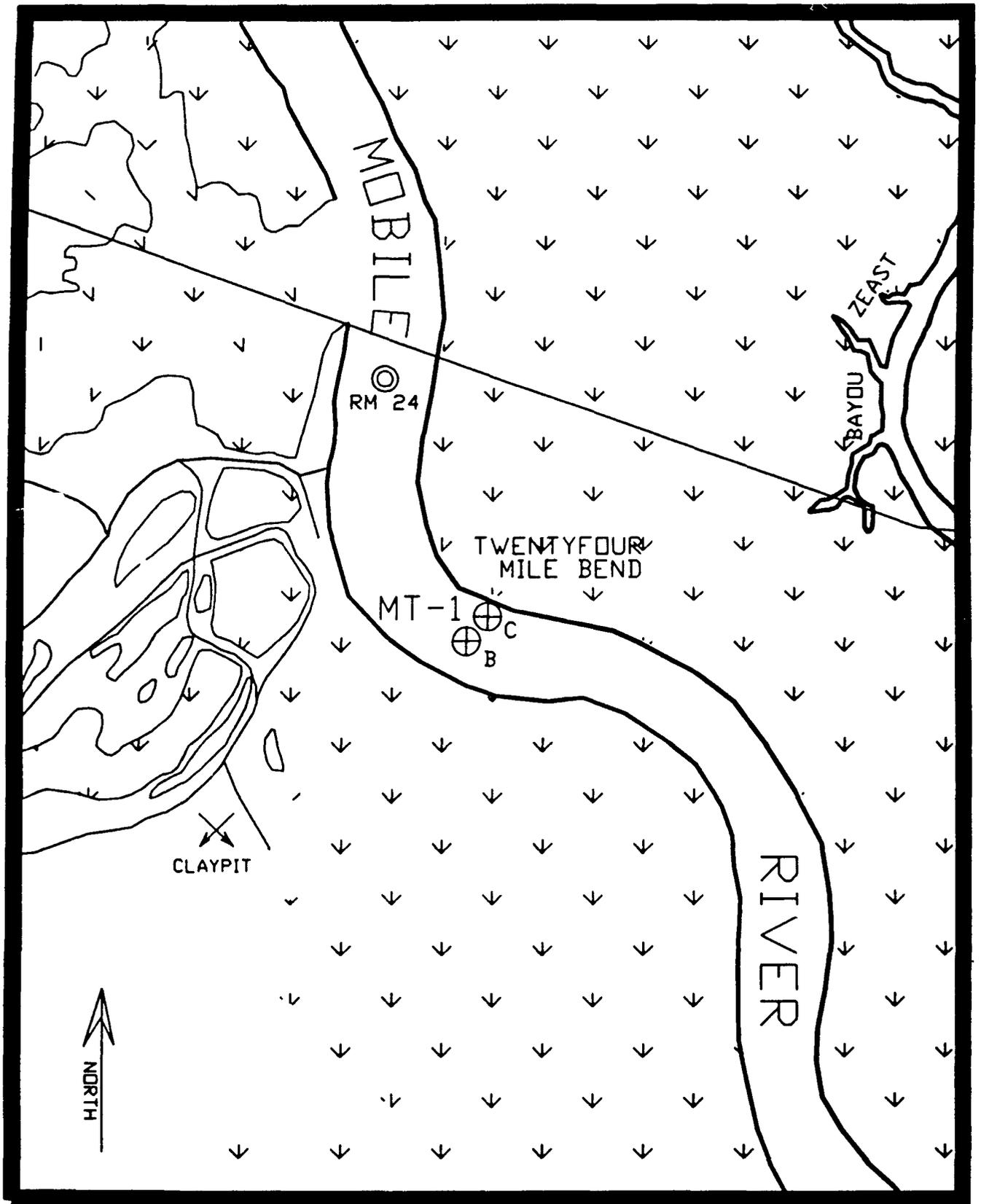


FIGURE 3

Site location for water quality and sediment sampling in the Mobile River, station MT-1, October 1993, respectively. MOBILE RIVER STUDY

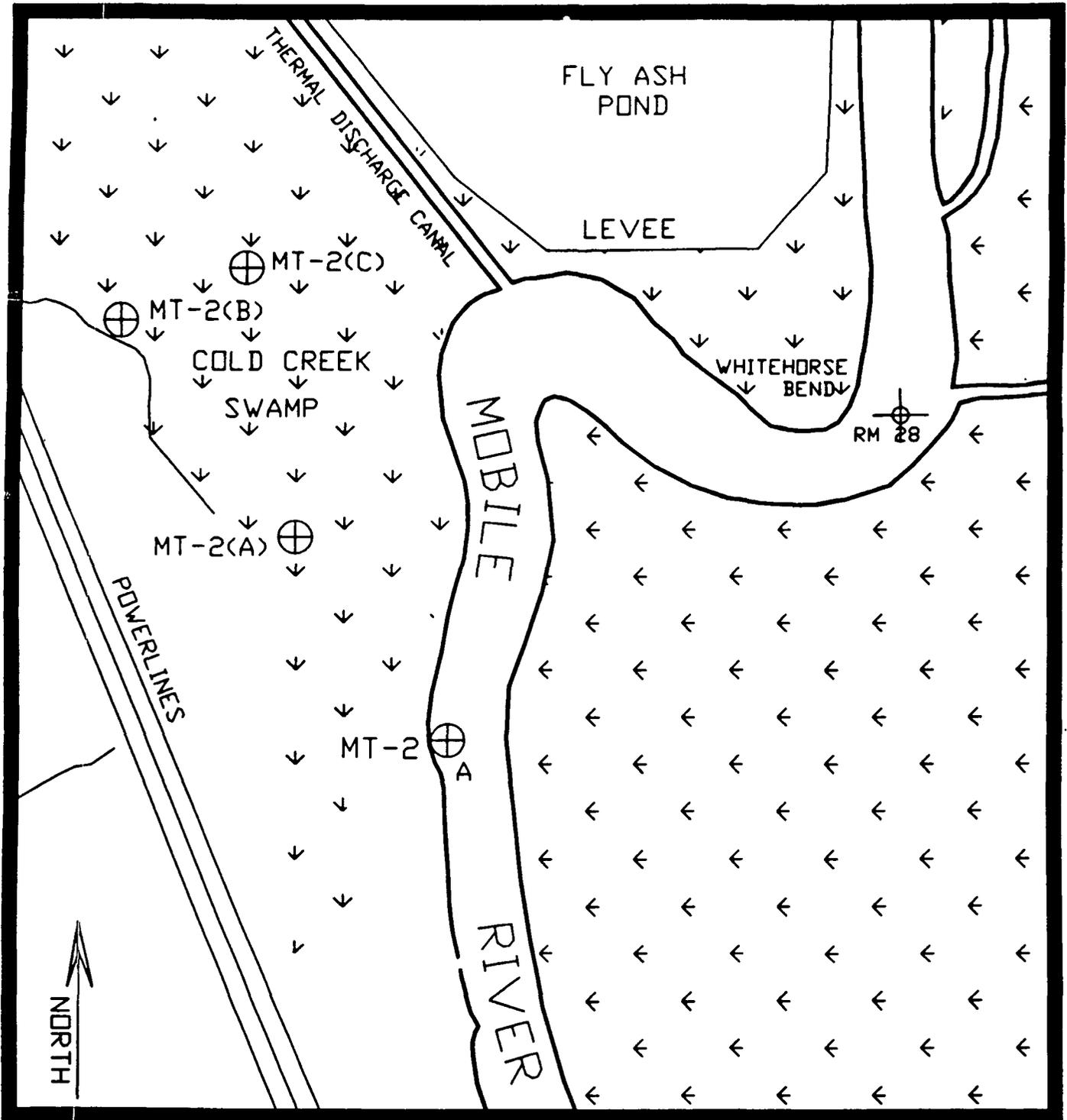


FIGURE 4

Site location for surface water and sediment sampling the river station MT-2 and in the floodplain wetlands associated with Cold Creek Swamp. October, 1993 and April, 1994 respectively. MOBILE RIVER STUDY

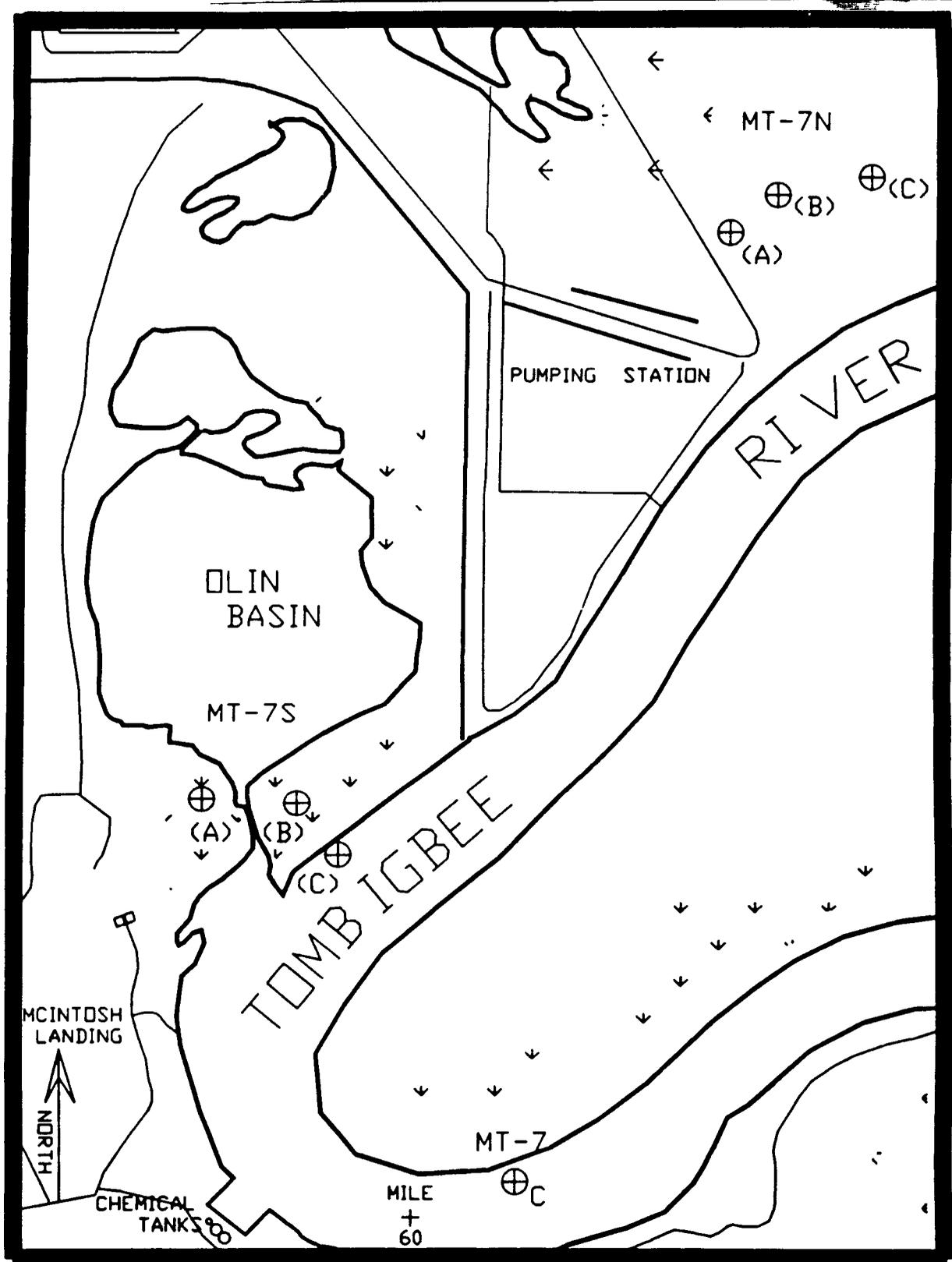


FIGURE 5

Site locations for water quality and sediment sampling in the river (MT-7), and floodplain wetlands MT-7S, and MT-7N, October 1993, and April 1994, respectively.
MOBILE RIVER STUDY

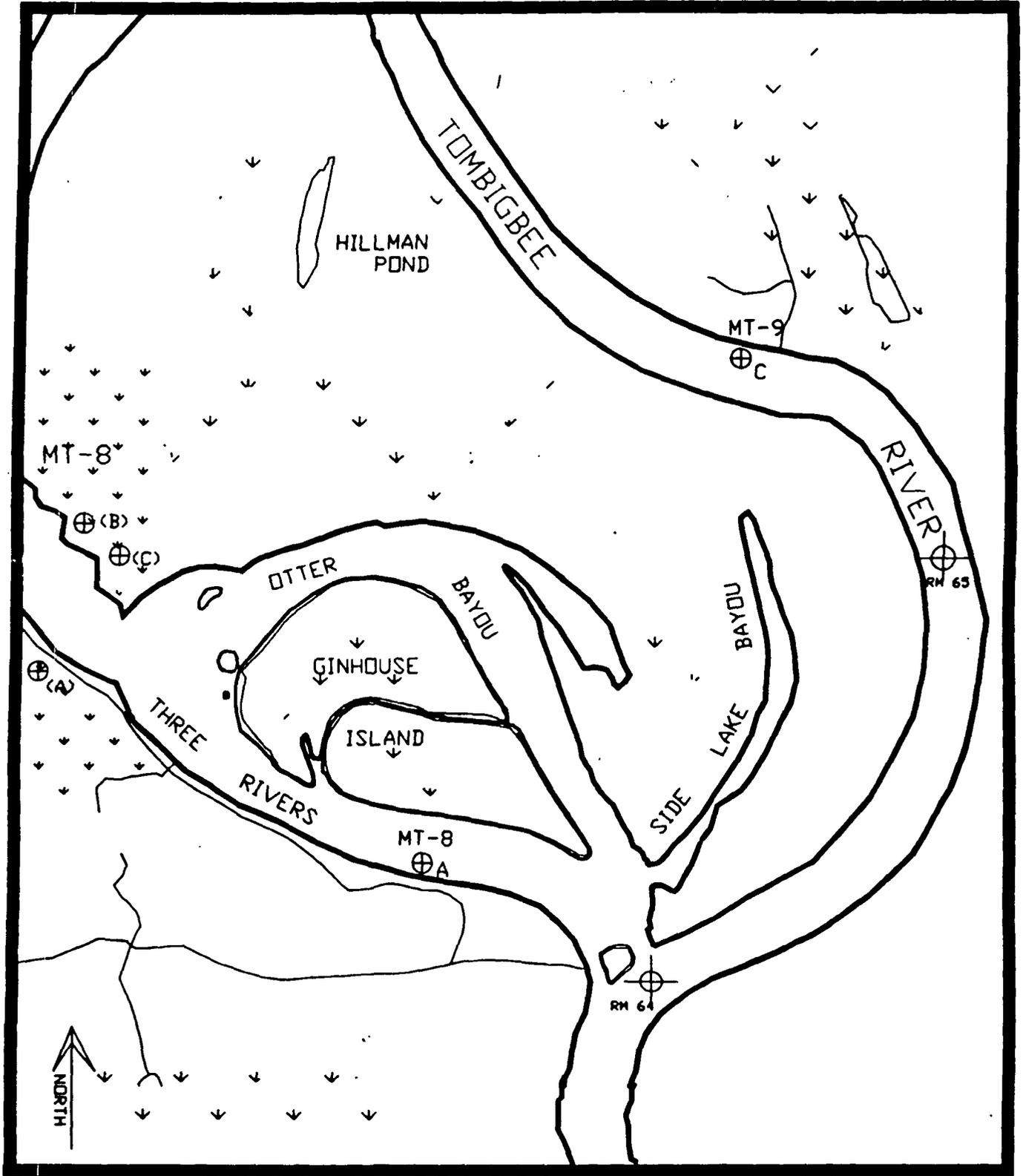


FIGURE 6

Site location for water quality and sediment sampling in the river MT-9, and MT-8, and floodplain wetlands, MT-8, October 1993 and April 1994, respectively.
MOBILE RIVER STUDY

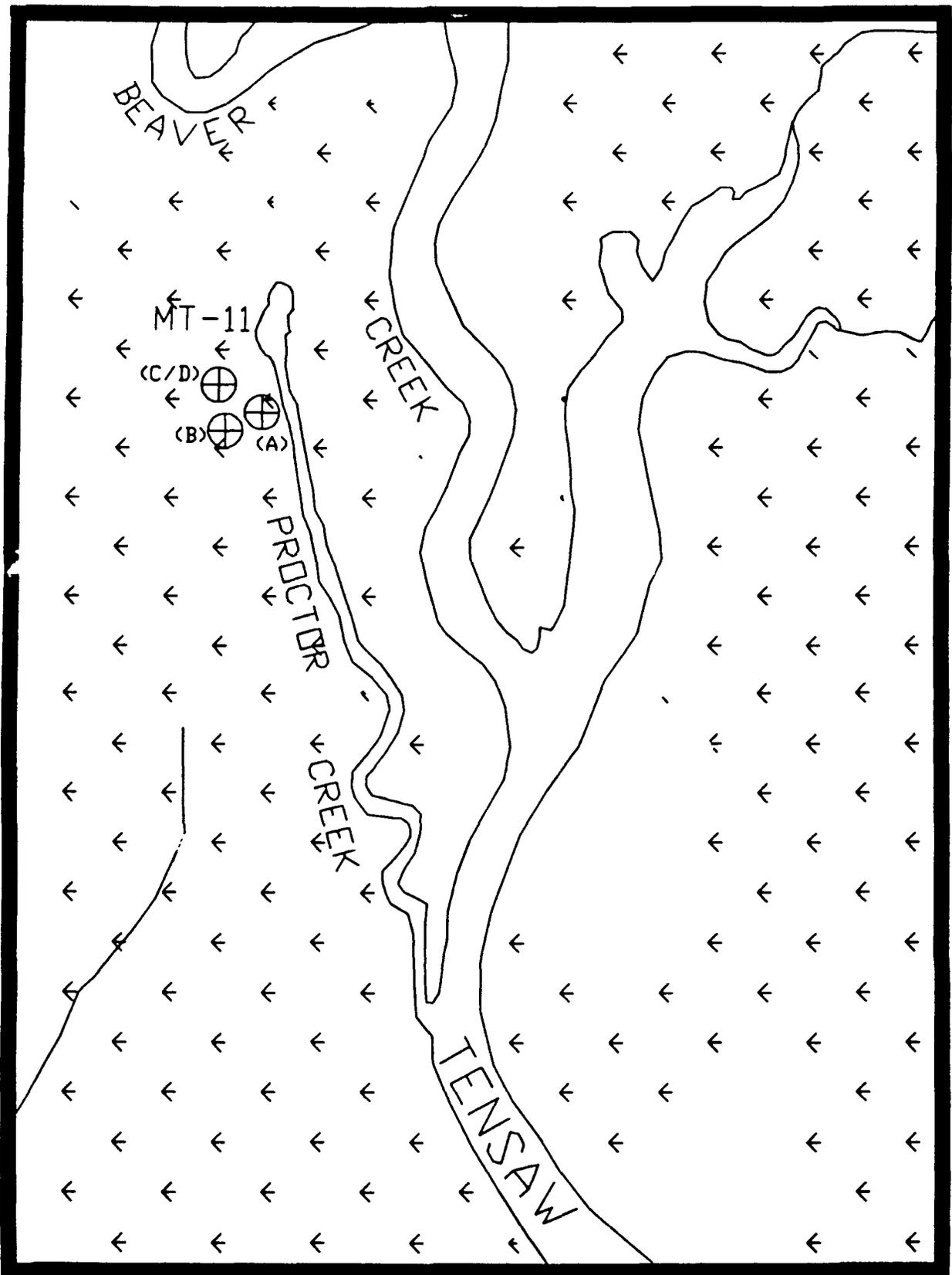


FIGURE 7

Site locations for water quality and sediment sampling in the floodplain wetlands, MT-11. April 1994. Tensaw Lake area of Tensaw River. MOBILE RIVER STUDY

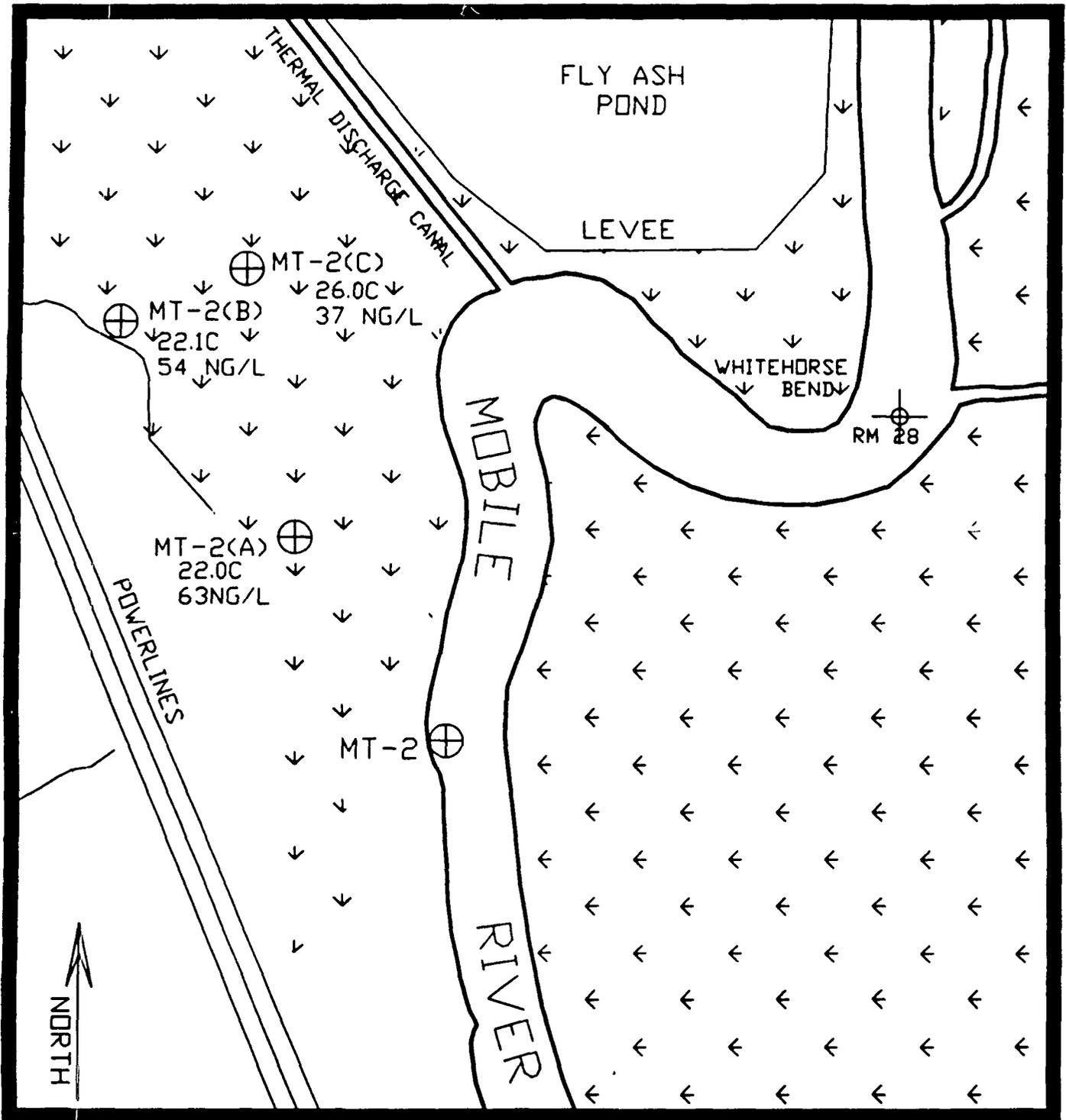


FIGURE 8

Sampling site locations and results for total mercury, and temperature readings (Centigrade) in the floodplain wetlands associated with Cold Creek Swamp, and station MT-2, April 1994. MOBILE RIVER STUDY

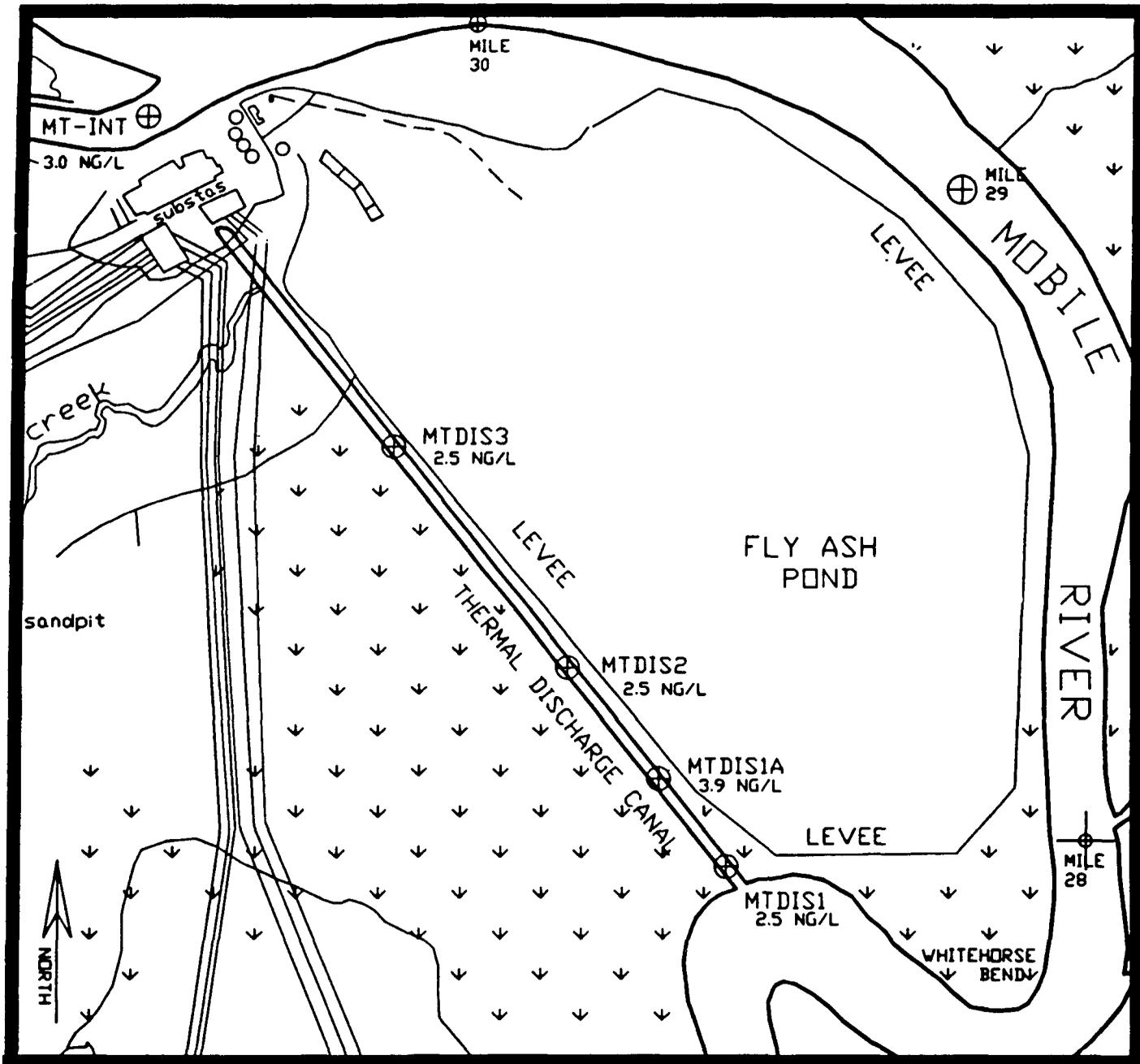


FIGURE 9

Sampling sites and results for total mercury in canal surface water, November, 1994. Barry Stream Electric Generating Facilities, cooling water return to the Mobile River. MOBILE RIVER STUDY

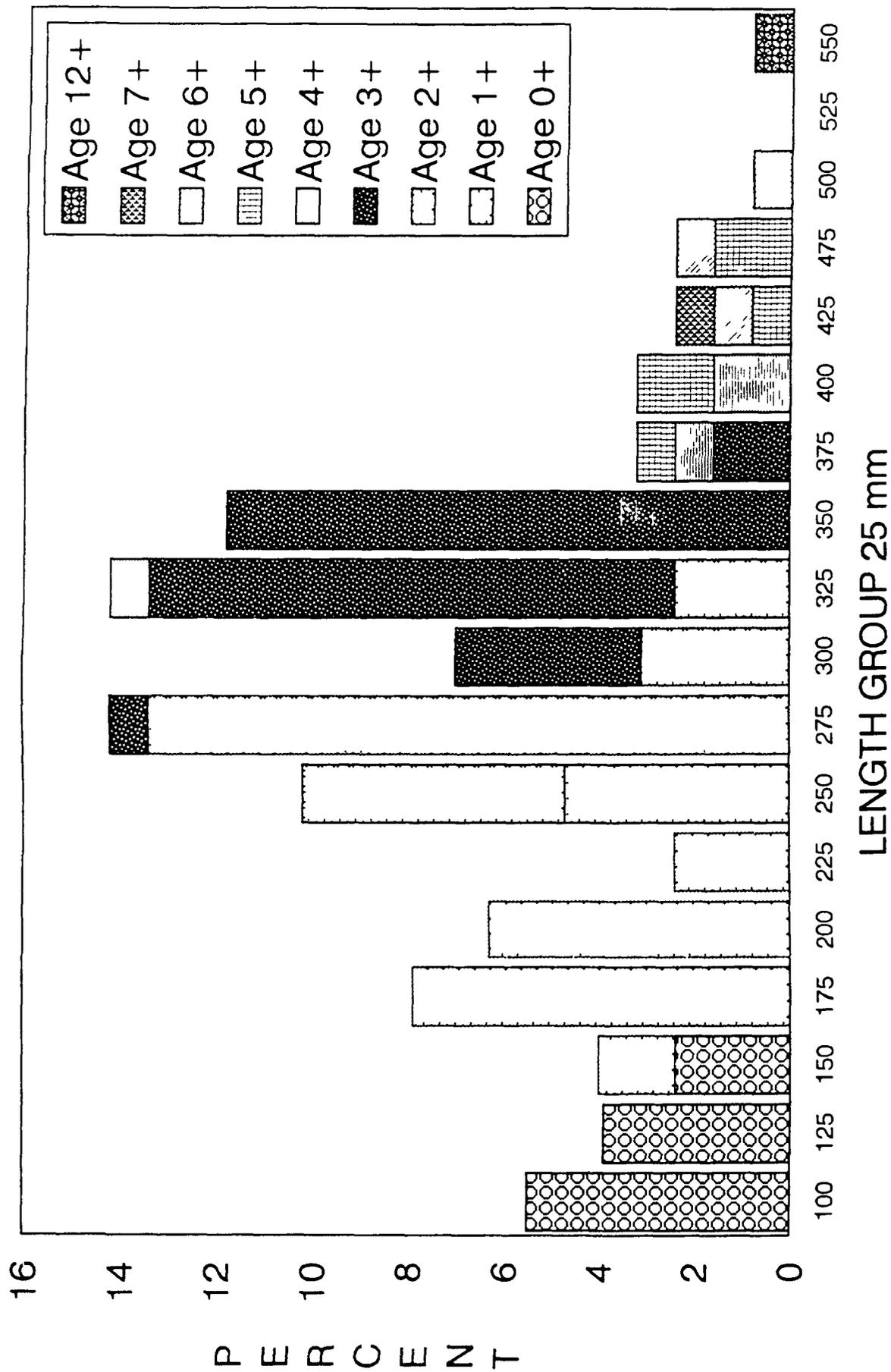
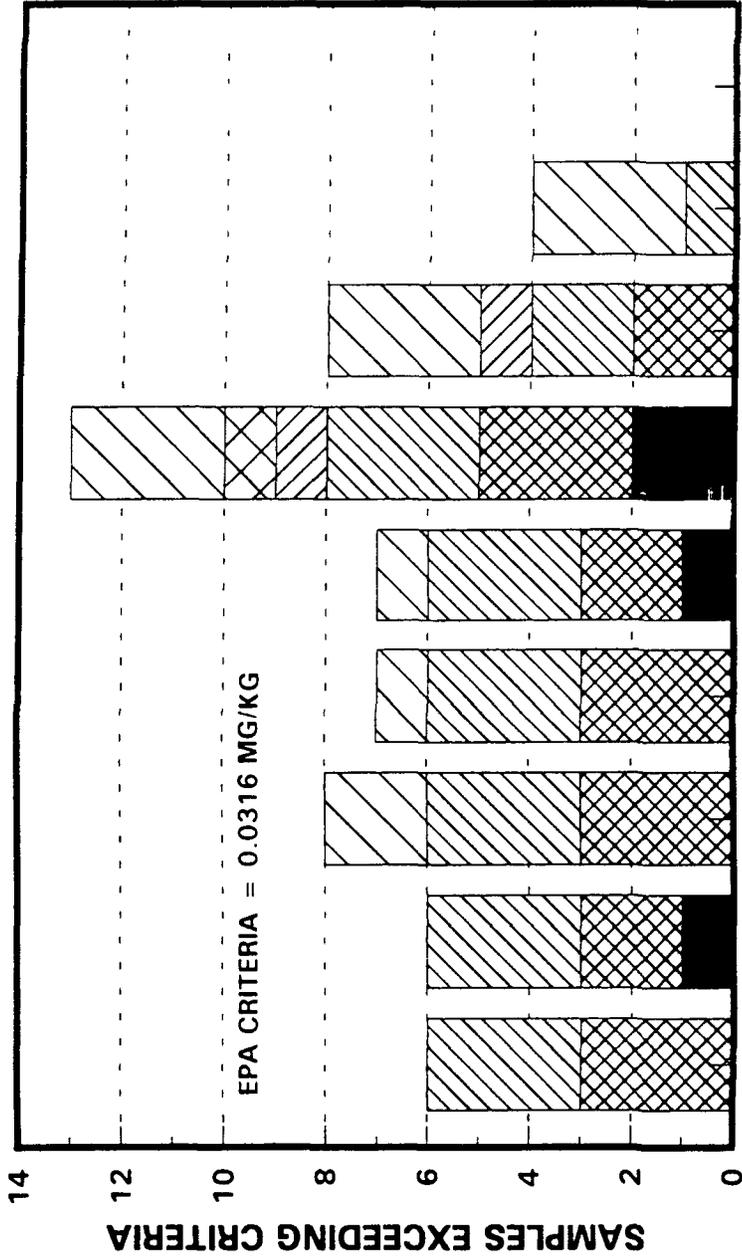


Figure 10. Length of age frequency for Largemouth Bass from the Upper Mobile Delta, Mobile River. Fall, 1991. Figure provided by the Alabama Division of Game and Fish, District 5.

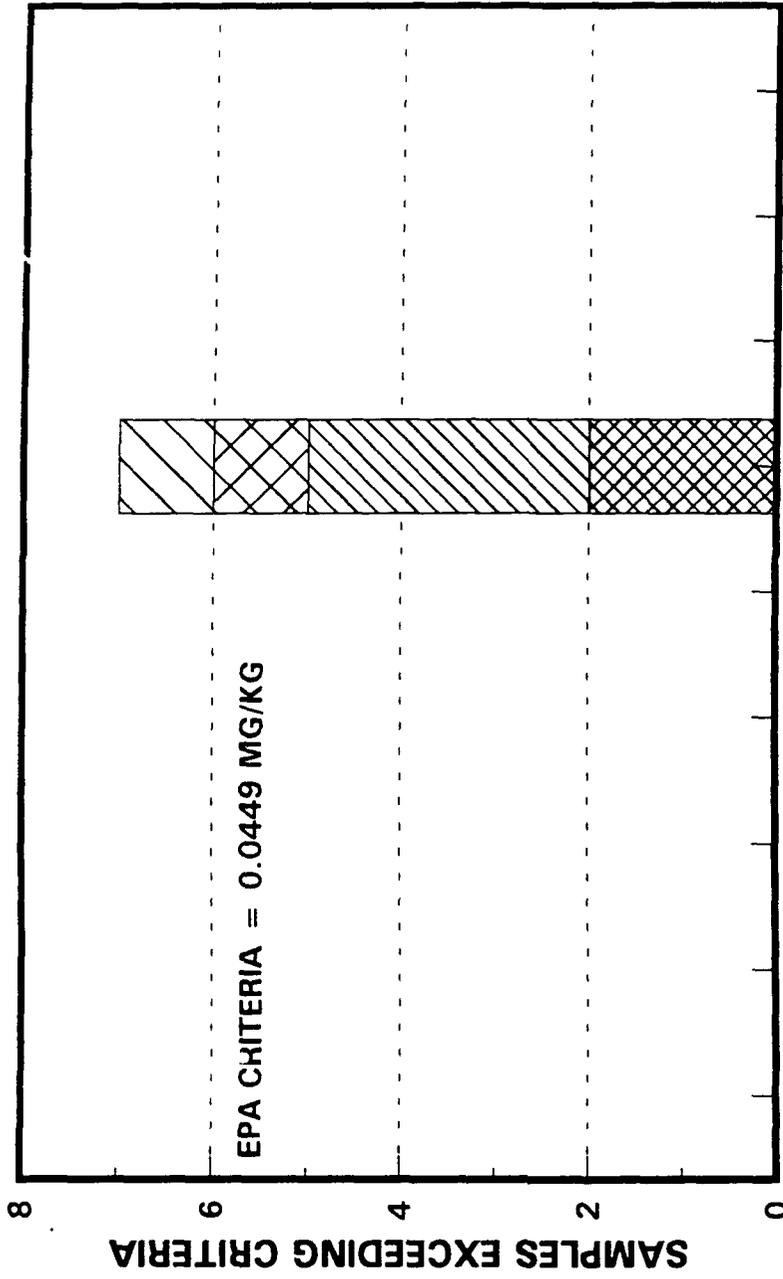
Figure 11. Fillet samples exceeding DDE criteria relative to station, species and size. Mobile River Study. Nov. 1993



MOBILE/TOMBIGBEE RIVER STATION	MT - 0	MT - 2	MT - 3	MT - 4	MT - 5	MT - 7	MT - 8	MT - 9	MT - 10
CC SM	0	1	0	0	1	2	0	0	0
CC MED	3	2	3	3	2	3	2	0	0
CC LG	3	3	3	3	3	3	2	1	0
LMB SM	0	0	0	0	0	1	1	0	0
LMB MED	0	0	0	0	0	1	0	0	0
LMB LG	0	0	2	1	1	3	3	3	0

CC (CHANNEL CATFISH)
LMB (LARGE MOUTH BASS)

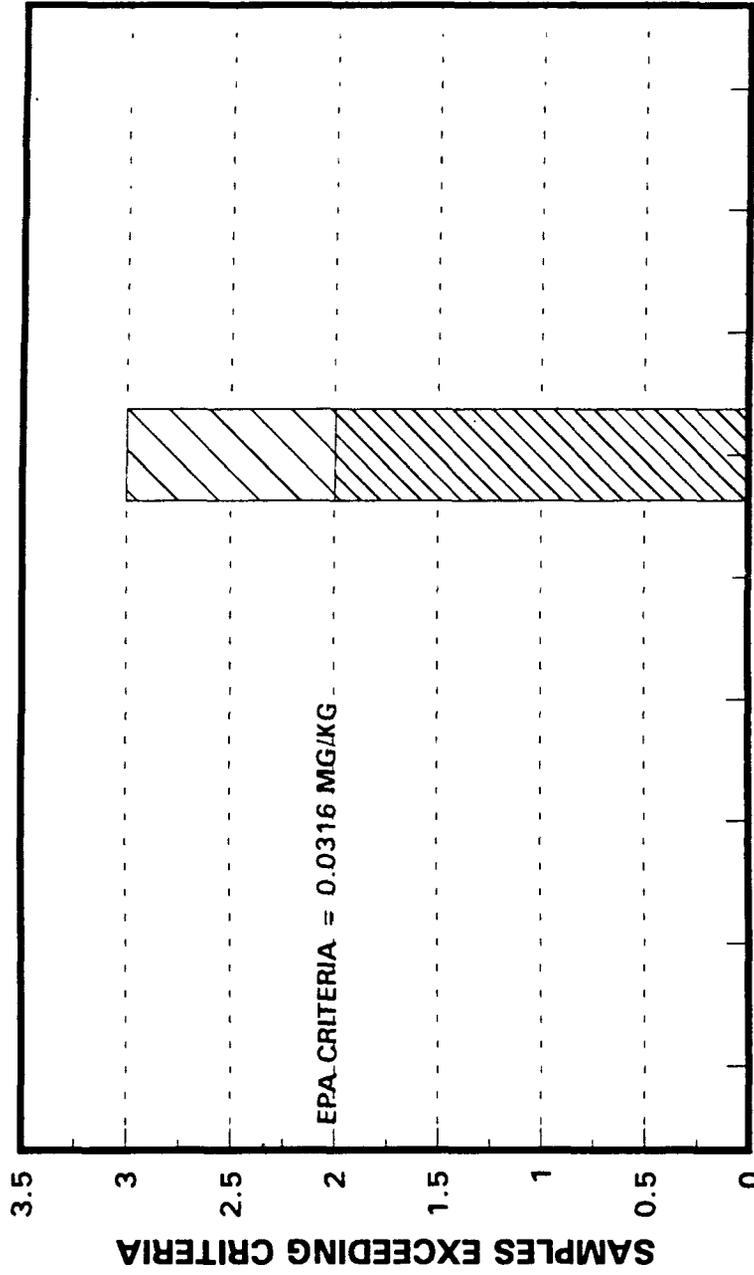
Figure 12. Fillet samples exceeding DDD criteria relative to station, species and size. Mobile River Study. Nov. 1993



MOBILE/TOMBIGBEE RIVER STATION	MT - 0	MT - 2	MT - 3	MT - 4	MT - 5	MT - 7	MT - 8	MT - 9	MT - 10
CC SM	0	0	0	0	0	0	0	0	0
CC MED	0	0	0	0	0	2	0	0	0
CC LG	0	0	0	0	0	3	0	0	0
LMB SM	0	0	0	0	0	0	0	0	0
LMB MED	0	0	0	0	0	1	0	0	0
LMB LG	0	0	0	0	0	1	0	0	0

CC (CHANNEL CATFISH)
LMB (LARGE MOUTH BASS)

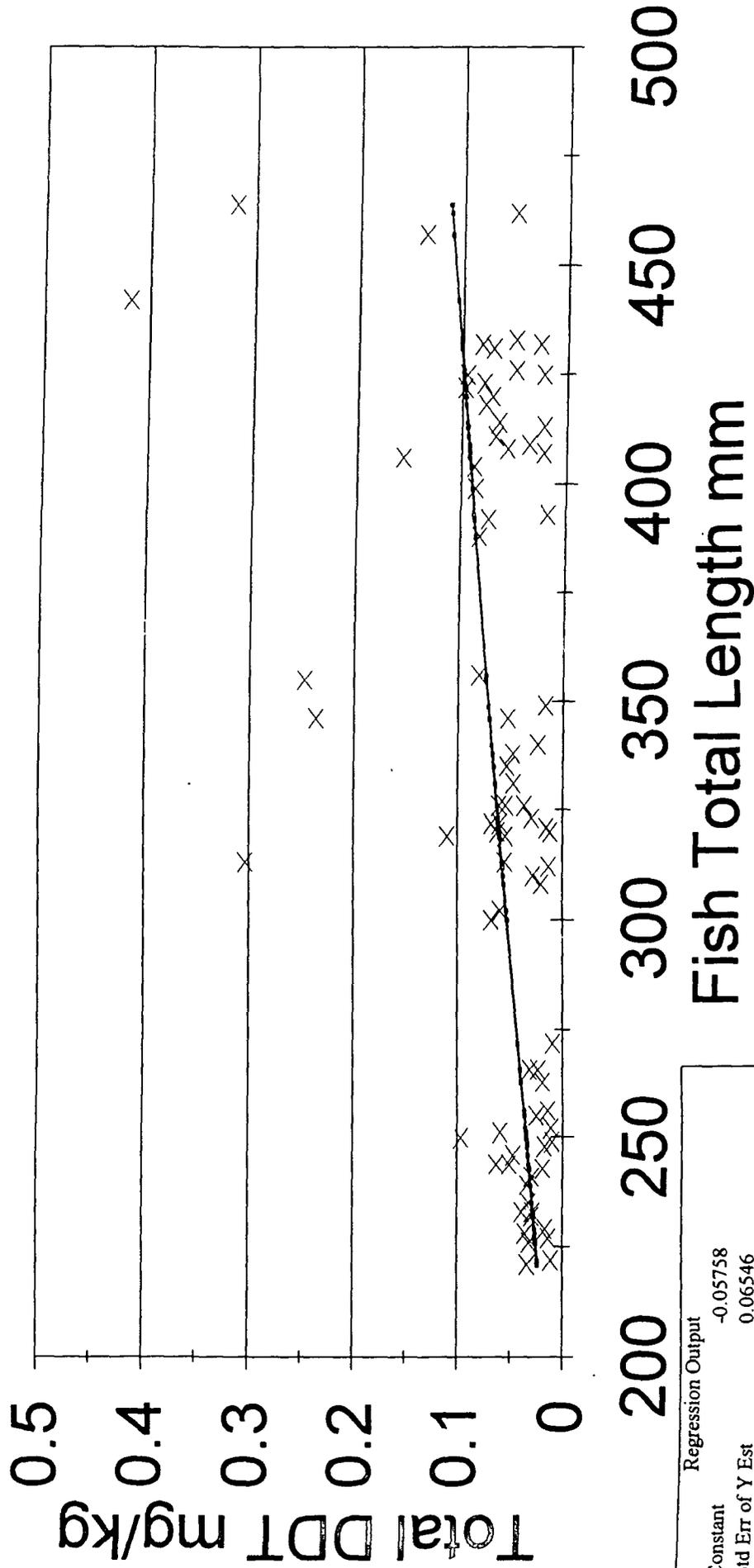
Figure 13. Fillet samples exceeding DDT criteria relative to station, species and size. Mobile River Study. Nov. 1993



MOBILE/TOMBIGBEE RIVER STATION	MT - 0	MT - 1	MT - 2	MT - 3	MT - 4	MT - 5	MT - 6	MT - 7	MT - 8	MT - 9	MT - 10
CC SM	0	0	0	0	0	0	0	0	0	0	0
CC MED	0	0	0	0	0	0	0	0	0	0	0
CC LG	0	0	0	0	0	0	0	2	0	0	0
LMB SM	0	0	0	0	0	0	0	0	0	0	0
LMB MED	0	0	0	0	0	0	0	0	0	0	0
LMB LG	0	0	0	0	0	0	0	1	0	0	0

CC (CHANNEL CATFISH)
LMB (LARGE MOUTH BASS)

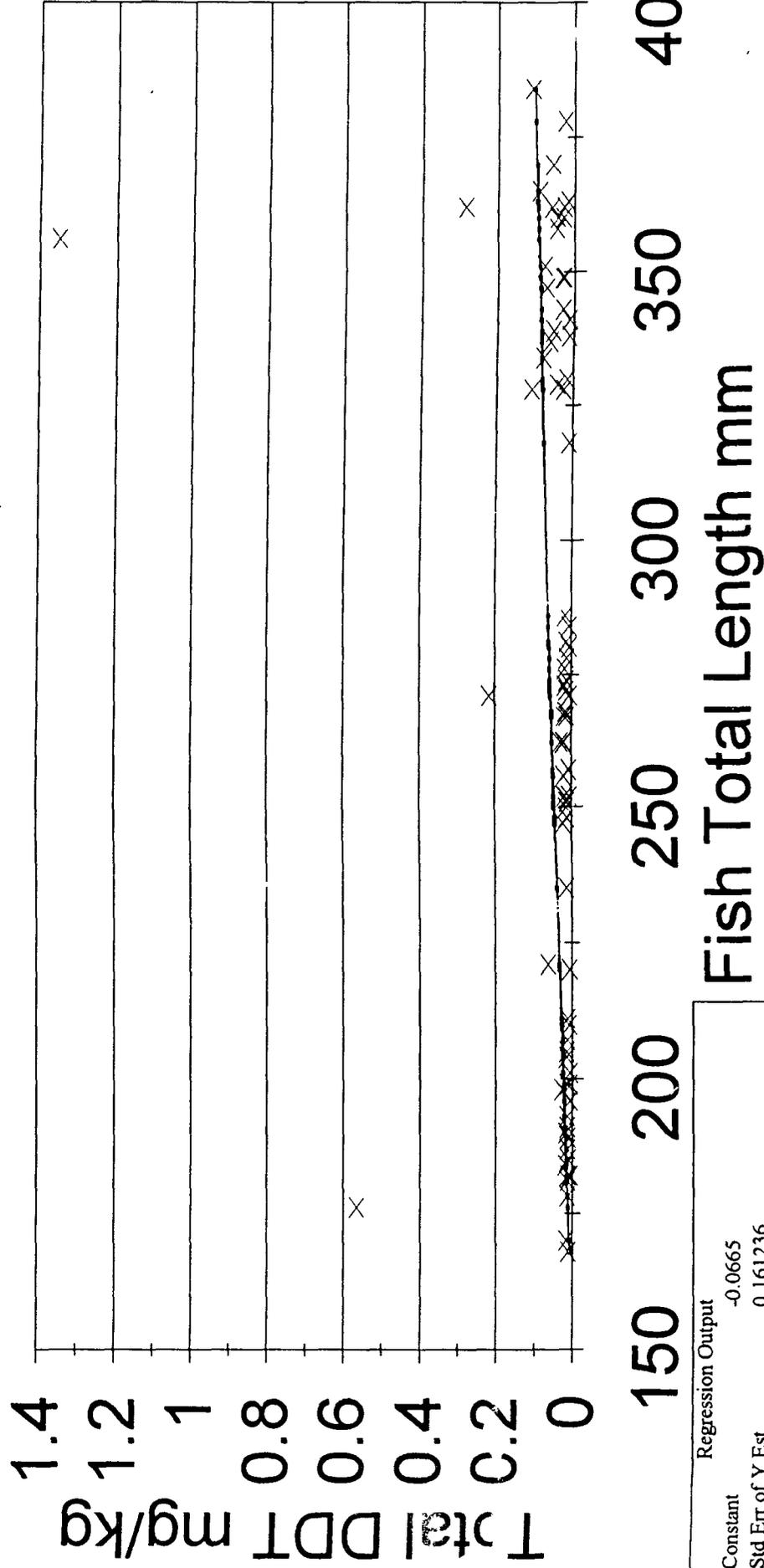
Figure 14. Relationship between Channel Catfish length and fillet concentration of total DDT. Mobile River Study. November, 1993



Regression Output	
Constant	-0.05758
Std Err of Y Est	0.06546
R Squared	0.152339
No. of Observations	81
Degrees of Freedom	79
X Coefficient	0.000369
Std Err of Coef.	9.8E-05

— Regression Line

Figure 15. Relationship between Largemouth Bass length and fillet concentration of total DDT. Mobile River Study. November, 1993



Regression Output	
Constant	-0.0665
Std Err of Y Est	0.161236
R Squared	0.033194
No. of Observations	81
Degrees of Freedom	79
X Coefficient	0.000451
Std Err of Coef.	0.000274

--- Regression Line

Figure 16. Relationship between size of Channel Catfish and fillet concentration of Mercury. Mobile River Study. November, 1993

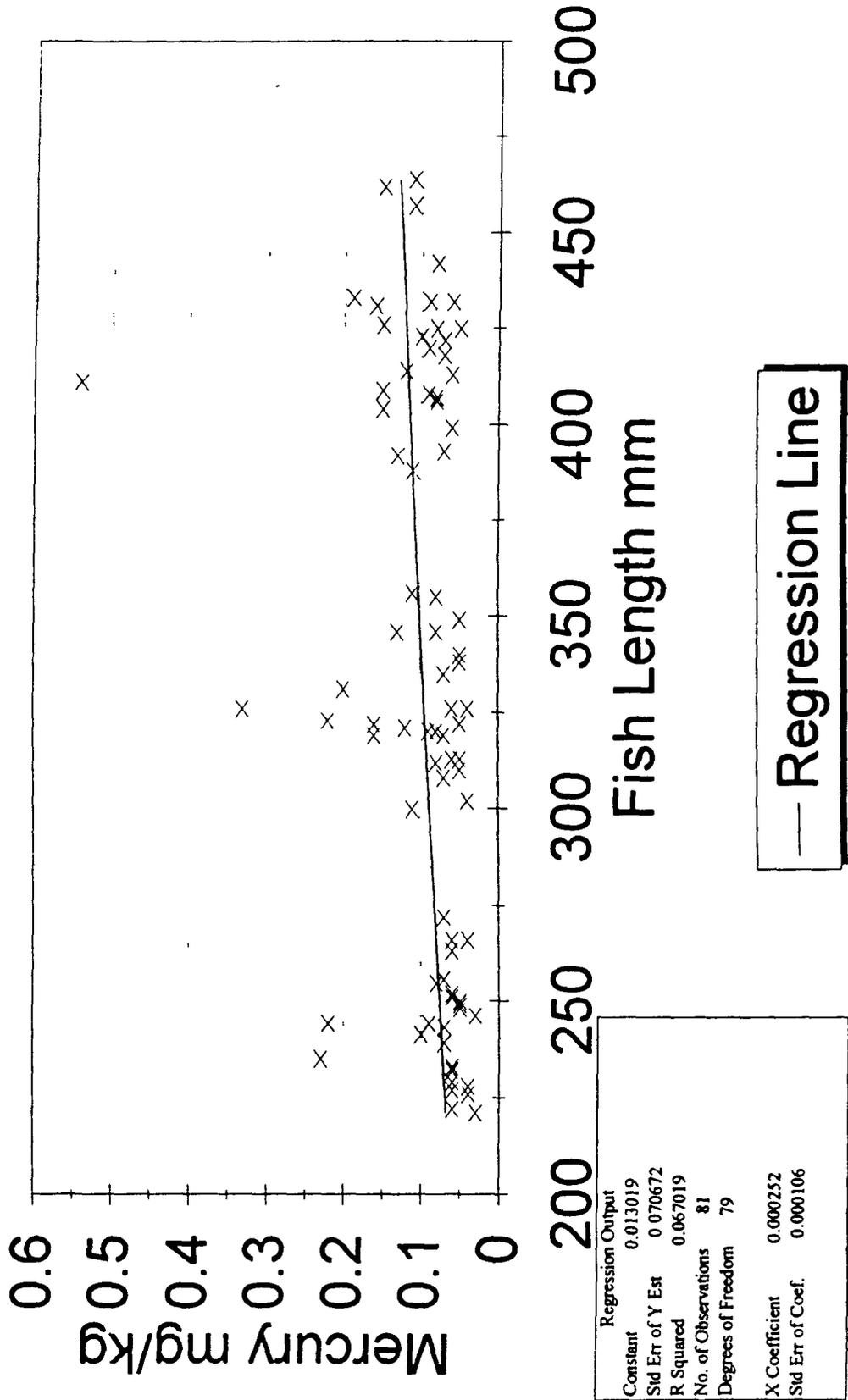
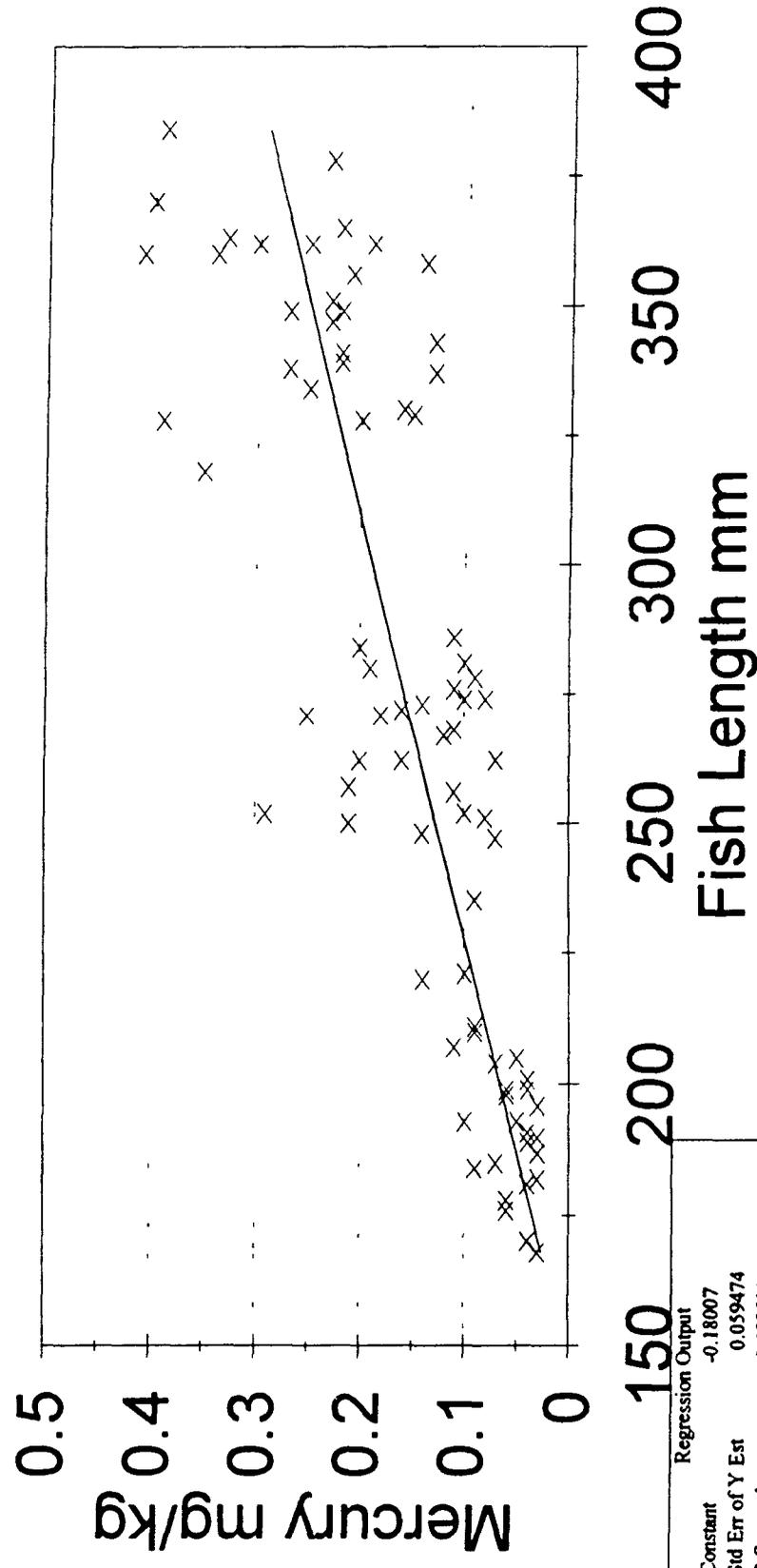


Figure 17. Relationship between size of Largemouth Bass and fillet concentration of Mercury. Mobile River Study. November, 1993



Regression Output	
Constant	-0.18007
Std Err of Y Est	0.059474
R Squared	0.652611
No. of Observations	81
Degrees of Freedom	79
X Coefficient	0.00123
Std Err of Coef.	0.000101

— Regression Line

Figure 18. Range and mean concentration of Mercury in Largemouth Bass fillet samples prepared of large fish. Mobile River Study. November, 1993

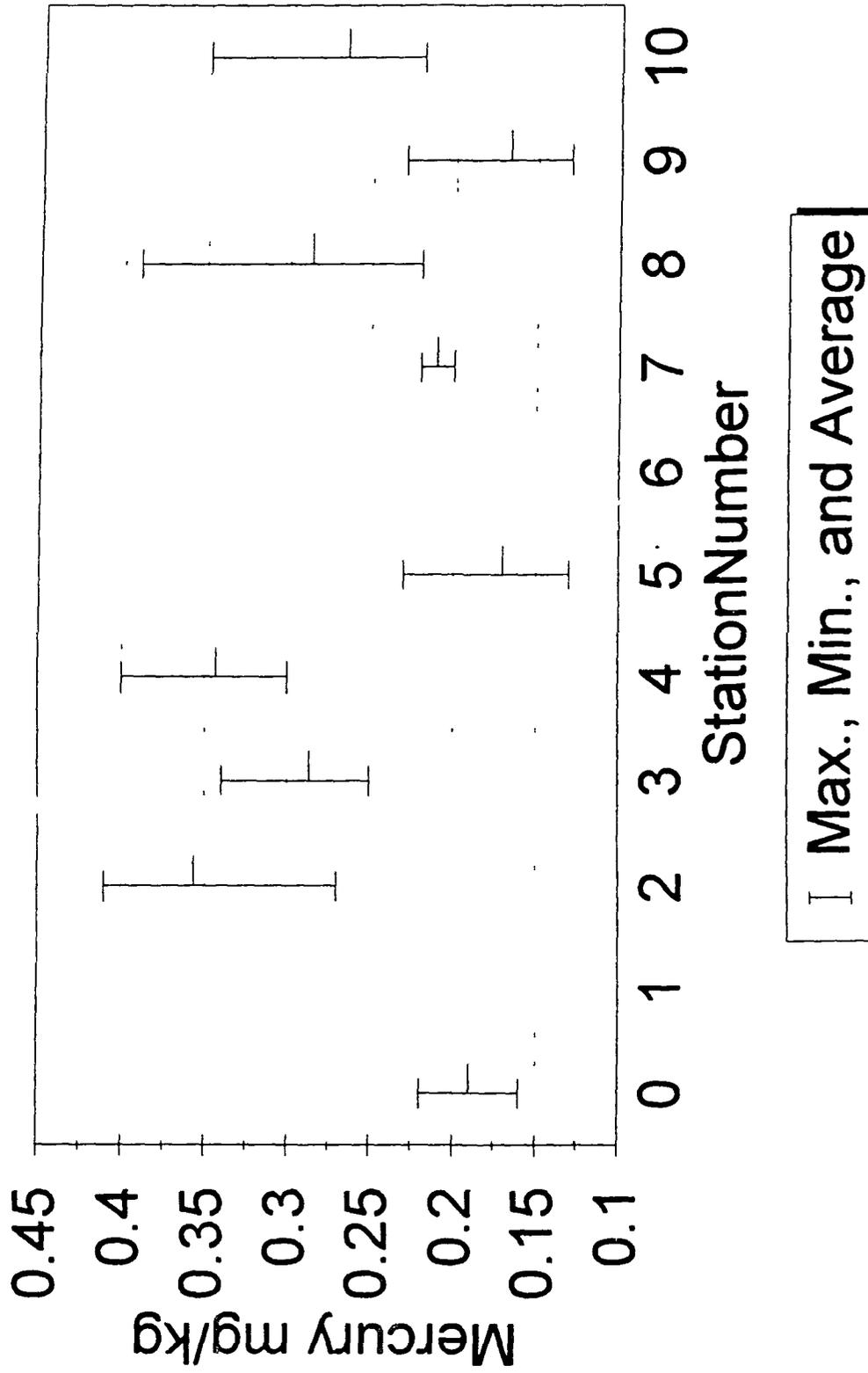
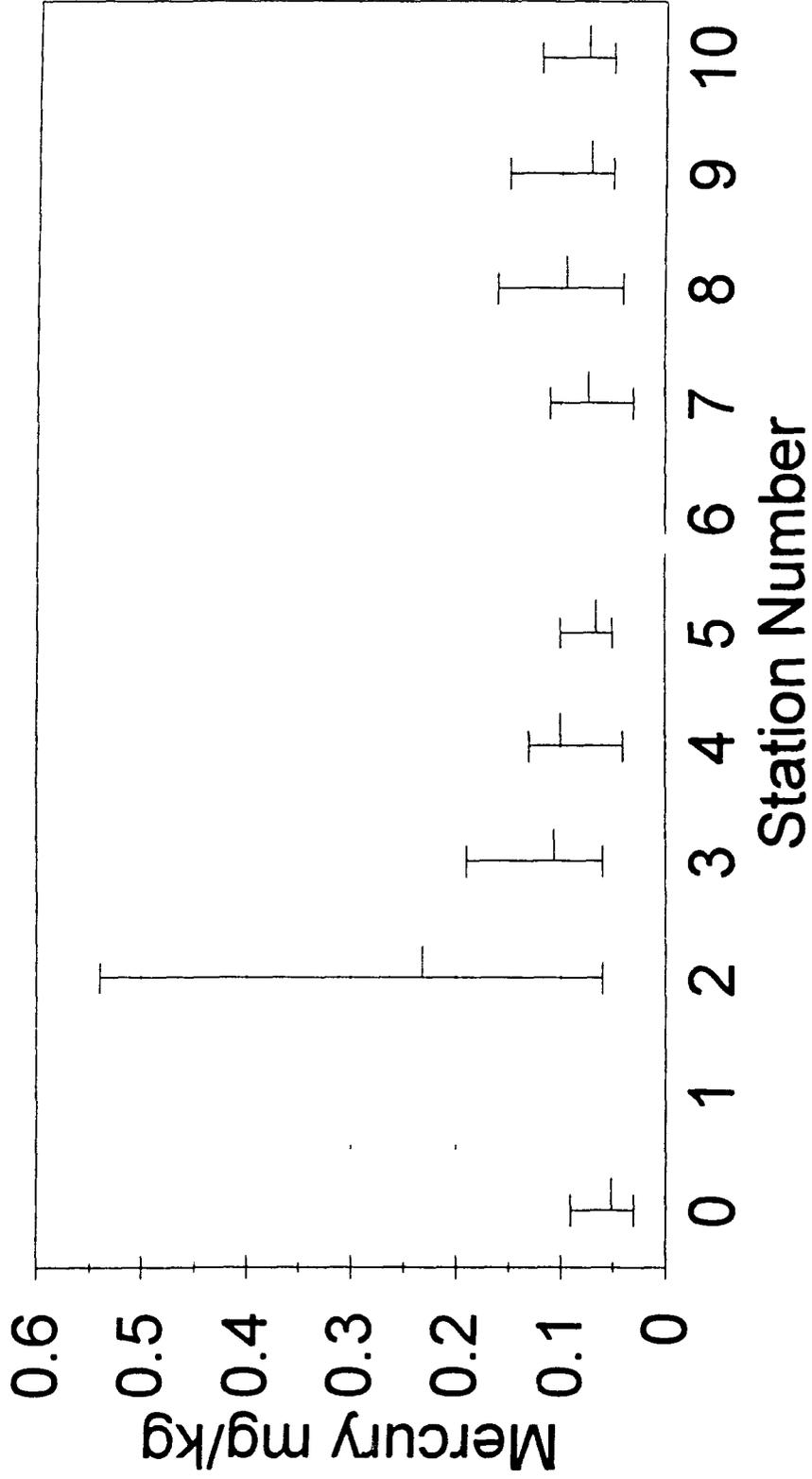
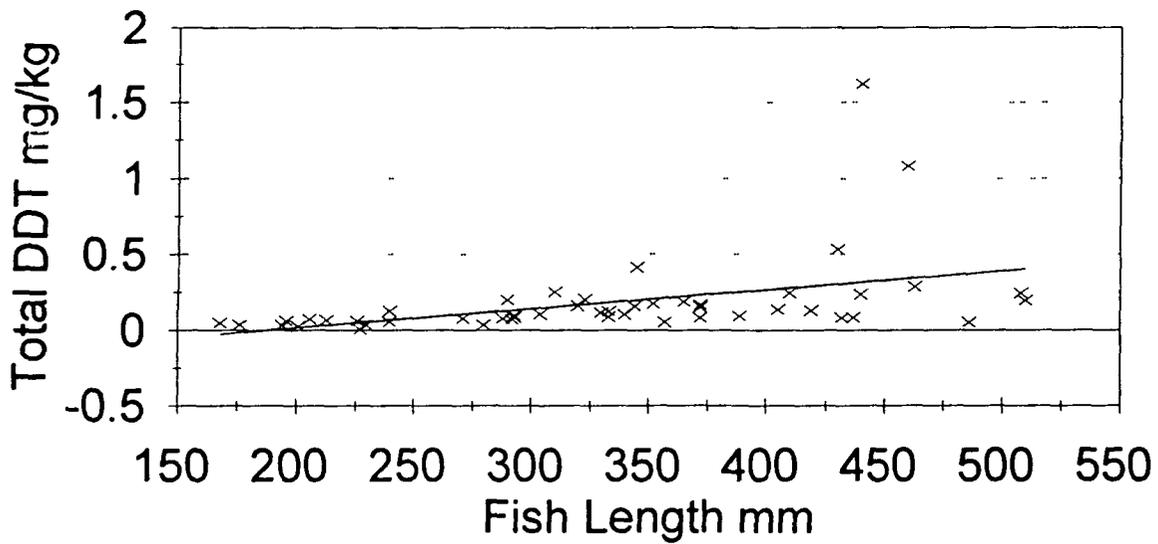


Figure 19. Range and mean concentration of Mercury in Channel Catfish fillet samples. Mobile River Study. November, 1993



I Max., Min., and Average

Figure 20 Relationship between Largemouth Bass total length and whole body concentration of total DDT. Mobile River Study. November, 1993



— Regression Line (Linear Fit)

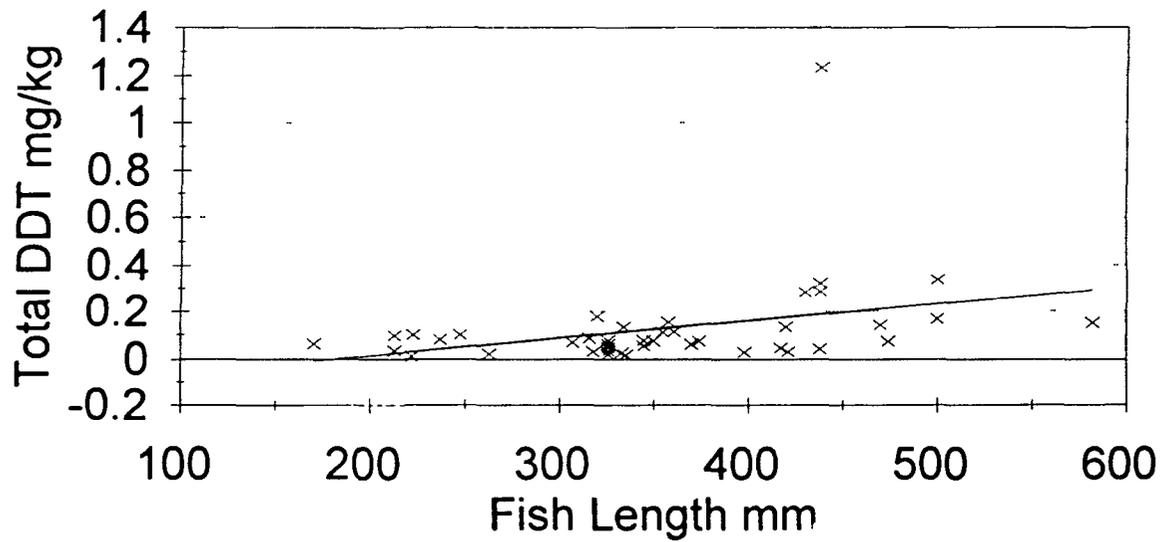
d/2

Regression Output:

Constant	-0.23125
Std Err of Y Est	0.246132
R Squared	0.181985
No. of Observations	49
Degrees of Freedom	47

X Coefficient(s)	0.00125
Std Err of Coef.	0.000387

Figure 21. Relationship between Channel Catfish total length and whole body concentration of total DDT. Mobile River Study. November, 1993



— Regression Line (Linear Fit)

d2

Regression Output:

Constant	-0.12891
Std Err of Y Est	0.183595
R Squared	0.111094
No. of Observations	42
Degrees of Freedom	40
X Coefficient(s)	0.00072
Std Err of Coef.	0.000322

Figure 22. Relationship between whole body lipid content and size of Largemouth Bass. Mobile River Study. November, 1993

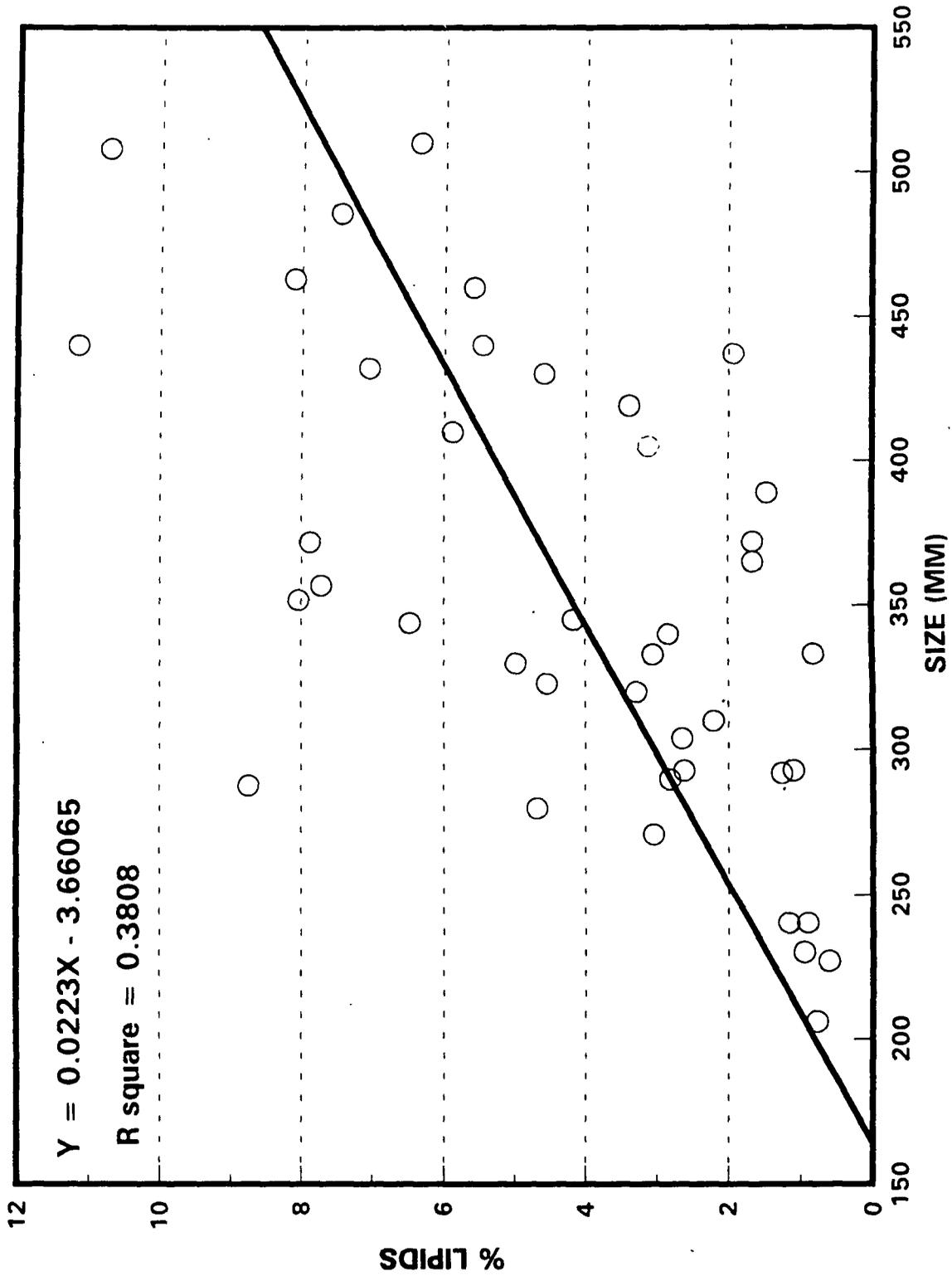


Figure 23. Relationship between whole body lipid content and size of Channel Catfish. Mobile River Study. November, 1993

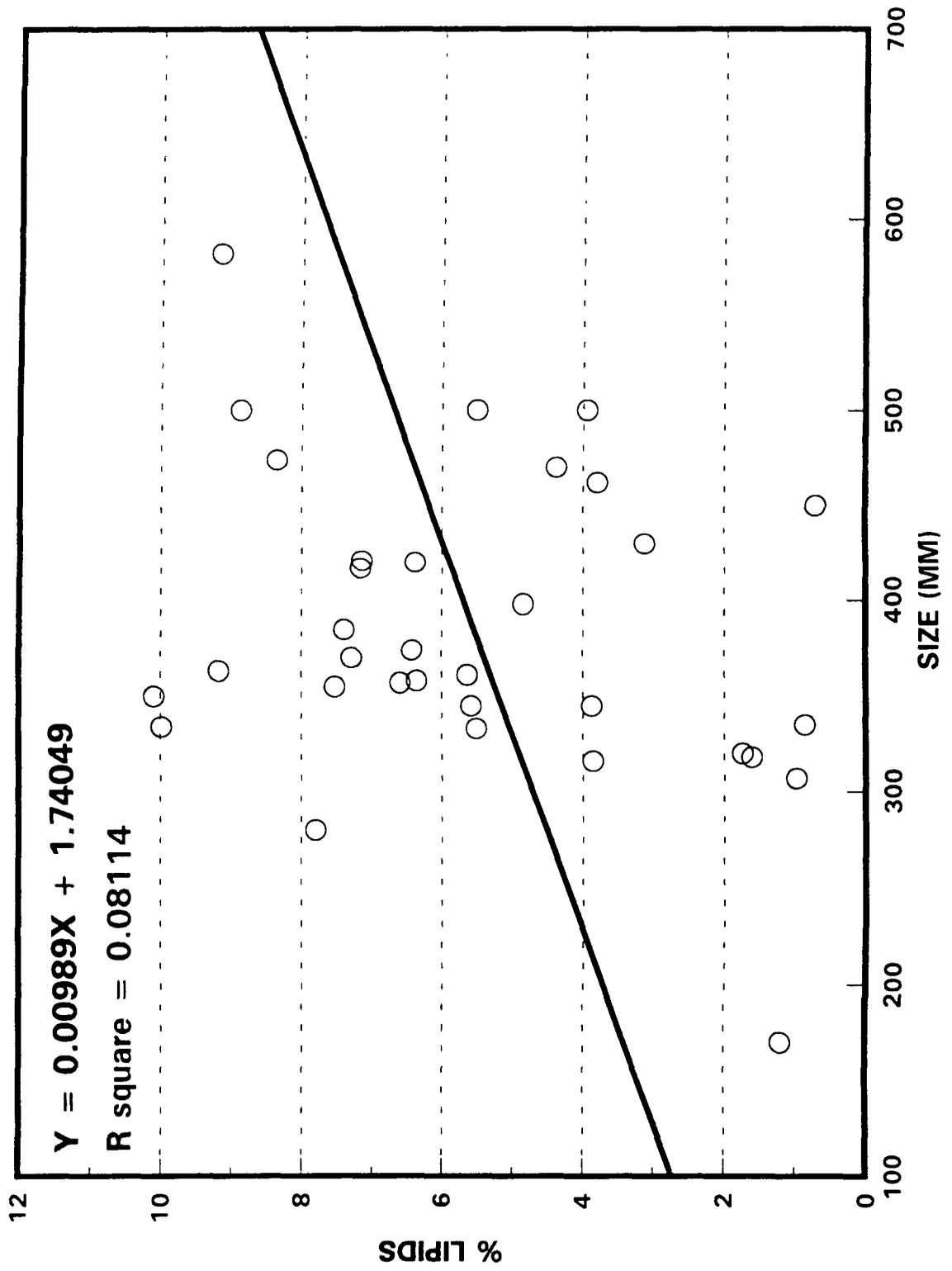
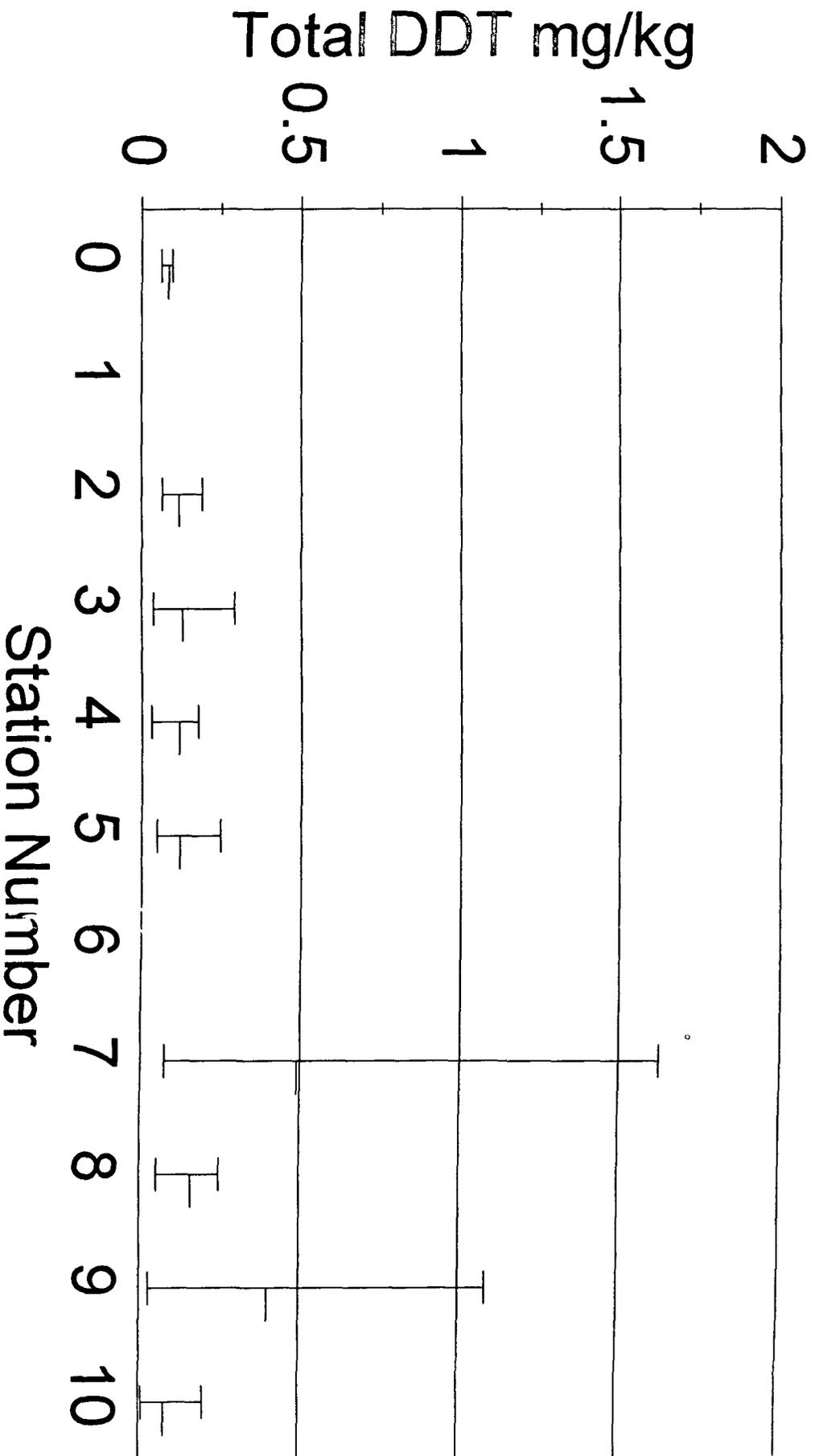
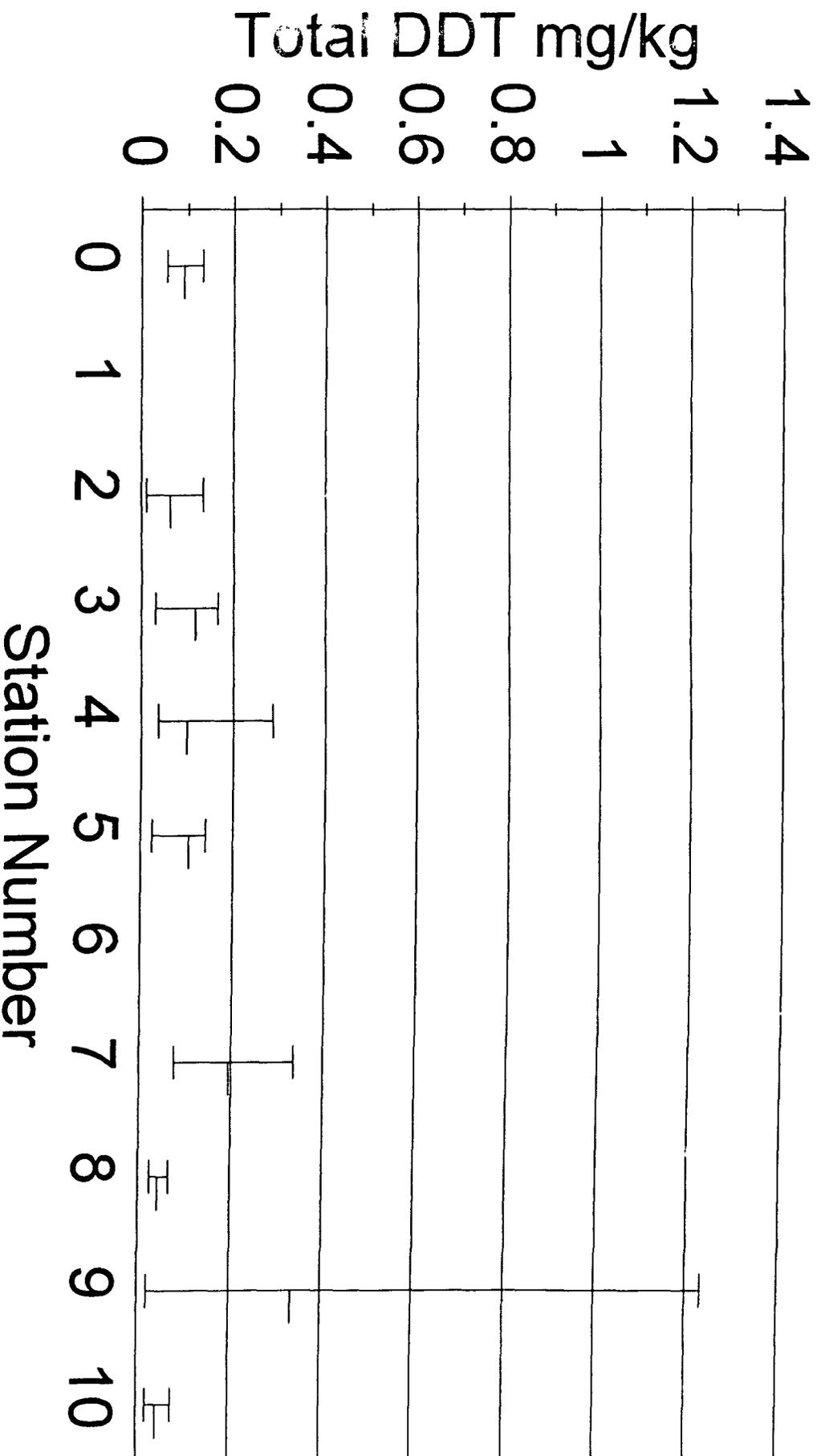


Figure 24. Average and range of total DDT concentration of Largemouth Bass whole body samples. Mobile River Study. November, 1993



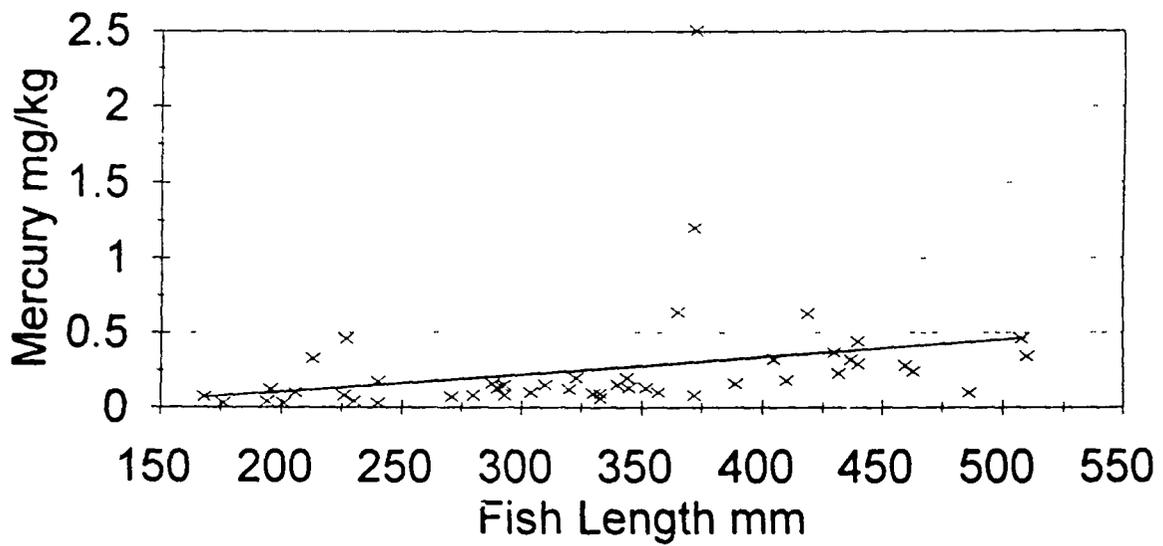
I Max., Min., and Average

Figure 25. Average and range of total DDT concentration of Channel Catfish whole body samples. Mobile River Study. November, 1993



I Max., Min., and Average

Figure 26. Relationship between size of Largemouth Bass and whole body concentration of Mercury. Mobile River Study. November, 1993

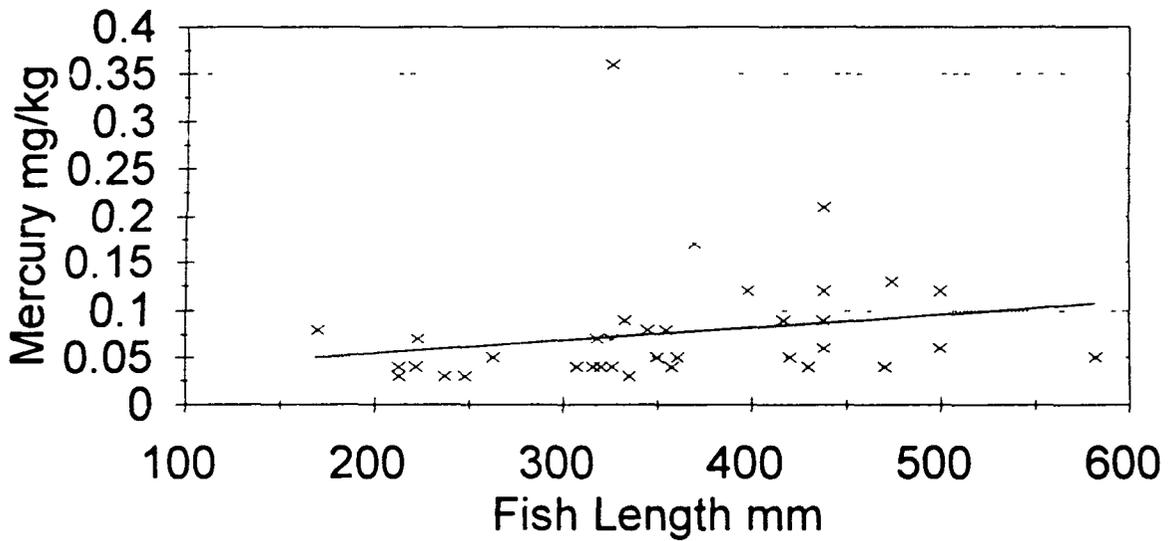


— Regression Line (Linear Fit)

Regression Output:

Constant	-0.12922
Std Err of Y Est	0.375168
R Squared	0.077047
No. of Observations	49
Degrees of Freedom	47
X Coefficient(s)	0.001167
Std Err of Coef.	0.000589

Figure 27. Relationship between size of Channel Catfish and whole body concentration of Mercury Mobile River Study November, 1993



— Regression Line (Linear Fit)

Regression Output:

Constant	0.028174
Std Err of Y Est	0.060568
R Squared	0.038533
No. of Observations	40
Degrees of Freedom	38
X Coefficient(s)	0.000131
Std Err of Coef.	0.000106

Figure 28. Average and range of mercury concentrations in Largemouth Bass whole body samples relative to sampling station Mobile River Study, November 1993.

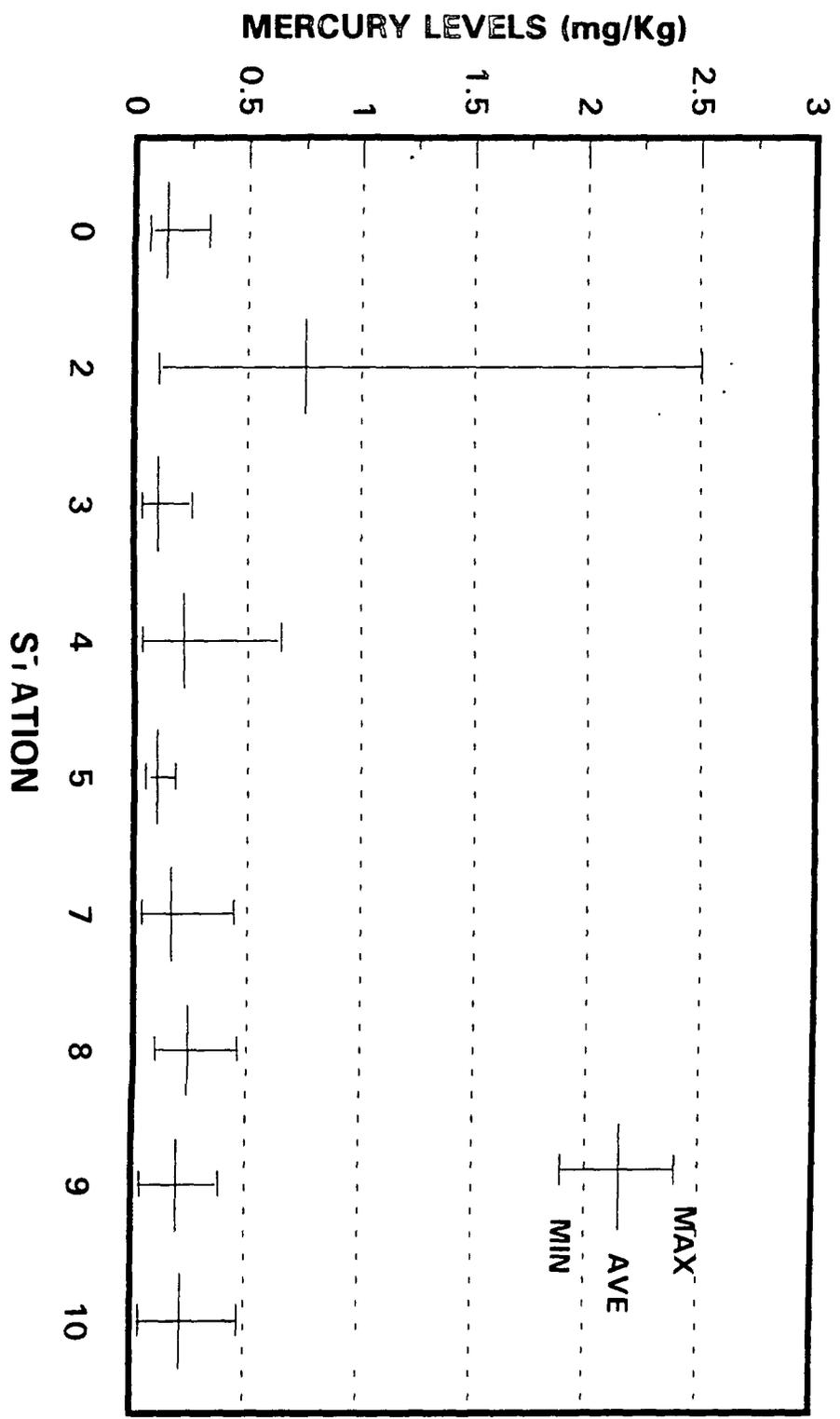


FIGURE 29. Average and range of mercury concentrations in Channel Catfish whole body samples relative to sampling station Mobile River Study. 1993 - 1994

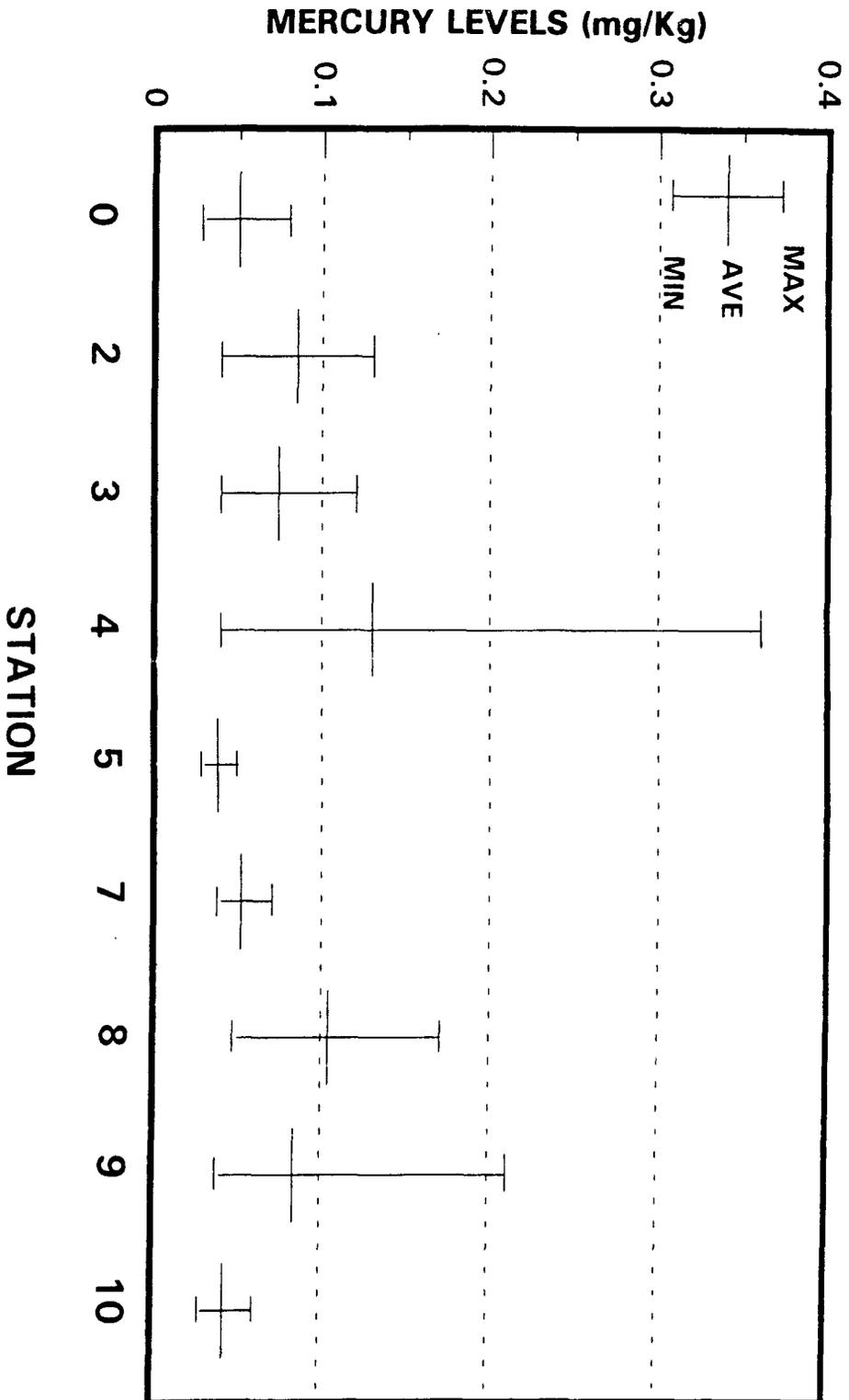
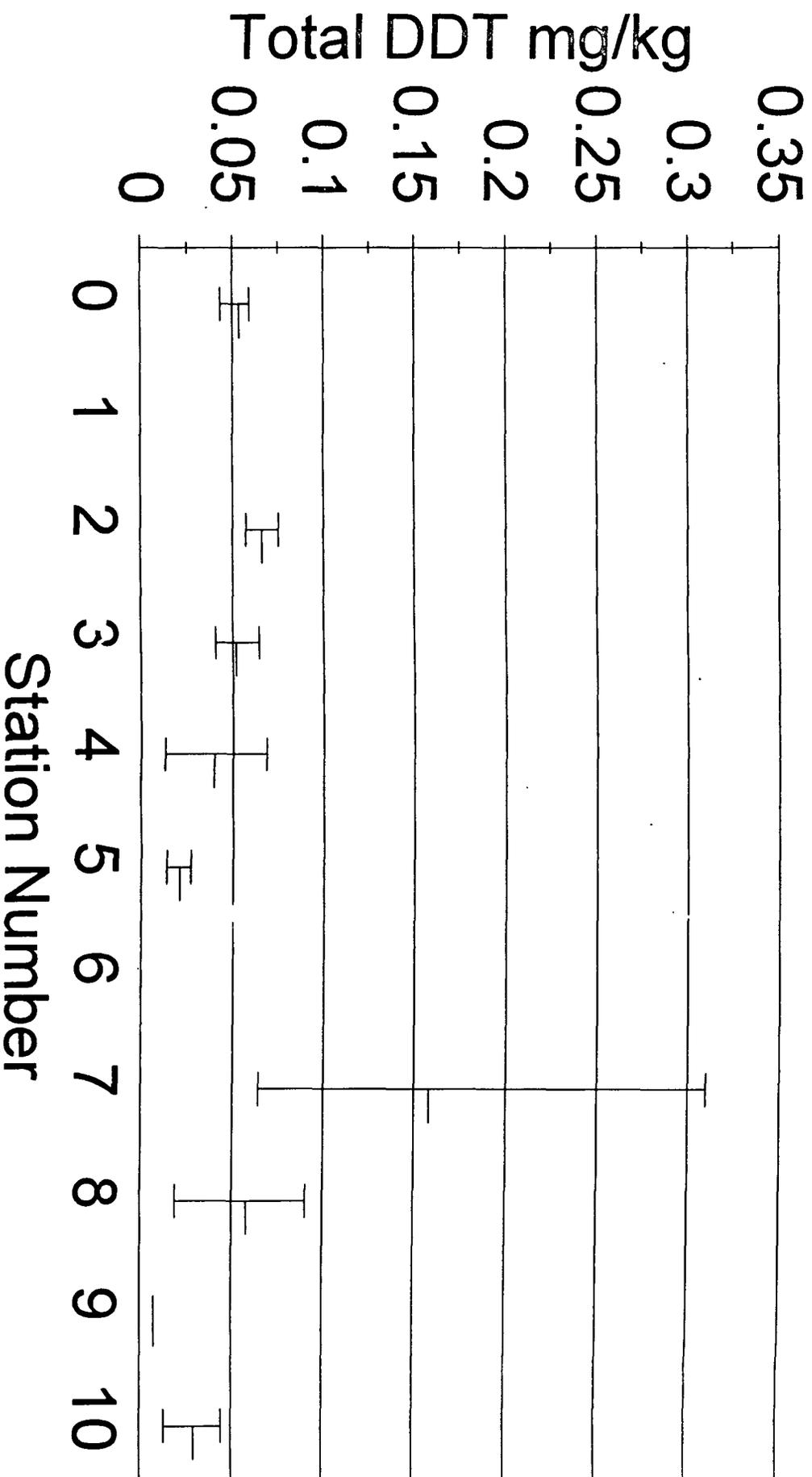


Figure 30. Average and range of total DDT concentration of Forage Fish whole body samples. Mobile River Study. November, 1993



I Max., Min., and Average

Figure 31. Mean Fish Health Index (FHI) Scores For Largemouth Bass and Channel Catfish
Mobile River, Alabama, November 1994

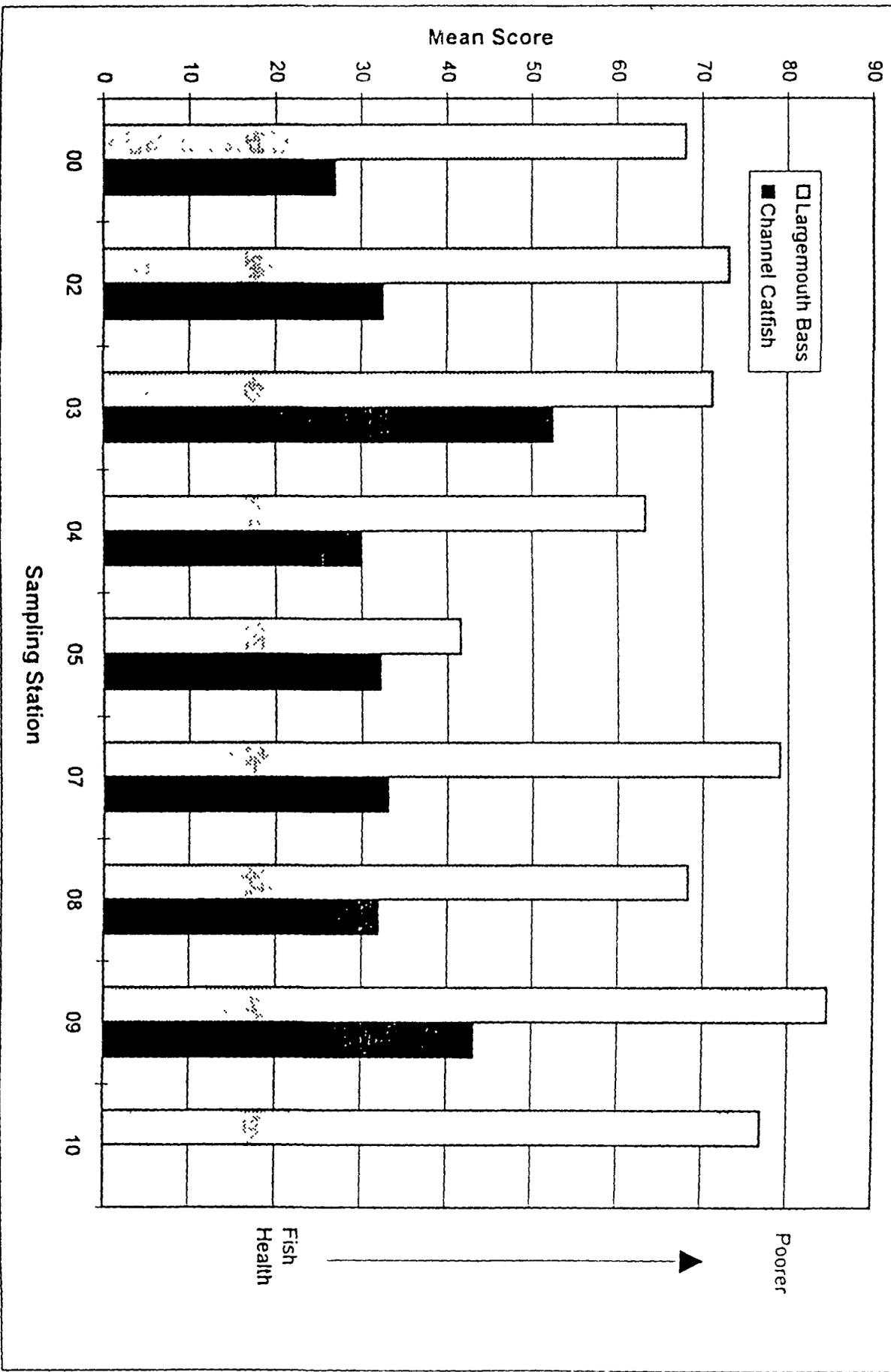


Figure 34 Temporal trend in Total DDT concentration of Largemouth Bass whole body and fillet tissue samples from the McIntosh area of the Tombigbee H.iver. Mobile River Study.

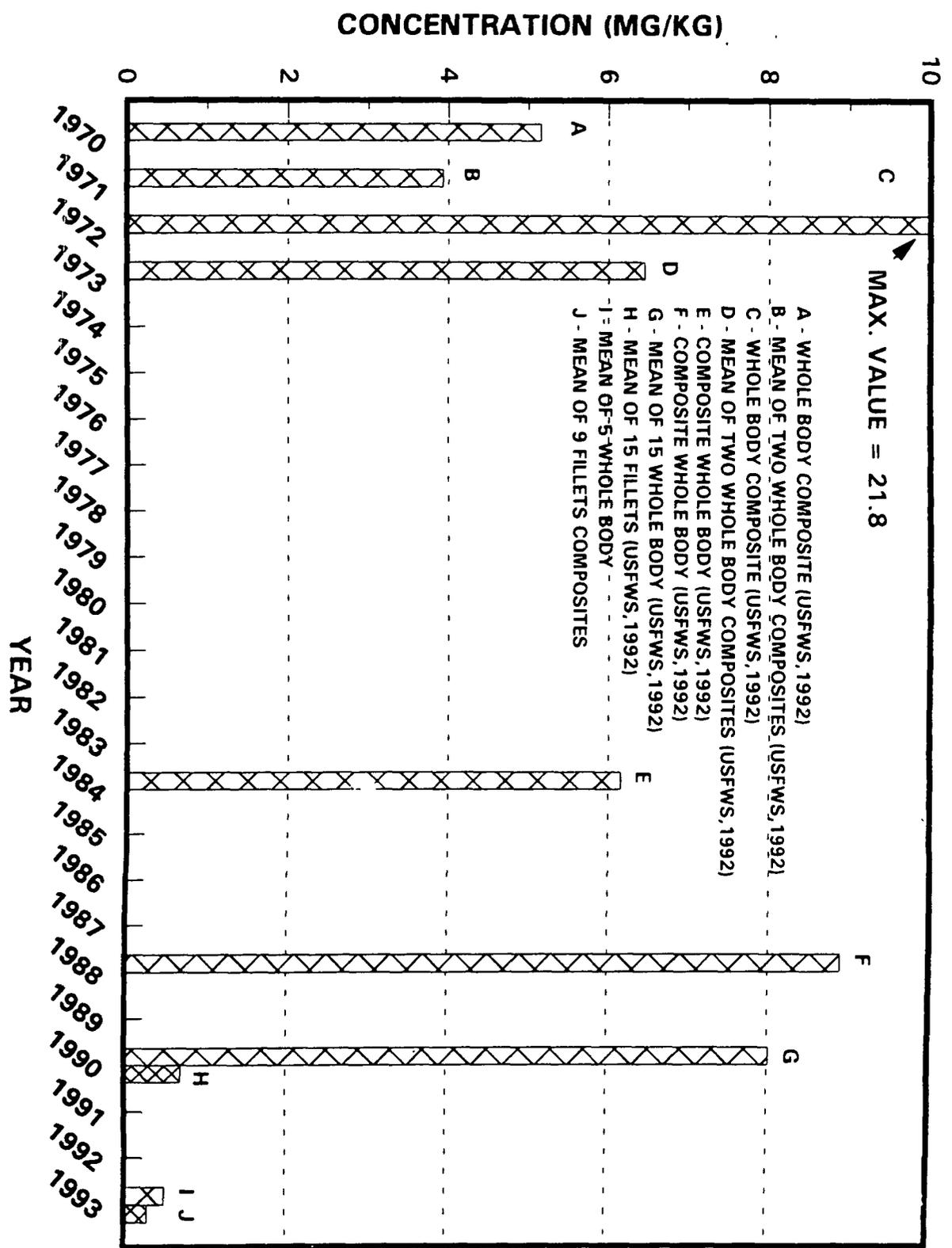
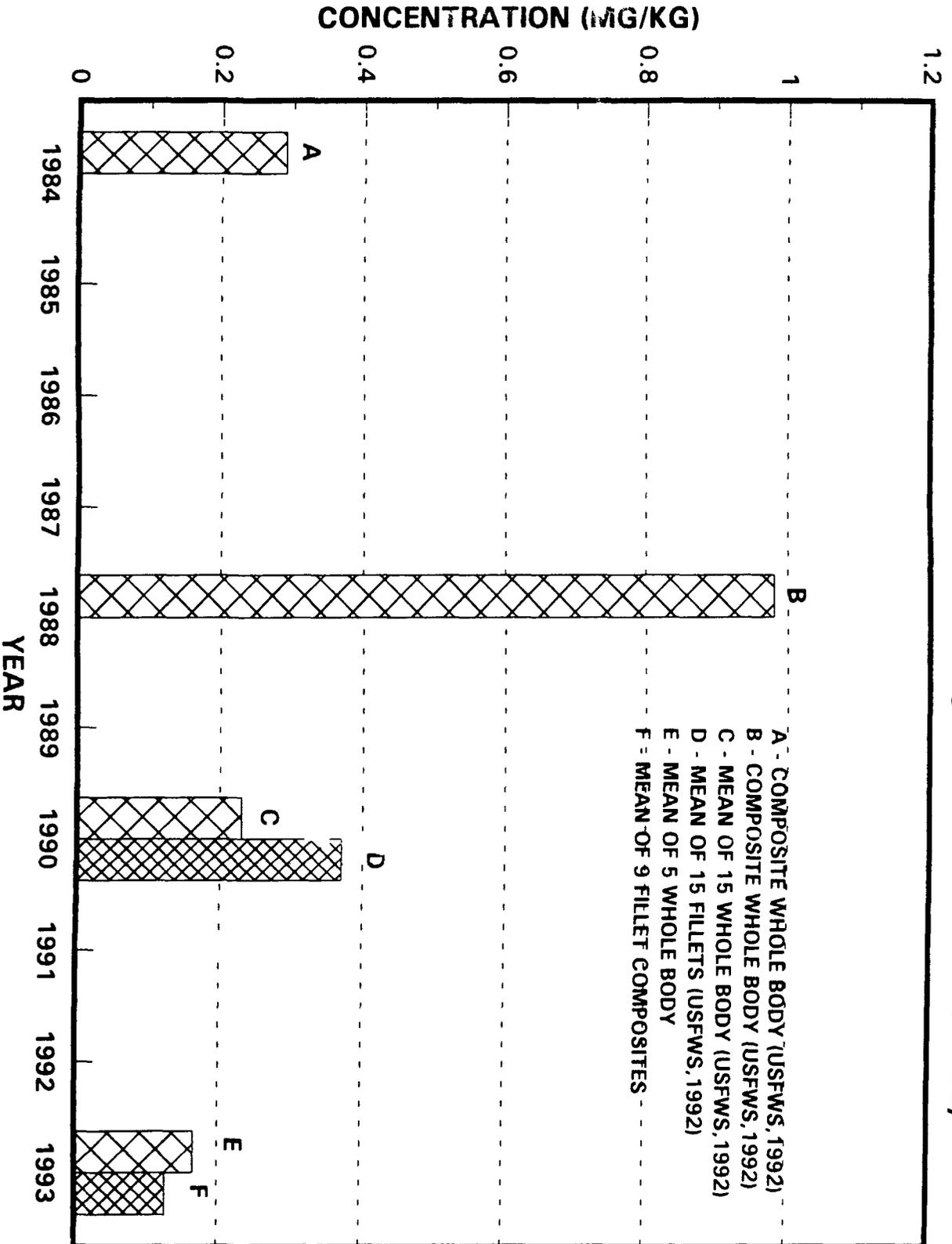


Figure 35 Temporal trend in Total Mercury concentration of Largemouth Bass whole body and fillet tissue samples from the McIntosh area of the Tombigbee River. Mobile River Study.



APPENDIX A

**PLAN OF STUDY (POS) AND
RELATED AMENDMENT**

TABLE OF CONTENTS

INTRODUCTION	
Background	1
Goal	2
Analytical and Sampling Options.	2
STUDY DESIGN CONSIDERATIONS	2
General Study Approach	2
Study Area	2
Potential Chemicals of Concern	3
Precision, Accuracy, Representativeness, Completeness, and Comparability.	4
SAMPLING DESIGN	4
General Considerations	4
Station and Sampling Site Selection.	5
Sample Analysis.	6
Sample Collection and QA/QC.	6
Water.	7
Sediments.	8
Fish for Tissue Analyses	8
Fish Health Assessment	9
DATA ANALYSIS	10
Study Area Characterization.	10
Risk Assessment.	10
Potentially Responsible Party.	11
PROJECT SCHEDULE.	12
REFERENCES.	13
TABLES.	15
FIGURE.	24

INTRODUCTION

Background. The Mobile/Tombigbee River is a waterway extending north from Mobile Bay to Pickwick Reservoir on the Tennessee River. Along its course upstream from Mobile Bay are four Superfund National Priority List (NPL) Sites. The Stauffer Chemical (LeMoyne Plant) Site located in Axis, Alabama and the Stauffer Chemical (Cold Creek Plant) Site located in Bucks, Alabama are approximately 20 miles north of Mobile, Alabama at River Mile 26. The Olin Corporation (McIntosh Plant) and the Ciba-Geigy Corporation (McIntosh Plant) are located in McIntosh, Alabama approximately 50 miles north of Mobile, Alabama at River Mile 60 (Figure 1).

Each of these Sites have backwater or floodplain wetland areas that are adjacent to and are hydrologically connected to the Mobile/Tombigbee river system. From the results of background information and on-going investigations initiated through the CERCLA process it has been shown that each of these wetland areas contain sediments with elevated levels of hazardous substances. The presence of these contaminants in the wetland areas and the knowledge that the wetland areas are intimately related to the Mobile/Tombigbee river system leads the U.S. Environmental Protection Agency (EPA) to suspect that the River system has been contaminated by the activities of these four NPL Sites. In addition, other study findings reported by the U.S. Fish and Wildlife Service (USFWS), Alabama Department of Environmental Management (ADEM), and EPA have shown elevated levels of mercury and DDT in the fish captured in this river system. Both of these substances are known to be Chemicals of Concern at these NPL Sites (Table 1). Information submitted to EPA also suggests that contaminants were also directly discharged into the river. EPA believes that the evidenced contamination poses a potential threat to human health and the environment. Therefore, the EPA, Region IV, Waste Management Division, Office of Superfund, has initiated the Mobile River Study to address the Agency's concern. In a letter dated May 25, 1993, EPA notified the Potentially Responsible Parties (PRPs) that new operable units had been designated for their Sites and that these operable units would be termed the Mobile River Study. The letters identified the Mobile River Study as operable unit 4 for the Stauffer Chemical (Lemoyne Plant) and the Stauffer Chemical (Cold Creek Plant), operable unit 3 for the Olin Corporation (McIntosh Plant), and operable unit 5 for the Ciba-Geigy Corporation (McIntosh Plant). The letters also notified the PRPs that EPA was invoking its right under Section 1104(b) of CERCLA to undertake an initial Remedial Investigation that would determine the extent of contamination from the four NPL Sites into a 44 mile river segment which extends from just south of the Stauffer Chemical (LeMoyne Plant) Site to just north of the Ciba-Geigy Corporation (McIntosh Plant) Site (Figure 1) and that EPA would not use the special notice provisions of CERCLA Section 122(e), 42 U.S.C. Section 9622(c).

Goal. The goal of the Mobile River Study is to assess the contamination of the river, including those hazardous substances, pollutants and contaminants associated with and potentially emanating from the four NPL Sites and entering the designated river segment. As a mean to this end, the objectives of this study will include:

- Characterizing the quality of water and sediments of the river segment and associated wetland areas in terms of potential chemicals of concern,
- Assessing chemical contamination of selected and representative fish species or communities of the river segment,
- Determining the health condition of a top predator game fish species of the river segment.

The data collected from the initial Mobile River Remedial Investigation will be used to better characterize the contamination in the river segment, assess the risk to human health and the environment, and assess contributions from the four NPL Sites. Table 2 lists the media to be sampled and the use of the data.

Analytical and Sampling Options. Surface water, sediment, and fish tissue will be sampled. Tables 3 through 6 list the data quality objectives (DQOs) for each media to be sampled. All samples will be analyzed in accordance with analytical support level 4. A description of the analytical support levels is provided in Table 7 and was obtained from the **Data Quality Objectives for Remedial Response Activities Manuals** (2,3).

STUDY DESIGN CONSIDERATIONS

General Study Approach. To attain the above goal and objectives, the river and its associated wetlands and fisheries will be sampled at stream sites located on the reach of river extending from the downstream vicinity of Cold Creek to an area upstream of McIntosh, Alabama, a distance of about 44 river miles (Figure 1). The study will be conducted in two phases. The first phase is a screening effort followed by a more narrowly focused second phase of study. The sampling framework will provide a basis for statistical comparisons between and within station parameters. Sampling is anticipated to occur during low flow conditions which usually coincide with the summer to early fall period of the year.

Study Area. The study area appears fairly typical of the Mobile/Tombigbee River in terms of general shoreline configuration and habitat, river width, and depth. The river's

navigation channel is maintained at a minimum depth of 9 feet, however, depths greater than 35 feet are not uncommon.

Under normal low flow conditions of the summer and early fall, river currents are often slow enough to create a general appearance of slack water. River bank erosion appears severe and common along the shore of the Tombigbee River upstream of the Alabama River confluence. Tidal amplitude effects of Mobile Bay are apparent in the study area and possibly as far upstream as Coffeerville Lock and Dam (RM 116). During low flow conditions, a saltwater wedge originating from the Bay can extend upstream in the Mobile River and past the confluence of Cold Creek (RM 26). The absence of a fully mixed water column can also be expected elsewhere in the study area because of possible thermal stratification.

The river's width varies greatly along the study area but generally falls within a range of 500 to 1000 feet. Average width of the river system tends to increase substantially downstream of the confluence of the Alabama River.

Sandy sediments tend to be the predominant substrate type associated with the Tombigbee section of the study area. In some instances, the navigation channel features a scoured bottom substrate represented by mainly an aggregate of pebbles and coarse sand. For the Mobile River segment of the study area, the sediment composition is typically represented by a substrate of fine to coarse sand in the navigation channel and mud in the bottom areas between the channel and the shoreline. Since the Mobile/Tombigbee waterway is maintained for navigation and not flood control, overbanking of the river during storm flow conditions is not unusual. With overbanking, nutrients and settleable solids are supplied throughout the river floodplain and associated wetlands. Much of the organic and inorganic materials, which could include the potential chemicals of concern, flooding the wetlands are deposited as sediment and are subjected to a myriad of possible chemical and biological processes. In these processes, materials, whether natural or man-made, can be transformed from their original chemical form, sequestered in the floodplain sediments, or mobilized for reprocessing and transport elsewhere.

Potential Chemicals of Concern. Potential chemicals of concern have been identified from the findings of investigations on the wetland areas associated with the four Superfund Sites (Table 1). Mercury and DDT are of particular concern because of their reported concentrations in the sediments and aquatic biota sampled in the designated operative units of the Superfund Sites. Environmental concerns for these contaminants are heightened due to the collective findings of other studies reported by the Alabama Department of Environmental Management, EPA, and the USFWS. The compound DDT was found in the tissues of Largemouth Bass collected from the river in the vicinity of McIntosh, Alabama. Concentrations for DDT from whole fish analyses ranged

from 0.36 to 34.52 ppm and were indicated as excessive for fish-eating bird species (1). Over the past two decades, EPA and ADEM have reported mercury concentrations exceeding 1 ppm in filets from Largemouth Bass collected from the reach of the river currently the subject of this study. A mercury level of 1 ppm in fish filets exceeds the Food and Drug Administration's action level for considering fish consumption advisories.

In preparing the list of concern, the assumption was made that all of the cited constituents (Table 1) could potentially reach the river and pose an environmental concern. Collectively, 40 chemicals of potential concern were identified. Many of these compounds, if released to the river, would potentially escape measurement for various reasons including dilution effects, volatility, hydrolysis, or minimal analytical detection limits of the chemical methods used for their analysis.

Precision, Accuracy, Representativeness, Completeness, and Comparability. The precision, comparability and accuracy of sample analyses are addressed in the **Analytical Support Branch Operations and Quality Control Manual** (4) or as specified by the existing US-EPA standard procedures and protocols for contract analytical laboratory programs. All samples will be collected and handled in accordance with the **Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual** (5) and/or the **Ecological Support Branch Standard Operating Procedures Manual, 1992** (6). This will result in collection of representative samples of the various media. Completeness will be achieved for 99 percent of all the samples collected (1 percent may be lost as a result of sample breakage in the laboratory or during transport). It is also anticipated that 99 percent of the samples analyzed will result in valid data. Fish collection and preparation of fish tissue samples for chemical analyses will be accomplished with guidance provided by in **USEPA Fish Sampling and Analysis: A Guidance Document for Issuing Fish Advisories (Draft)** and **Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Water** (7,8). The protocol developed by the Tennessee Valley Authority (TVA) (9) will be followed for the assessment of fish health conditions in the study area of the river. All samples collected for chemical analysis will be booked into the ESD or Contract Laboratory Program (CLP) laboratories through the Regional Sample Control Center (RSCC), to ensure availability of space and continuity of data.

SAMPLING DESIGN

General Considerations. To narrow the array of potential chemical constituents of concern as listed in Table 1, a select number of representative sediment and water samples from the study area will be analytically screened for the elements and compounds of interest. Chemicals quantified in the screening phase of the study will then be targeted in the second or

definitive phase of the study when sediments, water, and fish samples will be collected at the eleven stations indicated in Figure 1. Based upon findings from the definitive study, a follow-up or third phase of the study could be formulated, if necessary, to address data gaps relative to the initial study objectives and respond to additional assessment questions of concern.

Summer through early fall is the anticipated period of sampling for this study. Generally during this time, low flow conditions are encountered. Low flows tend to minimize dilution effects, provide for a more stable sampling environment and pose worst case seasonal conditions for water quality and aquatic biota. Minimum dissolved oxygen concentrations and maximum water temperatures for example are generally encountered during this time and can pose a natural stress to the aquatic life. These conditions when coupled with other environmental stressors, such as the potential chemicals of concern, can add to the natural adverse stresses with the effects being manifested in the health condition of the exposed fish community.

Over the course of the spring through early fall periods of the year, fish will experience their maximum growth rate and develop their greatest body fat or lipid content by winter. Chlorinated pesticides such as DDT are extremely lipid soluble; hence, the late fall to winter would be the preferred time to sample fish tissue for lipid soluble pesticides. High flow conditions are not, however, suited for the planned sampling regime. The fish tend to be more dispersed and their habitat more difficult to access under high flow conditions. For these reasons, the summer to early fall season of the year was selected as the sampling period for the study.

Station and Sampling Site Selection. The general location of sampling stations selected for this study are indicated in Figure 1. Eleven sampling stations are planned for this study. Of this number three stations will serve as reference sites (MT8, MT9 and MT10) and will be strategically located outside the potential influence of the four Superfund Sites. The station array does not purposely reflect randomness. Instead, station placement is biased to characterize upstream/downstream conditions relative to the sources of potential chemicals of concern. A similar characterization is also extended to the Alabama River and its confluence with Mobile/Tombigbee River (Figure 1).

Station selections as indicated in Figure 1 will remain tentative until the screening phase of the study is completed. In the screening phase, each of the indicated river stations will be surveyed for the primary type of bottom substrate characterizing the river and the presence and type of floodplain forested wetland flanking the station area. The bottom substrate of both the river and wetlands would likely represent areas for accumulating fine particles and sorbed chemicals. Depending upon the survey findings of the screening study, the tentative

stations may be adjusted longitudinally upstream or downstream to help assure that these types of substrates, wetlands in particular, are represented in the sampling strategies. In evaluating sampling results via an upstream/downstream comparison, similar substrate types are essential to the evaluation. Likewise, the reference stations will be selected to also facilitate comparison of similar substrates. Once the final stations are determined, they will be geographically referenced with a Global Positioning System (GPS).

To characterize the quality of the surface water and bottom sediments at each station, sampling locations will be keyed to a transect extending across the river and into adjacent floodplain wetlands. For the river, *per se*, the transect will be divided into three segments of similar lengths. Facing upstream, the left, middle, and right segment of the transect will be designated the west (A), mid (C), and east (B) sampling zones for the river. Similarly, the floodplain wetlands associated with the transect, sampling locations will be designated either the west or east bank and subject to the same sampling strategy applied to the river.

In sampling the fish communities, a subarea of the river around each designated station will be defined as the fish sampling area. Fish collected from anywhere within this area will be referenced to the designated station. Depending on the level of effort required to collect the required fish species and sample size, the up and downstream boundaries of the subarea will probably be different from station to station. In any case, the upstream and downstream boundaries of each subarea will also be georeferenced.

Sample Analysis. All sediment and surface water samples will be analyzed in the laboratory for extractable organic compounds (base/neutral and acid extractables - including routine pesticides and PCBs), volatile organic compounds, metals, special pesticides and cyanide (Table 1). Additional laboratory analysis required on only sediments include total organic carbon, bulk density, and moisture content. For water, additional laboratory analyses include dissolved organic carbon, particulate organic carbon, and ultra trace levels for mercury. Fish tissue samples will be analyzed for routine pesticides, extractable organic compounds and metals including mercury.

Sample Collection and QA/QC. For both the screening and definite phase of the study, all samples will be collected in accordance with the appropriate Standard Operating Procedures (SOPs). The quality assurance and quality control procedures described in this section will help insure that representative samples are collected from the various media sampled. Table 8 lists the number of samples anticipated for each media sampled, including QA/QC samples. The reported sample counts for water and bottom sediments are considered to be a maximum possible number for the study. As later discussed in the water sampling

section, actual sample numbers will largely depend on river conditions at the time of the survey.

Duplicate or split samples will be collected at two of the sample locations for each matrix and analyzed for extractable organic compounds and metals. This will provide a check for sampling techniques. In addition, each week water samples are collected, water trip blanks will be prepared with organic-free water for volatile organic analysis. The trip blanks will be handled and stored with the samples collected from the site. This will provide a check to determine if samples may have been contaminated during handling, storage, and shipment. Preservative blanks will be collected at the beginning of the project and at the end of each week water samples are collected to insure the integrity of the preservatives. Equipment rinse blanks will be collected from equipment cleaned on-site, using organic/inorganic free water, at least once a week or more frequently at the discretion of the field project manager and analyzed for parameters of concern. The equipment rinse blanks will be collected to ensure that the sampling equipment is properly field cleaned.

All sample containers will be obtained from the ESD bottle repository. Sample containers used will be in accordance with the requirements specified in Appendix A of the ECBSOPQAM, and/or the **Ecological Support Branch Standard Operating Procedures Manual** (6) Table 9 indicates types of analysis required, type preservatives needed, and kinds of sample containers to be used in the study.

Water. At each of the river stations the left, middle, and right zones of the river transect will be sampled. The sampling will begin with establishing a vertical profile of the water column in terms of temperature (C°), dissolved oxygen (ppm), pH, conductivity (umhos/cm), and REDOX (millivolts). For this task, remotely deployed, calibrated probes will be required. The profiles will provide a means to assess the degree of water column stratification and determine the need for two level sampling of the water column. To define stratification, it is assumed that a surface to bottom gradient will usually occur for these particular parameters during the given sampling period, i.e., dissolved oxygen and temperature values decreasing with depth.

For purposes of this study, the boundary dividing the upper and lower strata of the water column can be defined by the depth at which the dissolved oxygen concentration decreases to one ppm or less or when the REDOX readings are less than a positive 200 millivolts. These values will help determine the apparent oxidizing or strongly reducing strata of the water column which are significant factors affecting the chemical quality of the water. Another factor affecting the chemical characteristics of the water column is density stratification. Determining the presence and location of a thermocline or the freshwater/saltwater interface (clinograde) serves to identify

the upper and lower strata of the water column based upon density differences. For this study, the thermocline is defined as the water column depth at which temperature changes one degree C° or more within a one meter depth interval. To identify the clinograde boundary, an increase in conductivity to 1000 umhos/cm or more indicates the freshwater/ saltwater interface of the water column.

For water sampling sites where the water column is fully mixed, a water grab sample will be collected from mid depth. Under a stratified condition, the sample will be obtained at the mid point of depth within each of the two stratified layers of water. In cases where the sampling site in the floodplain wetland is covered with water, surface grab samples will be obtained prior to the collection of the substrate samples. All samples will be kept in designated containers, labeled, treated with an appropriate preservative, stored and shipped to a designated laboratory for analyses. The maximum surface water sample count for the definitive phase study (Table 8) is based on the assumption that at all stations, the water column is stratified in the three sampling zones and that the associated floodplain wetlands are also inundated on both sides of the river. Under this assumption, a total of twelve water samples per station is anticipated.

Sediments. Surficial samples (top 10 to 15cm) of river or wetland sediments will be generally collected along the same transect line used for surface water. Sediment sampling will be accomplished with either a coring or dredging device. Three sediment replicate samples per sand and/or mud substrate found at each station are required. Similarly, three replicate bottom substrate samples will be collected from the selected wetland sites. When taking a sample, minimum disturbance to the sediments is required to help assure representativeness of the site. Each sample will be visually examined on site, its characteristics noted, and then processed. All samples will be labeled, preserved, stored, and shipped to a designated laboratory for analyses. Sediment samples will be subject to particle size determinations and analyses for the potential chemicals of concern. Total sediment sample count is based on the assumption that each station will feature two substrate types in the river and that wetlands flank both sides of the river. This assumption would provide for the collection of 12 sediment samples per station.

Fish For Tissue Analyses. The sampling of the fish communities in the study area may involve a wide array of capture gear including fish shockers, trotlines, and nets because of the species and large numbers of fish required for tissue analyses. The goal of the sampling effort is two fold. First, collect two species of gamefish in sufficient numbers to facilitate a fish tissue contamination assessment relative to three size groups per species. Largemouth Bass (a top predator) and Channel or Blue

Catfish (bottom feeder) are the gamefish species of interest. Secondly, collect sufficient numbers of a species representing the forage fish community of the river. Guidance for the collection, field dressing, and processing of fish tissue samples for chemical analysis is provided in **USEPA Fish Sampling and Analysis: A Guidance Document for Issuing Fish Advisories (Draft) February 1993** and **Fish, Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (7,8)**.

The field processing of the sampled fish will begin with assessing the general external condition, total length, and wet weight of each specimen collected for analyses. Large, medium, and small size specimens for each species will be aggregated into respective groups of similar lengths. The size interval for aggregating the samples will be determined in the field. The control for each size group will be established by the total length of the smallest member of the aggregate measuring no less than 25 percent the total length of the largest member. Total length will serve as the standard measurement of size. In summary, each fish species will be represented by three size groups.

From each size group, six replicate composite samples of filets will be prepared. A composite will be comprised of five filets with each filet from a different fish. Three of these composite samples will be analyzed for metals and three for organic compounds. The analyses of filets will serve mainly to aid in providing the basis for public health risk assessments.

For an ecological risk assessment, whole body analyses are required. To facilitate this analyses, five whole fish specimens will be collected for each species. The five specimens will be selected to represent a range of sizes. Each whole fish group will be analyzed for body concentrations of metals, extractable organic compounds, and pesticides.

A third species or an assemblage of species will be collected to represent the forage or prey component of the river's fishery. Typically, this component of the fish community is made up of minnows and other small fish species which are preyed upon by a variety of fish eating animals. Hence, the forage community can serve as a critical pathway for the bioaccumulation of mercury and pesticides in higher trophic levels of the riverine ecosystem.

Depending on abundance, three replicate composite samples of a forage species or an assemblage of several forage species will be collected. Each composite should be comprised of a minimum of 200 grams of fish weight. Each composite will be analyzed for the same chemical constituents assigned the filet whole fish assessment. Fish sample container, analysis required, and preservation needs are given in Table 9.

Fish Health Assessment. This component of the study will involve the development of a Fish Health Assessment Index (FHAI) which is an autopsy-based survey that quantifies the effects of

environmental stressors on resident fish species. The fish species of interest in this assessment is the Largemouth Bass which is considered to be a primary top predator of the Mobile/Tombigbee River system. The FHAI will be the results of on-site autopsies of freshly collected specimens of the targeted species. Specimens for the autopsy work will be submitted to the field laboratory with blind identity as to sample station location. Autopsy parameters and methods followed will be from the protocol developed by TVA (9). This assessment will not serve to elucidate cause and effects but rather to identify stress gradients in the study area and their geographical association with the Superfund sites.

DATA ANALYSIS

Study Area Characterization. To characterize the study area, the sampling framework was organized to facilitate a compare and contrast design. In this approach, eleven river stations were identified for sampling. Of this total, three and eight locations were designated as reference and potential impact sites, respectively. The reference stations were all positioned outside the influences from the NPL sites; hence, they are assumed to be outside the effects of potential chemicals of concern. Each station will be characterized in terms of its prominent physical, chemical, and selected biological features. Analytical results will be statistically treated to detect significant differences between and within stations. Data will be displayed in the form of tables, figures, and maps to determine the general health and condition of selected components of the ecosystem.

Risk Assessment. A human health and ecological risk assessment will be performed on the data obtained in this study. The human health assessment will follow the guidelines of the **Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A)** (10). For ecological risk assessment, a "weight of evidence" approach will be followed. Pertinent guidance will be derived from **Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual Interim Final** (11); **Framework for Ecological Risk Assessment** (12); **Peer Review Workshop Report on a Framework for Ecological Risk Assessment** (13); and **Report on the Ecological Risk Assessment Guidelines Strategic Planning Workshop** (14). Other documents and reference material that may be considered in the course of the ecological risk can include the following:

- **Exposure Analysis Modeling System: User Guide for EXAMS II Version 2.94.** (15).
- **The Potential for Biological Effects of Sediments - Sorbed Contaminants Tested in the National Status And Trend Program.** (16).

Primary Responsible Party. By the examination of the results showing the distribution of contaminants in the sediments, water, and fish, EPA will assess the contribution of contaminants from each of the four NPL Sites to the river area of concern. Also the findings of the risk assessment will be used to determine the threat to human health and the environment from the contaminants and their distribution. The distribution of contaminants, risk to humans, and risk to the ecosystem will serve as a basis to aid in the determination of any necessary further actions to be taken in the study area of the river. Further actions under CERCLA may be required. If no further action is required at the Sites, a "No Action" Record of Decision (ROD) will be established.

PROJECT SCHEDULE

Plan of Study Review	9/7-20/93
Meeting to Discuss Review Comments	9/15/93
Revision to Plan of Study	9/25/93
Phase I - Screening Sampling	10/4-8/93
- Screening Result	12/15/93
Phase II - Fish Sampling	11/1-10/93
- Fish Tissue Results	5/15/94
Phase II - Sediment/Water Sampling	7/15/94
- Analytical Results	9/15/94
Phase II - Fish Health Assessment	8/1/94
- Assessment Results	9/15/94
Draft Final Report Review .	11/1/94
Final Report	12/15/94

REFERENCES

1. United States Fish and Wildlife Service. **An Evaluation of Mercury and DDT Contaminants in Fish and Sediments Collected From the Tombigbee River near McIntosh, Alabama.** U.S. Fish and Wildlife Enhancement, Daphne, Alabama, July 1992.
2. United States Environmental Protection Agency. **Data Quality Objectives for Remedial Response Activities, Volume 1, Development Process.** Office of Emergency and Remedial Response and Office of Waste Programs Enforcement, Washington, DC 20460. EPA 540/G-87/003A, March 1987.
3. United States Environmental Protection Agency. **Data Quality Objectives for Remedial Response Activities. Example Scenario.** Office of Emergency and Remedial Response and Office of Waste Programs Enforcement, Washington DC 20460. EPA/540/G-87/004, March 1987.
4. United States Environmental Protection Agency. **Analytical Support Branch Operations and Quality Control Manual (ASBOQCM).** Region IV, Environmental Services Division, Athens, Georgia 30605, September 1990.
5. United States Environmental Protection Agency, Region IV, Environmental Services Division. **Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual.** February 1991.
6. United States Environmental Protection Agency. **Ecological Support Branch Standard Operating Procedures Manual.** Region IV, Athens, Georgia 30605, April 1989.
7. United States Environmental Protection Agency, Region IV. **Fish Sampling and Analysis: A Guidance Document for Issuing Fish Advisories (Draft).** February 1993.
8. Klemm, Donald J., Quentin J. Stober, and James M. Lazorchak. **Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters.** U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati Office of Modeling, Monitoring Systems, and Quality Assurance, Office of Research and Development, Cincinnati, Ohio 45268. EPA/600/R-92/111, March 1993.
9. Adams, Marshall S., Allen M. Brown, and Ronald W. Goede. **A Quantitative Health Assessment Index for Rapid Evaluation of Fish Condition in the Field.** Transactions of The American Fisheries Society. Volume 122 (1), January 1993.
10. United States Environmental Protection Agency. **Risk**

Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC 20450. EPA/540/1-89/002, December 1989.

11. United States Environmental Protection Agency. **Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual Interim Final.** Office of Emergency and Remedial Response, Washington DC 20460. EPA/540/1-89/1001, March 1989.
12. United States Environmental Protection Agency. **Framework for Ecological Risk Assessment.** Risk Assessment Forum. Washington DC 20460. EPA/630/R-92/001, February 1992.
13. United States Environmental Protection Agency. **Peer Review Workshop Report on a Framework for Ecological Risk Assessment.** Risk Assessment Forum. Washington DC 20460. EPA/625/3-91/022, February 1992.
14. United States Environmental Protection Agency. **Report on the Ecological Risk Assessment Guideline Strategic Planning Workshop.** Risk Assessment Forum. Washington DC 20460. EPA/650/R-92/002, February 1992.
15. Burns, L. A., 1989. **Exposure Analysis Modeling System: User Guide for EXAMS II Version 2.94.** United States Environmental Protection Agency, Athens, Georgia, 30605.
16. Long, Edward R. and Lee G. Morgan. **The Potential for Biological Effects of Sediment-Sorbed Contaminants in its Natural Status and Trends Program.** National Oceanic and Atmospheric Administration, National Ocean Service, NOAA Technical Memorandum NOS OMA 52. Seattle, Washington, 1989.

TABLE 1. Potential Chemicals of Concern
 Associated with Superfund Sites.
 Mobile River Study
 Alabama

Olin/McIntosh Site:

Alpha-BHC
 Arsenic
 Benzene
 Beryllium
 Beta-BHC
 Cadmium
 Chlorobenzene
 Chloroform
 Copper
 4,4'-DDD

4,4'-DDE
 4,4'-DDT
 Delta-BHC
 Dichlorobenzene isomers
 (1,2,4,5-tetrachlorobenzene*,
 1,2,4-trichlorobenzene)
 Gamma-BHC
 Hexachlorobenzene
 Lead
 Mercury
 Pentachlorobenzene*
 Pentachloronitrobenzene*
 Tetrachloroethylene

Ciba Geigy Site:

Alpha-BHC
 Ametryn*
 Atrazine*
 Beta-BHC
 Bladex*
 Chlorobenzilate*
 DDD
 DDE
 DDT
 Delta-BHC
 Diazinon*
 Gamma-BHC
 Prometryn*
 Simazine*

Stauffer Sites:

Carbon Disulfide
 Carbon Tetrachloride
 Cyanide
 Mercury
 Thiocyanate*
 Thiocarbamates including;
 Molinate*
 Vernolate*
 Pebulate*
 Butylate*

Cycloate*
 EPTC*

* Special analytical services needed: not included with TAL/TAL

**TABLE 2. Data Uses
Mobile River Study
Alabama**

<u>MEDIA SAMPLED</u>	<u>RIVER CHARACTERIZATION</u>	<u>RISK ASSESSMENT</u>	<u>PRP DETERMINATION</u>
SURFACE WATER	YES	YES	YES
SEDIMENT	YES	YES	YES
FISH TISSUE	YES	YES	YES
FISH HEALTH	YES	YES	YES

**TABLE 3. Data Quality Objectives
Surface Water Samples
Mobile River Study
Alabama**

Media: River and wetland surface water

Location: Mobile/Tombigbee River and tributaries

Data Types: A. In situ - pH, specific conductivity, temperature, dissolved oxygen, redox.

B. Laboratory analyses - volatile organic compounds, base/neutral/acid extractable organic compounds, (including routine pesticides and PCB's) metals, ultra trace levels of total mercury, special pesticides (Table 1), cyanide, total dissolved organic carbon, and total particulate organic carbon.

Sample Type: Environmental, grab sample

In Situ Analytical Data Level: Level 2

Laboratory Analytical Data Level: Level 4

Field Quality Control Samples:
5 percent duplicate/split samples, (VOA trip blank, metals and cyanide preservative blank, and equipment rinse blank collected once per week or as needed).

Sampling Procedures:
See section 4, Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual and Ecological Support Branch Standard Operating Procedures Manual (5,6).

**TABLE 4. Data Quality Objectives
Sediment Samples
Mobile River Study
Alabama**

Media: Sediment

Location: Mobile/Tombigbee River and its tributaries

Data Types: A. In situ - visual inspection

B. Laboratory Analyses - Volatile organic compounds, base/neutral/acid extractable organic compounds, (including routine pesticides and PCB's) metals, special pesticides, cyanide, total organic carbon and bulk density (Table 1).

Sampling Type: Environmental, grab samples

In Situ Analytical Data Level: Not applicable

Laboratory Analytical Data Level: Level 4

Field Quality Control Samples:
5 percent duplicate or split samples

Sampling Procedures:
See section 4, Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual and Ecological Support Branch Standard Operating Procedures Manual (5,6).

**TABLE 5. Data Quality Objectives
Fish Tissue Samples
Mobile River Study
Alabama**

Media: Fish tissue

Location: Mobile/Tombigbee River and its tributaries
(see figure 1)

Data Types: A. In situ - none

B. Laboratory analyses: - Base/neutral/acid extractable organic compounds (including routine pesticides and PCB's), metals (excluding cyanide), and special pesticides (excluding Thiocarbamates).

Sampling Type: Environmental

Laboratory Analytical Data Level: 4

Field Quality Control Samples: 5 percent duplicate/split samples

Sampling Procedures:
See the **Fish Sampling and Analysis: A Guidance Document for Issuing Fish Advisories and Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters** (7,8).

**TABLE 6. Data Quality Objectives
Fish Health Assessment
Mobile River Study
Alabama**

Media:	Fish
Location:	Mobile/Tombigbee River and tributaries (see figure 6)
Data Types:	A. In situ - none B. Laboratory analysis - visual examination of fish body and internal organs
Sampling Type:	Environmental
Laboratory Analytical Data Level:	2, 3
Field Quality Control:	None
Sampling Procedure:	TVA Protocol for Conducting Fish Health Assessments (9).

TABLE 7. Analytical Levels
Mobile River Study
Alabama

<u>Level</u>	<u>Description</u>
1	Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and health and safety support. Data can be generated regarding the presence or absence of certain contaminants at sampling locations.
2	Field analysis. This level is characterized by the use of portable analytical instruments which can be used on-site, or in a mobile laboratory stationed near a site. Depending upon the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.
3	Laboratory analysis using methods other than the contract laboratory (CLP) or EPA, Region IV, ESD routine analytical services. This level is used primarily in support of field studies using standard EPA approved procedures. Some procedures may be equivalent to CLP/ESD routine analytical services, without the requirements for rigorous QA/QC documentation.
4	CLP or ESD routine analytical services. This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data.
5	Non-standard methods. Analyses which may require method modification and/or development. CLP special analytical services are considered level 5.

**TABLE 8. Sample Collection Summary
Mobile River Study
Alabama**

SAMPLE DESCRIPTION	SCREENING PHASE NUMBER SAMPLES	DEFINITIVE PHASE NUMBER SAMPLES	QA/QC DEFINITIVE PHASE
TRIP BLANKS (WATER)	0		4
TRIP BLANKS (SEDIMENT)	0		4
PRESERVATIVE BLANKS	0		4 (PER WEEK)
EQUIPMENT RINSE BLANKS	0		1 (1 PER WK IF CLEANED)
MATRIX WATER (EXT.)			2
MATRIX WATER (METALS)			2
MATRIX SEDIMENT (EXT.)			2
MATRIX SEDIMENT (METALS)			2
WATER SAMPLES	30	132	13 (DUPLICATES & SPLITS)
SEDIMENT SAMPLES	27	114	14 (DUPLICATES & SPLITS)
FISH TISSUE		350	35 (DUPLICATES & SPLITS)
TOTAL	57	596	83

TABLE 9 Sample Containers and Preservatives
Mobile/Tombigbee River Study
Alabama

WATER ANALYSIS

Extractable Organic (including routine pesticides and PCB's)	1 - 4 liter amber glass with Teflon liner	Iced 4° C
Specific Pesticides	1 - 4 liter amber glass (may need as many as 3 - 4 liter ambers) with Teflon liner	Iced 4° C
Volatile Organic	3 - 40 ml glass vials (going to ESD)	4 drops 1+1 HCL iced to 4° C
	2 - 40 ml glass vials (going to CLP)	4 drops 1+1 HCL iced to 4° C
Metals	1 - 1 polyethylene with polyethylene lined closure	50% HNO3 to pH <2, iced 4° C
Ultra Trace Level Mercury	1 - 500 ml Teflon container with Teflon liner	2 mls non-metal grade HCL analyzed before use
Cyanide	1 - 1 liter polyethylene with polyethylene lined closure	NaOH to pH > 12 iced 4° C
Total Dissolved Organic Carbon	1 - 500 mL polyethylene with polyethylene lined cap	Filtered (0.45µ) and acid preserved
Total Particulate Organic Carbon	1 - 500 mL polyethylene with polyethylene lined cap	Non filtered and acid preserved

SEDIMENT SAMPLE ANALYSIS

Extractable Organic (includes routine pesticides/PCB's)	1 - 8 oz widemouth glass jar with Teflon liner	Iced 4° C
Specific Pesticides	1 - 8 oz widemouth glass jar with Teflon liner (may need as many as 3 - 8 oz glass)	Iced 4° C
Metals/Cyanide	1 - 8 oz widemouth glass jar with Teflon liner	Iced 4° C
Volatile Organic	1 - 4 oz widemouth glass jar with Teflon liner	Iced 4° C
Total Organic Carbon	1 - 8 oz widemouth glass jar with Teflon lined lid	Iced 4° C
Bulk Density and Percent Moisture	1 - qt widemouth glass jar	Iced 4° C

FISH SAMPLE ANALYSIS

Routine Pesticides	Each whole body wrapped in foil (shiny side out) and then placed in plastic bag and sealed. Filet composite will be aggregated and placed together on same foil and wrapped together then sealed in plastic bag.	Iced 4° C freeze ASAP or within 24 hours
Metals	Each whole body placed in plastic bag and sealed. Filet composites will be aggregated in the same plastic bag and sealed.	Iced 4° C freeze ASAP or within 24 hours

**Mobile/Tombigbee River
Study Plan Amendment
February 28, 1994**

INTRODUCTION: The Environmental Protection Agency initiated the Mobile/Tombigbee River Study in the fall of 1993 to address the agency's concern that hazardous material originating from four NPL sites may be contaminating the river and posing a potential threat to human health and the environment. Implementation of the study was according to a Plan of Study which provides the bases for the investigation, identifies the goals and objectives, lists the chemicals of concern, and reports study design considerations and sampling strategies.

In brief the study employs a two phase approach to sampling. Phase I involved a screening study in which sampling was conducted at selected river stations located upstream and downstream of the NPL sites. The sampling effort was designed to facilitate a characterization of the chemical quality of water and sediments of the river and associated floodplain wetlands. Sampling for the screening phase of the study was partly completed the week of October 4, 1993. Sampling of the floodplain wetlands was not possible at this time for lack of permission for land access to the property; however, river water and sediments were obtained. Following the field work of the screening study, the second phase of the investigation was initiated with the collection of fish samples for tissue analyses. The fisheries work began the week of November 1, 1993 and was completed approximately six weeks later. The analyses of the tissue samples are scheduled for completion in April, 1994.

Analytical results for the chemical screening of water and sediment samples from the river show that chemicals of concern were found at concentrations comparable to reference conditions or below minimum detection limits for the analytical procedures employed. These findings give rise to the question that possibly the floodplain wetlands may play a more significant role than does the river in the fish tissue contamination issue.

The basis for this question involves several considerations. All four of the NPL sites are located in floodplain wetlands. With winter river stages, overbanking and the inundation of the floodplain wetlands are a common occurrence in the Mobile/Tombigbee River system. As overbanking occurs, fish can migrate from the river to the floodplain where they can merge with the wetland food chain. Duration of inundation in the wetlands can span several weeks thus providing both opportunity and pathways for fish to forage for food which may be contaminated with a chemical of concern and/or be directly exposed to contaminants in the wetlands. Potentially, contaminants in the floodplain wetlands could be directly link to the NPL sites, derived via the river from upstream

sources, or directly deposited in the wetlands through air deposition. In any case, the testing of surface water, sediments, and fish tissue samples from the floodplain wetlands would be necessary to adequately address the assessment question relative to the wetlands. To proceed with this sampling, the following sampling strategy is provided.

SAMPLING APPROACH: Sampling of the floodplain wetlands during times of inundation is planned for the period of March/April, 1993. River stages are anticipated to be sufficiently elevated during this time to effect overbanking and flooding of the wetlands. Under these hydrologic conditions, access to the floodplain wetlands from the river is presumed to be possible by boat. Sampling of the floodplain wetlands will be approached in the same manner as the Phase I screening study. Samples from the floodplain wetlands associated with the NPL sites and selected reference wetland will be analytically screened for chemical constituents of concern.

The sampling effort for the floodplain wetlands will involve the collection of sediments, surface water, and fish samples. Samples will be analyzed for the suite of chemicals identified in the initial Plan of Study. This sampling will remain within the scope of the initial Plan of Study and the stated study goals, objectives, sampling and analytical methods, and quality assurance procedures. Sample parameter will remain basically the same as initially planned with the exception of adding fish stomach content analyses.

STATION AND SAMPLING SITES: For purpose of the chemical screening phase of the study, five floodplain wetland areas were selected for sampling. Four of these coincide with river stations MT-0, MT-2, MT-7, and MT-8. The former three stations are located within the potential influence of the NPL sites. Station MT-8 is a backwater reference location which is positioned upstream of the NPL sites and outside their influence. A second backwater wetland reference station in the Tensaw Lake area is being researched for use as the fifth station (MTL).

Within each of the floodplain wetlands identified, sampling site selection will deviate from the initial Plan of Study. Originally sample collection in the floodplain wetlands would have occurred at three locations along an extension of a cross sectional transect of the river. Instead, each of the three sampling sites will be scattered to locations most representative of the floodplain wetland station. The positioning of these sites will be accomplished with the benefit of reconnaissance prior to sampling.

SITE SAMPLING: Sediment, surface water, and fish remain the primary sampling media of interest. Because of the environmental setting of the floodplain wetlands during periods of inundation, some deviation will be required in the sampling methods reported in the initial Plan of Study. The changes are following.

Water: The surface water column is expected to be vertically

mixed in the floodplain wetlands during the overbanking period. Under a non-stratified condition, the water column will be sampled at mid depth at each of three sites. Sample collection, handling, and preservation will be according to the initial Plan of Study. Sample summary is provided in Table I.

Sediments: Since sampling is anticipated to occur from a boat, a remote operated coring or augering device will be used to sample the sediments. Three replicate samples will be gathered at each sampling site, composited, and subsampled for chemical analyses. Handling and preservation of samples will be according to the initial Plan of Study. Sample summary is provided in Table I.

Fish: The Largemouth Bass, Channel Catfish, and forage fish are the species of interest. An array of sampling gear will probably be required to catch representative samples of the target species for each of the floodplain wetland areas selected for study. For the Bass and Catfish, the goal of the sampling is to collect adequate numbers of fish to constitute a sample of sufficient filet and whole body biomass to represent the three size group established in the Plan of Study. Similarly, the forage fish community will be sampled until sufficient numbers are available to constitute an adequate composite of biomass for chemical analyses. The stomach content of the captured fish will be examined to determine the type of food items consumed relative to size class. The food items will also be analyzed for chemical constituents of concern providing the biomass of the sample is of adequate size. A sample summary is provided in Table I.

APPENDIX B

IN SITU MEASUREMENTS AND RESULTS

In Situ Measurements and Results

DO concentrations were near levels of saturation and generally similar among the stations except MT-8, a back water area of the river known as Three Rivers Lake. DO values were slightly less than saturation and characterized by a profile of decreasing concentrations from surface to bottom. The lower concentration of DO near the bottom probably reflected decreased effects of vertical mixing in the water column as compared to the river.

Thermal stratification of the water column was evident at station MT-2 and was related to effects of the heated discharge originating with the Barry steam electric generation facility of the Alabama Power Corporation (Figure 4). The facility's permitted Point of Discharge (POD) to the river was located approximately 500 yards upstream of station MT-2. Surface water temperature was 35.4 C which decreased to 28.1 C near the river bottom. The thermocline occurred at a depth of about 10 feet. Water temperatures at stations MT-1 and MT-0 ranged between 27.8 and 29.0 C and were similar to the readings measured below the thermocline at station MT-2. Temperature profiles of the water column in the upper reach of the study area (MT-7, 8, and 9) were characterized by cooler temperatures ranging from 24.5 to 26.4 C.

Conductivity reading indicated that the river was fairly well mixed along the vertical plain of the water column, except in the case of the navigation channel at station MT-0 (Table 2). At this station, the conductivity profile for the navigation channel indicated a relatively narrow range in values (305 to 311 umhos) from the surface to a depth of about 35 feet where the conductivity increased to 750 umhos and then to 6250 umhos at the bottom. The increased conductivity could best be explained by the probable effects of a strata of denser, saline water extending up channel from Mobile Bay, a result of freshwater stream flow merging with an estuary.

Another aspect of the conductivity regime at station MT-0 was

its profile established outside of the channel area at site MT-0C. This shallower area which flanked the navigation channel and adjoined the eastern shore of the river featured a relatively narrow range of readings from surface to bottom. These values were two fold greater in magnitude than readings in the river channel site (Table 2). This contrast would indicate that the water of the navigational channel was not fully mixed cross sectionally at station MT-0 at least during the time of sampling. The increased conductivity along the east side of the river at this location was likely reflecting residual effects of previous salinity intrusion into this area of the study reach. Upstream from station MT-0, the conductivity profiles for stations MT-1 and MT-2 were slightly decreased from the observation at the downstream sampling sites.

In the upper reaches of the study area near McIntosh, Alabama, the remaining stations for the screening study were located (stations MT-7, MT-8, and MT-9). The former station was situated approximately 300 yards downstream from the Olin Corporation's river loading facilities (Figure 5). At this site the conductivity profiles for the navigation channel and the shallower, near shore region flanking the east bank of the river shared a similar range of readings (Table 2). The river at this point appeared both vertically and horizontally mixed. The conductivity regime at this location was about 30 percent greater than observed at stations MT-7, MT-8 and MT-9 located upstream of the McIntosh area and probably best reflected a source of more mineralized water inflowing to the river.

The pH profiles for all stations sampled followed a fairly narrow range of 7.1 to 7.7.

The above reported profiles of the in situ parameters were considered in selecting sites and location in the water column to obtain representative samples for water analyses. Other considerations involved in the water and sediment sampling strategy included safety relative to anchoring the sampling boat, barge traffic and currents. In Table 2, sampling depths and sites are indicated.

Table B-1.

Vertical water quality profiles.
Mobile River Study. October, 1993.

STATION	DATE	DEPTH (FT)	TEMP. (°C)	D.O. (mg/L)	COND. (μ mho)	pH
MT-0C	10-6-93	1	28.5	6.5	630	7.2
		4	28.4	6.4	690	7.2
		7*	28.5	6.3	718	7.1
		10	28.5	6.3	713	7.2
		13	28.5	6.3	762	7.2
		15.5**	28.5	6.3	757	7.2
		MT-0B	10-7-93	1	28.0	6.9
		6	27.9	7.0	307	7.2
		11	27.9	7.0	309	7.2
		16	27.9	6.9	309	7.2
		21	27.8	6.9	310	7.2
		26	27.8	6.4	311	7.2
		31	27.8	6.6	309	7.2
		35	27.8	6.4	750	7.1
		38**	28.1	4.5	6250	6.5
MT-1A	10-7-93	1	29.0	7.0	284	7.2
		6	29.0	7.0	284	7.3
		11	29.0	6.9	283	7.2
		16	29.0	6.8	282	7.2
		21	29.0	6.8	282	7.2
		26	29.0	6.8	282	7.2
		31	29.0	6.8	283	7.2
		36	29.0	6.8	285	7.2
		41	29.0	6.8	281	7.2
		46	29.0	6.7	285	7.2
		51	29.0	6.7	282	7.2
		56**	29.0	6.7	283	7.2

Table B-1 cont.

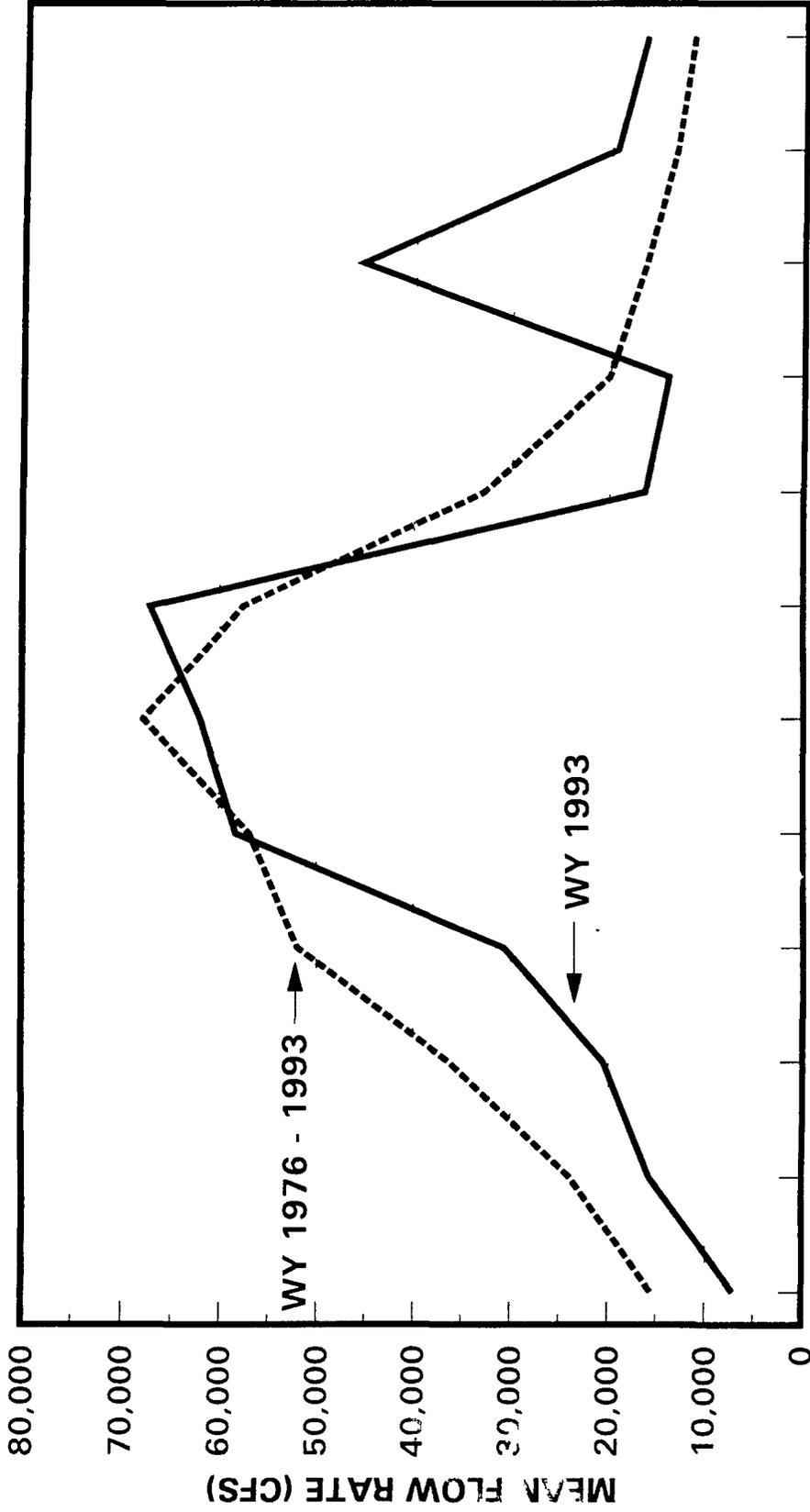
STATION	DATE	DEPTH (FT)	TEMP. (°C)	D.O. (mg/L)	COND. (µmho)	pH
MT-1B	10-6-93	1	28.9	7.1	287	7.3
		4	29.0	6.9	287	7.3
		7	28.9	6.8	286	7.3
		10*	29.0	6.8	285	7.2
		13	29.0	6.8	285	7.3
		16	28.9	6.7	288	7.2
		19	28.6	6.5	295	7.2
		20	28.6	6.5	298	7.2
MT-2A	10-8-93	1	35.4	6.8	249	7.2
		4	35.2	6.7	247	7.2
		7	32.5	6.7	243	7.2
		10	30.8	6.6	239	7.2
		13*	28.8	6.6	233	7.2
		17	28.3	6.6	230	7.2
		20**	28.1	6.5	229	7.2
MT-7C	10-7-93	1	26.3	8.9	410	7.2
		4*	26.1	8.3	490	7.3
		7**	21.0	8.0	528	7.3
MT-7B	10-7-93	1	26.2	8.2	467	7.5
		6	26.2	8.2	480	7.5
		11	26.2	8.2	480	7.5
		16	26.2	8.1	476	7.6
		21**	26.2	8.0	473	7.5
MT-9C	10-7-93	1	26.4	8.9	354	7.7
		4*	26.3	8.9	354	7.7
		7	26.3	8.8	354	7.7
		10**	26.3	8.8	354	7.7
MT-8	10-7-93	1*	25.6	7.5	309	7.2
		3	25.5	7.1	306	7.2
		6**	24.5	4.9	235	7.1

Station - A,B,C respectively indicate left, center and right quarter points of the river cross section facing upstream.

* - depth of water column grab sample for chemical analyses.

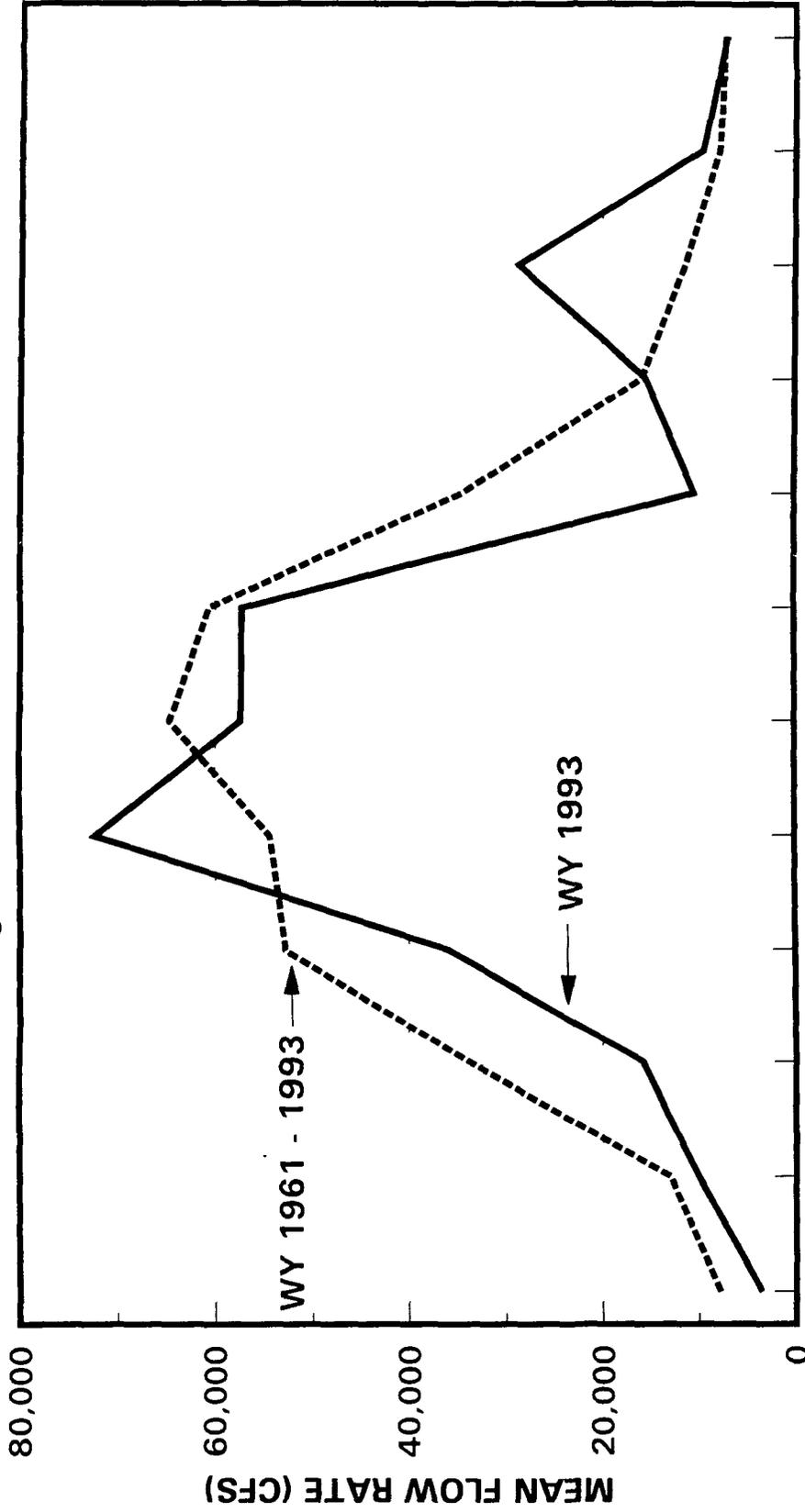
** - sediment grab sample for chemical analyses.

**Figure B - 1 Mean Flow by Month (USGS)
Alabama River at Claiborne L & D**



MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
—	7,087	15,760	20,530	30,740	58,250	61,970	67,130	16,340	14,000	45,430	19,420	16,400
- - -	15,560	23,940	36,380	51,950	56,860	67,770	57,560	32,850	20,050	16,290	13,270	11,560

**Figure B - 2 Mean Flow by Month (USGS)
Tombigbee River at Coffeeville L & D**



MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
—	3,590	10,080	15,800	35,850	72,320	57,350	57,310	10,340	15,390	28,680	9,577	7,064
- - -	7,843	12,980	33,710	52,800	54,370	64,710	60,660	34,500	15,780	11,350	7,841	7,264

APPENDIX C

**FISH COLLECTION PROTOCOL,
MOBILE RIVER STUDY,
1993-94.**

Fish Collection Protocol, Mobile River Study, 1993-94.

Largemouth Bass, Channel Catfish and forage fish for the Mobile River Study were captured between November, 1993 and 1994. All collected species were harvested using boat mounted electrofishing equipment. Additionally Channel Catfish were also collected in cheese-baited box traps. Once caught, the fish were immediately transferred to a cooler which held bagged ice and was lined with plastic. After a short reach of the river was electrofished, the fish were sorted with gloved hands, measured, placed in individual plastic bags with station number and specific fish number noted, sealed, returned to cooler and information recorded onto a field log sheet. At the end of the fishing session, fish were transported to the processing area.

FILLETING PROCESS

Talc free gloves were worn anytime fish were handled and were changed between every composite or individual fish sample. Individual fish were grouped according to size class and species. Individual fish were measured to determine total body length (from the tip of the nose to the tip of the compressed caudal fin) in millimeters and weighed to the nearest gram while still in their individual bags, and this information was recorded on the log sheet. The fish were then removed from the plastic bag with gloved hands and placed in a glass pan with other fish of the same composite sample. The bag was weighed and its weight recorded on the log sheet. When all five fish had been weighed and measured, five to ten scales were removed from the left side of each of the fish below the lateral line and posterior to the pectoral fin for possible fish aging studies. These scales were placed in appropriately marked individual manila envelopes. Two tags were prepared for each fish with its individual fish number and the addition of an "R" on one tag and an "L" on the other to identify the right or left fillet and placed in the mouth of the fish, (Example 1-32R, 1-32L). The fish were then scaled (Largemouth Bass) or skinned (Channel Catfish), rinsed with organic free water and placed in a clean glass pan. The individual fish were transferred to a glass plate for filleting. The right and left fillet, including the belly flap, were removed using stainless steel fillet knives. Sex was determined whenever possible and recorded. External anomalies were noted and recorded. The left fillet was weighed and placed on a piece of plastic (with the numbered tag from the fish's mouth) for metals analysis and the right fillet weighed and placed on a piece of aluminum foil, with its numbered tag, for organics analysis. The left fillets for each composite sample were individually wrapped in plastic and placed in a single plastic bag. The right fillets were individually wrapped in aluminum foil and placed in a single plastic bag. Custody tags were placed with the fillets, information logged and the fish frozen for transport to the Athens Ecological Support Branch Lab for processing.

PROCESSING FILLET SAMPLES

The five fish fillets comprising each composite were removed from the freezer to partially thaw so that they could be cut into small pieces with a stainless steel knife. These pieces were placed in a blender which had been prechilled with dry ice and blended to a uniform consistency. Additional dry ice was added as necessary to enhance this process. The thoroughly blended sample of all five fillets was then placed on foil or in a plastic bag (depending on analysis protocol), loosely sealed and allowed to sublime in the freezer for approximately 48 hours. Fish were removed from the freezer, thoroughly mixed and aliquots measured for analysis of metals or organics. The aliquots were then tagged and shipped on dry ice to the analytical laboratories. Chain-of-custody protocol was followed throughout the study.

WHOLE BODY FISH

Whole body fish were tagged and logged and placed in the freezer at the field processing laboratory upon arrival from the field. The frozen fish were transported to Athens for final processing. Processing consisted of thawing the fish enough to allow them to be cut into small pieces, placed in a grinder and ground. The intestinal tracts of all catfish were removed because of the presence of cheese bait which was used to bait the traps. The fish were sent through the grinder three times to facilitate thorough mixing of all parts of the fish. Aliquots were measured for metals and organic analyses, wrapped, frozen, chain-of custody initiated, and shipped on dry ice to analytical laboratories.

DECONTAMINATION PROCEDURES.

All equipment, with the exception of dip nets, were cleaned with tap water and laboratory detergent using a brush, if necessary, to remove particulate matter and surface films. The equipment was rinsed thoroughly with tap water, rinsed thoroughly with deionized water, rinsed twice with isopropyl alcohol, rinsed thoroughly with organic free water and allowed to air dry as long as possible or wrapped in aluminum foil for longer storage. All equipment was decontaminated after each sample.

Dip nets were cleaned with laboratory detergent and thoroughly rinsed with tap water, allowed to air dry as long as possible and wrapped in plastic bags. Dip nets were changed between stations.

APPENDIX D

FISH HEALTH INDEX (FHI) PROTOCOL

Fish Health Index (FHI) Protocol

Introduction

This protocol is designed to assess the general health of fish populations in a reservoir or river system. The FHI is based on the Health Assessment Index (HAI) developed by Adams et. al (1993) and the Fish Health / Condition Assessment Procedures developed by Goede (1993). Autopsies are performed on a population of live fish, concentrating on the following specific tissues and organs. The tissue and organs examined include:

Length	Fat
Weight	Gall bladder
Eyes	Hind gut
Gills	Kidney
Pseudobranch	Liver
Thymus	Spleen
Fins	Blood
Opercles	

Each tissue or organ is assigned a numerical value based on general condition or degree of damage. Each fish receives a total score by summing individual values for each tissue or organ. The mean score for a "population" of fish can be compared statistically with mean scores of other populations.

A. Apparatus and Equipment

- Hematocrit Centrifuge
- Hematocrit tubes
- Hematocrit seal
- Hematocrit rack
- Protometer
- Forceps
- Blunt nose scissors
- Scalpels
- Fillet knives
- Glass pans
- Balance
- Measuring board
- Latex rubber gloves
- MS-222 (tricaine methanesulfonate)
- Camera
- Camera stand
- Film
- Paper towels
- Kimwipes
- Trash bags

Opti-visors
Stereo microscope

Field Collection Equipment

Electrofishing unit
Generator
Dip nets
Live well
Electricians gloves
Rubber boots
Boat

B. Fish Collection

The optimum sample size is 15 fish, however, as few as 10 is acceptable. Fish should be collected via electrofishing or a passive collection method. Active collection methods such as seining should be avoided as they can produce external injuries that may bias results. Upon collection, immediately place fish in a live well and disturb them as little as possible until they are anesthetized in preparation for the autopsies. A minimum length of 250 mm is recommended for bass and 325 mm for catfish, although it is possible to autopsy smaller fish.

C. Autopsy Procedure

Immobilize fish by placing them in a 100 mg/l (ppm) solution of MS-222 (tricaine methanesulfonate). A 100 ppm solution is made by adding 4 g powdered MS-222 to approximately 10 gallons (40 liters) of water. Wait 5 to 10 minutes for the anesthetic to take effect. Fish are properly anesthetized when regular, rhythmic opercular activity ceases. At this point fish will remain alive but anesthetized for several hours.

External Examination

Begin the external exam by laying an anesthetized fish on a measuring board and recording its length in mm. Next transfer the fish to a scale and record its weight in grams. Now lay out the fish and examine, in order, the following tissues and organs, recording the condition of each tissue or organ with a number or letter code as listed below:

Eyes:

Normal (N) - No aberrations in evidence. Good "clear" eye.

Exophthalmic (popeye) (E1, E2) - Swollen, protruding eye. More commonly referred to as "popeye". It is coded as E1 or E2. This refers to the presence of exophthalmia in one eye or two eyes.

Hemorrhagic (H1, H2) - Refers to bleeding in the eye.

"Blind" (B1, B2) - This is a very graphic category and you need not know whether the eye is functionally blind. It generally refers to opaque eyes. The nature of the opacity is not important here.

"Missing" (M1, M2) - An eye is actually missing from the fish.

"Other" (OT) - Any manifestations which do not "fit" the above. Describe it in the remarks column.

Fins:

It must be remembered that this particular assessment system is concerned primarily with health and condition. It is not concerned with aesthetic values. Eroded or "ragged" fins are definitely indicative of a departure from normal condition and health. Previously eroded fins which are completely healed over and showing no evidence of the active erosion are, for the purposes of this assessment, considered normal. The evaluation of fins is relative to the degree of active erosion process in evidence. For the purposes of this procedure, the number and location of fins involved is not significant. If only one fin is displaying active erosion, the observation must be ranked and recorded. If several fins are displaying erosion with unequal severity, the observation must refer to the most severe in evidence. This unequal nature of the observations, in this case, is less significant in a full 15 fish sample. The classification is as follows:

No active erosion (0) - Normal appearing fins with no active erosion. This would include previously eroded fins which were completely healed over.

Mild active erosion (1) - Active erosion process but no hemorrhage or secondary infection in evidence.

Severe active erosion (2) - Active erosion with hemorrhage and/or secondary infection in evidence.

Note! Make a general remark relative to which fins were involved and any other observation of special significance. There is a space for this type of entry at the bottom of the data collection worksheet. This is particularly important in the summary.

Opercles:

It is necessary only to observe the degree of shortening of the opercles. The classification is as follows:

Normal opercle (0) - No shortening; gills completely covered

Mild shortening (1) - Slight shortening of the opercle with a very small portion of the gill exposed

Severe shortening (2) - Severe shortening of the opercles with a considerable portion of the gill exposed.

Gills:

Normal (N) - No apparent aberrations in gills. Be very careful in this observation. The gill can easily be effected by the manner in which the fish is handed during and after collecting. Be alert and aware.

"Frayed" (F) - This generally refers to actual erosion of tips of gill lamellae resulting in "ragged" appearing gills. Mere separation of gill lamellae can be construed to be "frayed" but that condition may have been caused by something as simple as the manner in which the gill was exposed by the investigator.

"Clubbed" (C) - This refers to swelling of the tips of the gill lamellae. They can often appear bulbous or "club" like. The causes are not pertinent until interpretation is considered.

"Marginate" (M) - A graphic description of a gill with a light discolored margin along the distal ends or tips of the lamellae or filaments. Margination can be and often is associated with "clubbing". If both seem to apply it is not a problem. It is important that you noted that it was not normal. Use the one which seems most appropriate.

"Pale" (P) - This refers to gills which are definitely very light in color. Severe anemia can result in gills which are discolored to the point of being white. Severe bleeding induced during sampling of blood can also result in somewhat pale gills. Gills begin to pale somewhat after death also. This is not uncommon in fish taken from nets. All of this should be considered in making the observation.

Other (O1) - Any observation which does not fit above. Describe in remarks.

Pseudobranchs:

Normal (N) - The pseudobranch is located dorsally and anterior to the gills in the branchial cavity and can be easily observed under the operculum. The normal pseudobranch is quite "flat" or even concave in aspect and displays no aberrations.

Swollen (S) - The "swollen" pseudobranch is convex in aspect and not difficult to discern upon close examination.

Lithic (L) - Mineral deposits in pseudobranchs, manifested by appearance of white, somewhat amorphous spots or foci.

Swollen and Lithic (S&L) - Lithic pseudobranchs are often also swollen.

Inflamed (I) - This is a generic use of the term, inflamed, and would more appropriately be termed "redness" because it also includes observations of hemorrhage and any other cause of redness. The term, "inflamed" has been traditionally used to describe this condition and is thus continued for that reason.

Other (OT) - This term will cover any manifestation observed in the pseudobranch which is not covered in the categories. Be sure to describe in remarks.

Thymus:

Assessment of the thymus involves degree of petechial or "pinpoint" hemorrhage.

No Hemorrhage (0) - The thymus displaying no hemorrhage is considered to be a normal condition, although this assumption is still under investigation. Caution must be exercised here because when the thymus involutes or ceases to function there is no observable petechial hemorrhage. This happens normally as the fish mature. In salmonids, involution of the thymus is thought to happen at two or three years of age but there is considerable disagreement among investigators about that point.

Mild hemorrhage (1) - A few red spots or petechial hemorrhages in evidence. This might be only two or three small spots.

Moderate hemorrhage (2) - More than a few red spots.

Severe Hemorrhage (3) - Many "pin point" hemorrhages in evidence with some of them coalescing. The general area may also have a swollen tumescent appearance but that should be recorded in remarks.

Internal Examination

Once the external examination has been completed, position the fish "belly up" and, using sharp/blunt scissors, make a ventral cut from the anal vent forward to the pectoral girdle. Do not insert the scissors so far that the internal organs are damaged. In largemouth bass and other centrarchids carefully cut through the pectoral girdle to lay open the pericardial cavity and expose the heart and aorta. In catfish leave the pectoral girdle intact.

Liver:

Upon opening the fish, immediately inspect and record the color and condition of the liver. This must be done prior to collecting blood. Collecting blood and even minor hemorrhaging sustained during dissection can quickly drain color from the liver.

Normal (A). Good, solid red color.

Lighter-or less vivid red color. Not so pale as to be classed general discoloration. Still considered to be normal.

"Fatty" liver (C). Light tan color, such as "coffee with cream".

Nodules (NO) Nodules in the liver, i.e. white mycobacterial cysts and incipient nodules, such as those in hepatoma.

Focal discoloration (DF). Change of color in local areas or foci of the liver.

General Discoloration (DG). Color change in the whole liver.

Other (OT). Aberration or deviation in liver which does not fit into above scheme. Class as OT and describe in remarks.

Blood

Following inspection of the liver, collect blood. Blood is collected with a sharpened, heparinized microhematocrit tube via a cardiac puncture. In bass blood is tapped from the aorta. By inserting a finger into the buccal cavity and gently pressing upwards, the heart and aorta can be immobilized against the roof of the pericardial cavity, making cardiac puncture much easier. In catfish the same technique can be used to immobilize the heart and aorta, but, since the pericardial cavity is not open, the cardiac puncture is more difficult. Once the heart and aorta are immobilized between the floor and raised roof of the pericardial cavity, the sharpened capillary tube is thrust through the membrane separating the pericardial and coelomic cavities and into the pericardial cavity in the suspected location of the aorta. If the aorta is punctured, a spurt of dark red blood will partially fill the tube. If a clear yellow or pale red fluid enters the tube, the aorta was missed. Try again with a fresh hematocrit tube. When the aorta has been punctured, blood can be pumped into the tube by gently releasing and then reapplying pressure on the aorta with the finger still inserted in the buccal cavity. The tube once filled is sealed with hematocrit clay and placed in a numbered rack. Make every effort to ensure samples are matched with the appropriate fish. After collecting a blood sample, proceed with the autopsy as outlined below.

Note: After 30 minutes or the collection of 6 to 8 samples, whichever comes first, place tubes in a hematocrit centrifuge and spin for five minutes. Hematocrits should be read within 2 hours of collection or before the blood begins to coagulate. To read hematocrits:

Obtain an hematocrit reader and place the filled hematocrit tube so that the bottom of the red portion is at the 0 line and the meniscus of the clear plasma is at the 100% percent mark. The packed red cell volume of the blood is the hematocrit and is read as a percentage of the total blood volume.

The leucocrit is the buffy of gray zone which consist of the leucocytes or white blood cells an is also read as percent of the total volume on the hematocrit reader.

The protein content of the plasma is determined using a protein refractometer. Take the hematocrit tube and break it off just above the buffy, gray zone to obtain the clear plasma and express the plasma onto the clear glass surface of the protein refractometer. Avoid placing any glass fragments from the tube on the refractometer. Read the weight/volume percent of protein in the refractometer. The protein refractometer should be calibrated prior to use with distilled water.

After collecting a blood sample, proceed with the autopsy by examining, in order, the following tissues and organs, recording the condition of each tissue and organ with a number or letter code listed below:

Mesenteric Fat:

- 0 - No fat deposited around the pyloric caeca.
- 1 - Slight, where less than 50% of each cecum is covered with fat.
- 2 - 50% of each cecum is covered with fat.
- 3 - More than each cecum is covered with fat.
- 4 - Pyloric caeca are completely covered by a large amount of fat.

Spleen:

Black (B) - The "black" is actually a very dark red color of the spleen.

(Red coloration of the spleen. There is subjective variation among investigators as to whether the spleen is black or red, but both condition are considered normal.)

Granular (G) - Granular or "rough" appearance of the spleen. This is also considered normal.

Nodular (NO) - The spleen contains or manifests fistulas or nodules of varying sizes. These are often cysts, such as those encountered with mycobacterial infections.

Enlarged (E) - Spleens can, on occasion, be significantly and noticeably enlarged.

Other (OT) - Occasionally there are observable, gross aberrations which do no fit the above. There may be spleens with a gray mottling and some with very small spleens. These should be classed as "other" and described in remarks.

Hindgut:

A short distance of the hind gut should be "opened". This should, in fact, have been accomplished as mentioned above when the body cavity was incised. If not, it must be opened to expose the "inner lining" or mucosa. Using the handle of a forceps or some other appropriate blunt instrument, lightly "scrape" out the contents of the hindgut so that you can observe relative reddening or inflammation.

- 0 - No inflammation or reddening of the hindgut.
- 1 - Mild or slight inflammation or reddening of the hindgut
- 2 - Moderate inflammation of the hindgut.
- 3 - Considerable, severe inflammation or reddening of the hind gut.

Kidney:

Normal (N) - Good firm dark red color lying relatively flat dorsally in the visceral cavity along the length of the ventral surface of the vertebral column. It will be necessary to pull the swimbladder and some of the mesentery aside to expose the kidney to view.

Swollen (S) - Enlarged or swollen wholly or in part.

Mottled (M) - Gray discoloration, mottled or "patchy" in appearance ranging from scattered patches of gray to total gray discoloration. This is not to be mistaken with the superficial gray appearance induced by the mesenteric membranes on the surface of the kidney. This should be moved aside before observation is recorded.

Nodular (NO) - The kidney may have a "granular" or nodular appearance and texture. This may be induced by granulomatous concretions.

Urolithiasis (U) - This condition is also known as nephrocalcinosis and involve mineral material in the deposition of a white or "cream-colored" amorphous tubules of the kidney. it can range in appearance from very small white spots to severe involvement with very large "serpentine" deposits. These sites of deposition are not to be confused with the Stannius bodies corpora of Stannius which are present in salmonid kidneys and have endocrine function. The Stannius bodies are generally not associated with the tubules and usually occur at the "edges" in an area about midway along the kidney. They appear more globular than do the urolithic deposits.

Other (OT) - This is used to class any aberrations which do not fit into the above scheme. Record it as OT and describe it in the remarks.

Gall Bladder -

- 0 - Yellow, empty of partially full
- 1 - Yellow, full or distended

- 2 - Grass green
- 3 - Dark green

Sex:

Male (M) - Testes observed

Female (F) - Ovaries observed Note if "ripe" with eggs

Unknown (U) - immature or undeveloped gonads

General Observations and Remarks

Anything which appears to be abnormal should be noted. It is recommended that the mesenteric tissues in the visceral cavity be checked for hemorrhage and inflammation and if these conditions are present they should be so noted in general remarks.

D. Scoring

Once autopsies are completed, transcribe the number and letter codes assigned to the condition of each tissue/organ to a numerical score according to the table below. Note that no score is given to sex, fat deposits, and gall bladder. Conditions associated with these tissues/organs are not considered pathological but simply a physiological or nutritional state that varies on a seasonal or other periodic basis.

<u>Tissue or Organ</u>	<u>Condition</u>	<u>Score</u>	<u>Tissue or Organ</u>	<u>Condition</u>	<u>Score</u>
<u>Eyes</u>	N	0	<u>Spleen</u>	B	0
	E1,E2	30		GR	0
	H1,H2	30		NO	30
	B1,B2	30		E	30
	M1,M2	30		OT	30
	OT	30			
<u>Fins</u>	0	0	<u>Hind Gut</u>	0	0
	1	10		1	10
	2	20		2	20
				3	30
<u>Opercles</u>	0	0	<u>Kidney</u>	N	0
	1	10		S	30
	2	20		M	30
<u>Gill</u>	N	0		NO	30
	F	30		U	30
	C	30		OT	30
	M	30	<u>Liver</u>	A	0
	P	30	C	30	
			NO	30	
<u>Pseudobranchs</u>	N	0	DF	30	
	S	30	DG	30	
	L	30	OT	30	
	SL	30	Blood:		
	I	30	<u>Hematocrit</u>	≥ 31	0
	OT	30		< 31	30
<u>Thymus</u>	0	0	<u>Leucocrit</u>	< 4	0
	1	10		≥ 4	30
	2	20	<u>Plasma Protein</u>	$3 \leq x \leq 6$	0
	3	30		> 6	30
			< 3	30	

E. Calculations and Summary Data

The following calculations are useful in assessing the overall fish health. The specific calculations performed will be determined by the specific objectives of a given study. Many of the following calculations can be done by hand, but for most studies the use of a computer or at least pocket calculator with a function key for calculating mean and standard deviation is recommended.

Ktl:

The value for Ktl is a ratio of length to weight. It is routinely expressed as $Ktl \times 10^5$ to mitigate the problem of carrying so many decimal places in the records. Use the following equation to obtain a value:

$$Ktl = \frac{W \times 10^5}{L^3}$$

Where:

W = Weight in grams

L = Total length in millimeters

Mean and Standard Deviation:

The mean is determined by totaling all of the values for the observations and dividing by the number of the observations. In-depth discussion of the standard deviation is beyond the scope of this presentation. Again, a pocket calculator or computer is recommended for making this calculation. In each sample of fish examined calculate means and standard deviations for the following observations:

Length
Weight
Ktl
Hematocrit
Leucocrit
Plasma protein

These calculations are made on raw data from autopsy sheets, not from assigned scores.

Fish Health Index (FHI) Score:

Calculate an FHI score for each fish by totaling the numerical score for each tissue/organ. For a given sample or population of fish calculate the mean and standard deviation from the individual FHI scores for fish in that sample. The mean FHI scores between samples can be compared statistically.

Values as Percents of Total Sample

This calculation expresses as a percent the number of fish in a sample with a specific physical/pathological condition. As an example, consider the eyes. The number of fish with normal eyes in a given sample is divided by the total number of fish in the sample (x 100) to yield the percentage of normal-eyed fish in that sample. Similarly, the percentage of fish in a sample with one blind eye (B1) can be calculated. A percentage can be calculated for any or all physical/pathological conditions. It is particularly useful for pinpointing a high incidence of disease in any one particular tissue or organ.

F. Interpretation

The state-of-the-art in this area has not been refined. Normal and abnormal conditions for each tissue and organ have been fairly well defined, but measures of overall fish health based on FHI scores, for a sample, are still being evaluated. The interpretation of overall fish health is complicated by the varying sensitivity of different fish species to environmental stresses. A viable strategy for investigating potential hazardous waste sites is to statistically compare the mean FHI score for a fish sample from a suspected "impacted" site with the mean score for fish from an established or selected "unimpacted" reference or background site on a species to species basis. Other strategies may prove equally enlightening as more FHI studies are completed.

APPENDIX D

FISH HEALTH INDEX (FHI) PROTOCOL

**Goede (1993)
AUTOPSY CLASSIFICATION KEY**

Length: Total length in millimeters
Weight: Weight in grams

Ktl: = $\frac{W \times 10^5}{L^3}$

Sex: F F, note if ripe
M

EXTERNAL EXAMINATION

Eyes: Normal (N)
Exophthalmic (popeye) (E1, E2)
Hemorrhagic (H1, H2)
Blind (B1, B2)
Missing (M1, M2)
Other (OT)

Fins: No active erosion; previous erosion healed over (0)
Mild erosion with no bleeding (1)
Severe active erosion with hemorrhage and/or
secondary infection (2)

Opercles: No shortening (0)
Mild shortening (1)
Severe shortening (2)

Gills: Normal (N)
Frayed (F) Clubbed (C)
Marginate (M) Pale (P) Other (OT)

Pseudobranch: Normal (N)
Swollen (S) Lithic (L)
Swollen and Lithic (SL)
Inflamed (I) Other (OT)

Thymus: No hemorrhage (0)
Mild hemorrhage (1)
Severe hemorrhage (2)

INTERNAL EXAMINATION

Fat: None (0)
Slight, ≤ 50% of each cecum is covered (1)
50% of each cecum is covered (2)
≥50% of each cecum is covered (3)
100% of each cecum is covered (4)

Spleen: Black (B) Red (R)
 Granular (G)
 Nodular (NO)
 Enlarged (E)
 Other (OT)

Hindgut: No inflammation (0)
 Slight inflammation (1)
 Severe inflammation (2)

Kidneys: Normal (N)
 Swollen (S) Mottled (M)
 Granular (G) Urolithic (U)
 Other (OT)

Liver: Red (A) Light red (B)
 Coffee & Cream (C)
 Nodular (D)
 Discoloration, focal (E)
 Discoloration, general (F)
 Other (OT)

Gallbladder: Yellow, empty or partially full (0)
 Yellow, full or distended (1)
 Grass green (2)
 Dark green (3)

Blood:

Hematocrit Volume of red blood cells (erythrocytes) expressed
 as percent of total blood volume. Centrifuged 5
 minutes.

Leucocrit Volume of white blood cells (leucocytes) expressed
 as percent of total blood volume. "Buffy" zone of
 the packed cell column.

Plasma protein Amount of protein plasma, expressed as gram percent
 (grams per 100 ml).

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/26/94 Unit _____
 Location JM, Row Washers MW Fish Source (E) Strain
 Investigator(s) _____ Hatch Date _____ Age _____
 Reason for Autopsy _____ Remarks _____
 Case History # _____ Tissue Collection # _____

Smp no	Lgth mm	Wght gm	Kil	Eye	Gill	Pskr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opt	Remarks
1	330	403		N	N	N	0	0	B	0	N	D/F	2	r:pe ♀	43	43	5.1	0	0	Fin removed in juv Liver - muscle 2/1
2	330	481		B1	N	N	0	0	R	1	N	DE	2	♀	39	39.2	5.0	0	0	
3	347	479		N	N	N	0	0	ND	0	G	DE	2	♀				0	1	lesion on lower jaw
4	370	599		N	N	N	0	1	0	0	G	DE	2	r:pe ♀				0	0	lesion on lower jaw
5	310	336		N	N	N	0	0	R	0	N	DB	0	r:pe ♀	40	40	4.0	0	0	lesion on lower jaw
6	330	433		N	N	N	0	0	ND	0	G	DE	2	♀	42	42.1	4.2	0	0	lesion on lower jaw
7	320	379		N	N	N	0	0	R	0	G	DE	1	♀	34	34	4.0	0	0	RBC's stuck in top of liver. Gut. 2/1
8	326	432		N	N	N	0	0	R	0	N	B	0	♀	36	38	4.8	0	0	
9	311	348		N	N	N	0	0	D	0	G	DF	2	♀	50	50	5.4	1	0	Spleen, see plate 4/2
10	245	159		N	N	N	0	0	R	0	N	B	1	♀	36	36.4	4.0	0	0	lesion on liver
11	320	334		N	N	N	0	0	R	0	G	DE	2	r:pe ♀				0	0	
12	300	287		B1	N	N	0	0	ND	0	G	DE	2	r:pe ♀	43	43	4.0	0	0	
13	396	811		N	N	N	0	1	ND	0	G	D	2	r:pe ♀				0	0	retaining in flavum noted liver
14	366	556		N	N	N	0	0	0	0	G	DF	1	r:pe ♀				0	0	retaining in flavum noted of spleen
15	352	565		N	N	N	0	0	R	0	S	BD	1	r:pe ♀				0	2	
16	463	1510		N	N	N	0	3	ND	0	N	D	0	r:pe ♀	40	40				flated before autopsy. Gold bla filiated before autopsy.
17	460	1349		N	N	N	0	2	R	0	N	D	2	♀	27.5	27.5	5.2	0	0	
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____

Skin _____ Other _____

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/27/94 Unit _____ Strain _____ Quality Control # _____
 Location Mobile Fish Source B Age _____ Case History # _____
 Investigator(s) JL, RW, MW Hatch Date _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kl	Eye	Gill	Pscr	Thy	Fat	Spl	Hind Gut	Kid	Lv	Bile	Sex	Hem	Leu	Pl. Pro	Fn	Op	Remarks
1	345	466		N	N	N	OK	0	NO B	0	G	F D	2	♂	40	40	4.6	0	0	
2	356	576		N	N	N	0	0	NO	0	G	0	2	♀	39	40	4.8	0	0	Regstrom l. view
3	346	486		N	N	N	0	0	NO	0	G	D	0	♀	38	38	3.9	0	0	Spine 2x
4	377	650		N	N	N	0	0	B	0	G	D	2	♀	39	40	4.2	0	0	
5	336	458		N	N	N	0	0	B	0	N	F D	2	♀	34	34.5	4.4	0	0	Brown cysts - 40x = 3mm Spine 2x
6	351	588		N	N	N	0	0	NO	0	G	D F	2	♀	34	34	4.0	0	0	Int. flexion reactions Spine 2x
7	335	500		B1	N	N	0	0	0	0	G	D F	2	U	35	35	3.7	0	0	Circulatory fluid Spine # 11
8	409	938		N	N	N	0	2	R	0	G	D F	0	♀	42	42	4.4	0	0	
9	378	729		N	N	N	0	0	R	0	N	A D	0	♀	36	36	3.6	0	0	
10	273	234		N	N	N	0	0	NO	0	G	B D	1	♀	34	34	3.0	0	0	
11	245	167		N	N	N	0	0	R	0	G	B D	1	♀	32	32	3.4	0	0	
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

11

GENERAL REMARKS

Fins _____
 Skin _____
 Other electro

Bass - 2
 7/2/95

FISH AUTOPSIES

Wildlife Resources
 2/91 FES-25

Date 10/27/94 Unit _____ Strain _____ Quality Control # _____
 Location SK1, Rk2, MW Fish Source 2 Hatch Date _____ Case History # _____
 Reason for Autopsy _____ Tissue Collection # _____

Smp no	Lght mm	Wght gm	KH	Eye	Gill	Pedr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Len	P. Pro	Fin	Opl	Remarks
1	260	215		B1	N	N	1	0	NO	0	G	BD	0	♀ ^{1/2}	34	35	4.7	0	0	
2	334	398		N	N	N	0	0	NO	0	G	BD	2	♀ ^{1/2}	33	34	4.6	0	0	fluid-filled/ha- (spleen) - 12x pincts
3	305	359		N	N	N	0	0	R	0	G	BD	0	♀ ^{1/2}	33	33.1	5.1	0	0	clot on top (spl 2x) 1 pinct
4	385	825		N	N	N	0	1	B	0	G	DF	0	♀ ^{1/2}	35	35	5.3	0	0	(spl 2x)
5	400	875		N	N	N	0	1	NO	0	G	DF	0	♀	30	30.2	4.2	0	0	plate #16
6	367	653		N	N	N	0	2	NO	0	G	DF	2	♀	33	34	5.0	0	0	(spl 2x)
7	253	180		N	N	N	0	0	R	0	G	AD	0	♀	36	36	3.9	0	0	
8	230	148		N	N	N	0	0	NO	0	G	D	2	♂?	37	37.2	4.0	0	0	parasitic near thymus
9	277	252		N	N	N	0	0	NO	0	N	B	2	♀	35	35	3.7	0	0	
10	256	183		N	N	N	0	0	NO	0	N	B	0	♀ ^{1/2}	33	35	2.9	0	0	lesion on body
11	420	1096		N	N	N	0	2	B	0	G	FD	2	♂	32	32	4.5	0	0	thiers taken before autopsy
12	445	1348	104mm	N	N	N	0	3	0	0	N	D	2	♀ ^{1/2}	29	29	5.4	0	1	thiers taken before autopsy
13	430	1148		N	N	N	0	3	NO	0	G	DF	1	♂	29	29	4.7	0	0	lesion on body
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____ Other electro.

FISH AUTOPSIES

Midlife Resources
2/91 FES-25

Date 10/28/94 Unit _____ Strain _____ Quality Control # _____
 Location _____ Fish Source D Hatch Date _____ Age _____ Case History # _____
 Investigator(s) _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kd	Eye	Gill	Pskr	Thy	Fat	Spl	Hind Gut	Kid	Lv	Bile	Sex	Hem	Leu	P. Pro	Fin	Op	Remarks
1	290	291		N	N	N	0	0	ND	0	G	DF	1	♀	39	39.2	5.2	0	0	Piece of caudal fin missing
2	305	336		N	N	N	0	0	ND	0	G	BD	0	♂	40	40	3.6	0	0	Small lesion on lower jaw
3	307	355		B1	N	N	0	0	ND	0	G	DF	2	♂	39.5	40	3.7	0	0	(skin 2x)
4	292	291		M1	N	N	0	0	R	0	N	A	1	♀	24	27	4.2	0	0	puke #17
5	326	395		N	N	N	0	1	E	0	G	A	0	♀	32	34	4.6	0	0	puke #15 not autopsied kidney
6	376	593		N	N	N	0	1	ND	0	G	AD	1	♀	33	34.5	4.2	0	0	
7	382	641		N	N	N	0	0	ND	0	G	ED	1	♀	33	35	4.2	0	0	Quiescent spleen Spleen-bladder diarrhea worms(?)
8	382	713		B1	N	N	0	1	B.	0	N	DE	2	♀	42	42	4.6	0	0	diarrhea worms(?)
9	280	209		N	N	N	0	0	ND	0	SG	D.	1	♀	31	31	2.9	0	0	11 mos spleen kidney highly inflamed
10	274	219		N	N	N	0	0	R	0	G	AD	2	♀	37	27	3.6	0	0	lesion on lower jaw
11	325	391		N	N	N	0	1	R	0	N	FD	1	♀	35	35.2	4.0	0	0	
12	260	207		N	N	N	0	0	R	0	N	B	1	♀	36	36	3.5	0	0	
13	238	146		B1	N	N	0	0	R	0	N	A	1	♂	39	39	3.7	0	0	(skin 2x)
14	260	201		N	N	N	0	0	ND	0	G	D	1	♀	39	39	3.9	0	0	blowholes from parasites (P) on (skin 2x)
15	245	148		N	N	N	0	0	ND	0	N	BD	0	♀	39	39	3.2	0	0	(skin 2x)
16	412	598		N	N	N	0	0	B	0	N	AD	2	♂	43	43	5.2	0	0	blowholes from parasites (P) on (skin 2x)
17	427	1176		N	N	N	0	3	ND	0	S	D	0	♀	37	37	5.4	0	0	blowholes from parasites (P) on (skin 2x)
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other electro shock.

Bass - Day 3
 #4
 p4 of 4

FISH AUTOPSIES

Wildlife Resources
 2/91 FES-25

Date 10/28/94 Unit _____ Strain _____ Hatch Date _____ Age _____ Quality Control # _____
 Location _____ Fish Source F Strain _____ Hatch Date _____ Age _____ Case History # _____
 Investigator(s) _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lght mm	Wght gm	Kid	Eye	Gill	Pskr	Thy	Fat	Spl	Hand Gut	Kid	Lv	Bile	Sex	Hem	Leu	R. Pro	Fin	Opd	Remarks
1	272	211		N	N	N	0	0	N0	0	SG	AD	2	♂	39	40	3.6	0	0	
2	228	135		N	N	N	0	0	N0	0	G	B	1	♂	35	35.2	4.6	0	0	
3	306	319		N	N	N	0	0	N0	0	G	A	1	♂	34	34	4.4	0	0	skin discusstes
4	225	123		N	N	N	0	0	RN2	0	G	AD	1	♂	38	35	4.0	0	0	skin discusstes
5	295	253		N	N	N	0	0	N0	0	S	AD	0	♂	40	40	4.9	0	0	plastic # 21
6	287	276		N	N	N	0	0	RN0	0	N	ED	0	♂	36	36	4.7	0	0	plastic # 21
7	254	189		N	N	N	0	0	R	0	G	A	2	♂	34	35	4.8	0	0	
8	313	355		N	N	N	0	0	N0	0	G	BD	0	♂	30	30	.	0	0	direct current photo # 21
9	365	565		N	N	N	0	0	N0	0	G	AD	0	♂	39	39	4.0	0	0	inflammation in stomach
10	374	627		N	N	N	0	0	N0	0	G	FD	1	♂	40	40	4.2	0	0	inflammation in stomach
11	366	587		N	N	N	0	0	N0	0	G	D	1	♂	36	36	4.4	0	0	
12	318	358		N	N	N	0	0	N0	0	G	AD	1	♂	41	41	3.8	0	0	skin discusstes inflammation (liver)
13	386	789		N	N	N	0	0	B	0	N	F	2	♂	33	33	4.5	0	1	no study on liver
14	510	2011		N	N	N	0	2	B	0	N	D*	F	♀	34	34	5.1	0	0	filled & before autopsy * include one nucle
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____ Other electro shock.

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/29/94 Unit _____ Strain _____ Quality Control # _____
 Location _____ Fish Source H Hatch Date _____ Age _____ Case History # _____
 Investigator(s) _____ Remarks _____ Tissue Collection # _____
 Reason for Autopsy _____

Smp no	Lght mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Lv	Bile	Sex	Hem	Leu	Pl. Pro	Fn	Opl	Remarks	
1	240	167		N	N	M	0	0	R	0	G	BD	2	♀	31	32	4.3	0	0		
2	348	508		B _L	N	N	0	1	R	0	G	AD	2	♀	34	34	4.5	0	0	lesion on jaw 11/14/94, sparsely new lesion on jaw	
3	261	195		B _L	N	N	0	1	B	0	N	A	2	♂	37	37	5.2	0	0		
4	414	919		B ₂	N	N	0	3	B	0	N	BD	0	♀	41	41.5	5.5	0	0		
5	390	963		N	N	N	0	3	R	0	Not	B	2	♀	39	39	5.0	0	0	Spleen Swollen. Kidney - infla. Lecum - infla. deteriorated fat in spleen	
6	395	999		N	N	N	0	0	R	0	G	HD	2	♀	31	32	5.3	0	0		
7	379	757		N	N	N	0	3	B	0	G	FD	2	♀	30	30	4.0	0	0	possible infection in renal kidney region on lower jaw	
8	340	746		N	N	N	0	3	B	0	G	FD	2	♀	35	34	4.7	0	0		
9	364	585		N	N	N	0	3	NO	0	G	AD	2	♀	35	37	5.0	0	0		
10	351	573		N	N	N	0	1	NO	0	G	D	2	♂	34	34	4.2	0	0	liver + spleen swollen - no pits	
11	334	425		N	N	N	0	0	B	0	N	DE	2	♀	37	33	4.3	0	0		
12	312	370		B ₂	N	N	0	0	NO	0	N	BD	0	♀	41	41.1	2.2	0	0		
13	297	340		B ₁	N	N	0	0	NO	0	G	BD	0	♀	30	30	4.0	0	0		
14	257	193		B ₁	N	N	0	0	R	0	N	BD	0	♂	37	37	3.6	0	0		
15	278	240		N	N	N	0	0	B	0	G	B	1	♀	32	32	2.8	0	0		
16	232	133		N	N	N	0	0	NO	0	G	BD	0	♀	37	37	3.8	0	0		
17																					
18																					
19																					
20																					

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other Electro fish.

15055
 10.3 of 15
 14

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/29/94 Unit _____ Strain _____ Quality Control # _____
 Location _____ Fish Source I Hatch Date _____ Age _____ Case History # _____
 Investigator(s) _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lght mm	Wght gm	Kd	Eye	Gill	Pebr	Thy	Fat	SpL	Hand Gut	Kd	Lv	Bile	Sex	Hem	Lou	Pt.	Fin	OpL	Remarks
1	325	459		N	N	N	0	1	ND	0	G	F	0	♀	37	372	5.6	0	0	muscle NO - sp.
2	361	625		N	N	N	0	1	NO	0	G	B ^D G	2	♂	35	25	5.8	0	0	
3	472	1118		N	N	N	0	0	NO	0	N	AD	2	♀	34	34	5.6	0	0	retro-muscle
4	446	1153		N	N	N	0	2	B	0	G	DF	0	♀	38	39	5.0	0	0	Intestine empty, no contents, etc.
5	396	938		N	N	N	0	0	B	0	N	DF	0	♂	39	40	5.3	0	0	Protein in intestine, etc. Possible inflammation, etc. (Spun 2x)
6	325	411		N	N	N	0	0	R	0	N	B.	2	♀	35	35	4.7	0	0	(Spouse necrosis m.l.v.)
7	344	490		N	N	N	0	0	NS	0	N	BD	1	♂	33	34	4.0	0	0	
8	378	713		N	N	N	0	1	B	0	N	B	0	♀	36	37	5.2	0	0	
9	342	483		N	N	N	0	0	NO	0	G	B	0	♂	34	35	5.3	0	0	
10	290	272		N	N	N	0	0	B	0	N	B	1	♂	33	33	4.6	0	0	Intestine empty, caudal artery, caudal vein
11	275	239		N	N	N	0	0	R	0	N	B ^D *	1	♀	28	28	3.8	0	0	*1 necrosis on lvs
12	261	198		N	N	N	0	0	R	0	N	B	0	♀	35	35	3.2	0	0	
13	230	118		N	N	N	0	0	B	0	N	B	1	♂	33	33	4.0	0	0	Intestine of base of tail (spun 2x)
14	520	2123		N	N	N	0	3	R	0	G	D	2	♀	31	31	5.8	0	0	filtered before autopsy. Min. gms in lvs
15	495	1772		N	N	N	0	2	R	0	G [*]	D	2	♀	39	39	5.7	0	0	F lvs to etof autopsy, * Spouse
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other _____

15 of 5

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/30/94 Unit _____ Fish Source A Strain _____ Hatch Date _____ Age _____ Quality Control # _____ Case History # _____ Tissue Collection # _____
 Location R41, 3K1, MW
 Investigator(s) R41, 3K1, MW
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kt	Eye	Gill	Pskr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks
1	266	228		B1	N	N	0	0	NO	0	0	DF	0	♂	39	39.2	3.8	0	0	
2	271	240		B1	N	N	0	0	R	0	0	DF	2	♂	47	48	4.5	0	0	
3	345	488		N	N	N	0	0	B	0	0	DF	2	♂	26	26	4.5	0	0	breakdown structure liver specimen, normal
4	325	464		N	N	N	0	0	NO	0	N	AD	2	♀	45	45	4.2	0	0	
5	379	675		N	N	N	0	1	NO	0	G	BD	2	♂	21	31	4.1	0	0	sparsely necrotic
6	428	1150		N	N	N	0	3	NO	0	G	ED	2	♀	42	44	5.9	0	0	inflammation in ventral kidney
7	445	1009		B1	N	N	0	1	B	0	N	BD	2	♀	46	46	4.7	0	0	
8	295	337		N	N	N	0	1	R	0	G	BD	2	♀	42	42	4.6	0	0	Distended liver, pale, normal
9	361	656		N	N	N	0	3	B	0	N	FD	2	♀	40	40	4.1	0	0	
10	297	308		B1	N	N	0	0	R	0	N	B	2	♀	33	33.2	3.7	0	0	
11	349	553		N	N	N	0	1	NO	0	G	ED	2	♀	43	43	3.3	0	0	
12	289	311		N	N	N	0	1	NO	0	G	AD	2	♂	41	41.5	3.3	0	0	(spine - 2X)
13	304	353		N	N	N	0	1	NO	0	G	AD	2	♀	39	39	3.6	0	0	sparsely necrotic - split liver
14	357	563		N	N	N	0	1	NO	0	G	HD	2	♀	42	42	3.3	0	0	sparsely necrotic
15	282	228		N	N	N	0	0	NO	0	G	AD	2	♀	43	43	3.5	0	0	sparsely necrotic
16	292	283		N	N	N	0	0	NO	0	G	AD	0	♀	39	39	4.0	0	0	sparsely necrotic on spine (2x)
17																				
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____

Skin _____ Other _____

(Bass) ventral part of liver

sp. 1, 1/4, K, L, " " " "

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/30/94 Unit _____ Strain _____ Hatch Date _____ Age _____ Quality Control # _____ Case History # _____
 Location SM, RW, MW Fish Source G Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lght mm	Wght gm	Kd	Eye	Gill	Pedr	Thy	Fat	Spl	Hnd Gut	Kid	Lv	Bile	Sex	Hem	Leu	Pl.	Fn	Opl	Remarks
1	290	283		B1	N	N	0	0	R	0	N	B	1	♂	35	35	3.5	0	0	
2	346	514		B1	N	N	0	0	NO	0	G	BD	0	♂	31	32	3.8	0	0	
3	370	655		N	N	N	0	1	NO	0	G	FD	0	♂	34	34	5.0	0	0	
4	331	564		N	N	N	0	0	NO	0	G	D	1	♀	29.8	30	4.5	2	0	
5	353	561		N	N	N	0	1	R	0	N	D	1	♀	38	38	3.8	0	0	
6	356	573		N	N	N	0	1	NO	0	G	DB	1	♂	41	41	4.4	0	0	
7	358	570		B1	N	N	0	1	R	0	N	BD	0	♂	41	41	3.6	0	0	
8	286	256		N	N	N	0	0	NO	0	N	BD	1	♀	36	36	3.5	0	0	
9	256	195		N	N	N	0	1	NO	0	G	BD	1	♀	47	47	5.9	0	0	
10	320	411		B1	N	N	0	0	NO	0	G	ED	2	♂	32	32	3.2	0	0	
11	237	143		N	N	N	0	0	NO	0	G	BD	2	♀	43	43.2	4.6	0	0	
12	240	156		N	N	N	0	1	NO	0	G	BC	2	♀	42	42	3.3	0	0	
13	223	123		N	N	N	0	0	NO	0	G	BD	1	♀	37	37	3.2	0	0	
14	473	1332		N	N	N	0	1	NO	0	G	BD	1	♀	36	36	5.0	0	0	
15	412	862		N	N	N	0	1	B	0	G	B	0	♀	33	33	5.9	0	0	
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Gonads

Other adventitious

leaf
p 3 of 3 new

Last fish Aug 1 1982

FISH AUTOPSIES

Wildlife Resources
2/91 FES 25

Date 10/26/84 Unit _____ Fish Source F Strain _____
 Location Mob. 12, 1A Hatch Date _____ Age _____ Quality Control # _____
 Investigator(s) J. M. Weeks, J. R. Williams Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lght mm	Wght gm	Kid	Eye	Gill	Pstbr	Thy	Fat	Spl	Hnd Gnt	Kid	Lv	Bile	Sex	Hem	Leu	Plt	Fin	Opl	Remarks	
1	407	450	0.67	N	N	N	0	0	R	0	N	A	1	U	18	18.5	3.2	0	0	Liver - one readable	
2	431	573	0.72	N	N	N	0	0	R/E	0	N	F	1	♀	24	25	3.7	0	0		
3	389	384	0.65	N	N	N	0	0	R	0	N	DB	1	♀ hype	25	26	2.6	0	0		
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other _____

left sk - Day 2
p1 of 5

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/27/94 Unit _____ Strain _____ Quality Control # _____
 Location sub. 12 #C Fish Source D Age _____ Case History # _____
 Investigator(s) WKL, RW, WJ Hatch Date _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lght mm	Wght gm	Kid	Eye	Gill	Pskr	Thy	Fat	Spl	Hnd Gut	Kid	Lv	Bile	Sex	Hem	Leu	Pl. Pro	Fn	OpI	Remarks	
1	332	262		N	N	N	tbl	3	R	0	N	B	1	U	28	29	4.5	0	0		
2	410	563		N	N	N	N	0	R	0	N	A	1	♀	31	32.2	6.0	0	0		
3	530	1275		N	N	N	N	1	R	0	N	F	1	♂?	11	12	3.0	0	0	Weg. in top of liver	
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

GENERAL REMARKS

Fins _____
 Gonads _____
 Skin _____
 Other frags

102 of 5'

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/27/94 Unit _____ Strain _____ Quality Control # _____
 Location Mubrite, Ac Fish Source B Hatch Date _____ Case History # _____
 Investigator(s) SM, RW, MW Remarks _____ Tissue Collection # _____
 Reason for Autopsy _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Pstbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opt	Remarks	
1	420	506		N	N	N	0 ^{AM}	0	R	0	N	B _D	0	U	20	21	3.6	0	0		
2	362	286		N	N	N	0 ^{AM}	0	R	0	N	A _D	0	♀	20	21	3.0	0	0		
3	430	510		N	N	N	0 ^{AM}	0	R	0	N	A _D	1	♀	24	25	3.0	0	0		
4	490	1014		N	N	N	0 ^{AM}	1	R	0	N	B _D	1	♂	32	33	3.2	0	0		
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

(3)

Fins _____ GENERAL REMARKS _____
 Gonads _____

Skin _____ Other by electrofishing

Fish Health Index (FHI) Protocol

Introduction

This protocol is designed to assess the general health of fish populations in a reservoir or river system. The FHI is based on the Health Assessment Index (HAI) developed by Adams et. al (1993) and the Fish Health / Condition Assessment Procedures developed by Goede (1993). Autopsies are performed on a population of live fish, concentrating on the following specific tissues and organs. The tissue and organs examined include:

Length	Fat
Weight	Gall bladder
Eyes	Hind gut
Gills	Kidney
Pseudobranch	Liver
Thymus	Spleen
Fins	Blood
Opercles	

Each tissue or organ is assigned a numerical value based on general condition or degree of damage. Each fish receives a total score by summing individual values for each tissue or organ. The mean score for a "population" of fish can be compared statistically with mean scores of other populations.

A. Apparatus and Equipment

- Hematocrit Centrifuge
- Hematocrit tubes
- Hematocrit seal
- Hematocrit rack
- Protometer
- Forceps
- Blunt nose scissors
- Scalpels
- Fillet knives
- Glass pans
- Balance
- Measuring board
- Latex rubber gloves
- MS-222 (tricaine methanesulfonate)
- Camera
- Camera stand
- Film
- Paper towels
- Kimwipes
- Trash bags

Opti-visors
Stereo microscope

Field Collection Equipment

Electrofishing unit
Generator
Dip nets
Live well
Eelectricians gloves
Rubber boots
Boat

B. Fish Collection

The optimum sample size is 15 fish, however, as few as 10 is acceptable. Fish should be collected via electrofishing or a passive collection method. Active collection methods such as seining should be avoided as they can produce external injuries that may bias results. Upon collection, immediately place fish in a live well and disturb them as little as possible until they are anesthetized in preparation for the autopsies. A minimum length of 250 mm is recommended for bass and 325 mm for catfish, although it is possible to autopsy smaller fish.

C. Autopsy Procedure

Immobilize fish by placing them in a 100 mg/l (ppm) solution of MS-222 (tricaine methanesulfonate). A 100 ppm solution is made by adding 4 g powdered MS-222 to approximately 10 gallons (40 liters) of water. Wait 5 to 10 minutes for the anesthetic to take effect. Fish are properly anesthetized when regular, rhythmic opercular activity ceases. At this point fish will remain alive but anesthetized for several hours.

External Examination

Begin the external exam by laying an anesthetized fish on a measuring board and recording its length in mm. Next transfer the fish to a scale and record its weight in grams. Now lay out the fish and examine, in order, the following tissues and organs, recording the condition of each tissue or organ with a number or letter code as listed below:

Eyes:

Normal (N) - No aberrations in evidence. Good "clear" eye.

Exophthalmic (popeye) (E1, E2) - Swollen, protruding eye. More commonly referred to as "popeye". It is coded as E1 or E2. This refers to the presence of exophthalmia in one eye or two eyes.

Hemorrhagic (H1, H2) - Refers to bleeding in the eye.

"Blind" (B1, B2) - This is a very graphic category and you need not know whether the eye is functionally blind. It generally refers to opaque eyes. The nature of the opacity is not important here.

"Missing" (M1, M2) - An eye is actually missing from the fish.

"Other" (OT) - Any manifestations which do not "fit" the above. Describe it in the remarks column.

Fins:

It must be remembered that this particular assessment system is concerned primarily with health and condition. It is not concerned with aesthetic values. Eroded or "ragged" fins are definitely indicative of a departure from normal condition and health. Previously eroded fins which are completely healed over and showing no evidence of the active erosion are, for the purposes of this assessment, considered normal. The evaluation of fins is relative to the degree of active erosion process in evidence. For the purposes of this procedure, the number and location of fins involved is not significant. If only one fin is displaying active erosion, the observation must be ranked and recorded. If several fins are displaying erosion with unequal severity, the observation must refer to the most severe in evidence. This unequal nature of the observations, in this case, is less significant in a full 15 fish sample. The classification is as follows:

No active erosion (0) - Normal appearing fins with no active erosion. This would include previously eroded fins which were completely healed over.

Mild active erosion (1) - Active erosion process but no hemorrhage or secondary infection in evidence.

Severe active erosion (2) - Active erosion with hemorrhage and/or secondary infection in evidence.

Note! Make a general remark relative to which fins were involved and any other observation of special significance. There is a space for this type of entry at the bottom of the data collection worksheet. This is particularly important in the summary.

Opercles:

It is necessary only to observe the degree of shortening of the opercles. The classification is as follows:

Normal opercle (0) - No shortening; gills completely covered

Mild shortening (1) - Slight shortening of the opercle with a very small portion of the gill exposed

Severe shortening (2) - Severe shortening of the opercles with a considerable portion of the gill exposed.

Gills:

Normal (N) - No apparent aberrations in gills. Be very careful in this observation. The gill can easily be effected by the manner in which the fish is handed during and after collecting. Be alert and aware.

"Frayed" (F) - This generally refers to actual erosion of tips of gill lamellae resulting in "ragged" appearing gills. Mere separation of gill lamellae can be construed to be "frayed" but that condition may have been caused by something as simple as the manner in which the gill was exposed by the investigator.

"Clubbed" (C) - This refers to swelling of the tips of the gill lamellae. They can often appear bulbous or "club" like. The causes are not pertinent until interpretation is considered.

"Marginate" (M) - A graphic description of a gill with a light discolored margin along the distal ends or tips of the lamellae or filaments. Margination can be and often is associated with "clubbing". If both seem to apply it is not a problem. It is important that you noted that it was not normal. Use the one which seems most appropriate.

"Pale" (P) - This refers to gills which are definitely very light in color. Severe anemia can result in gills which are discolored to the point of being white. Severe bleeding induced during sampling of blood can also result in somewhat pale gills. Gills begin to pale somewhat after death also. This is not uncommon in fish taken from nets. All of this should be considered in making the observation.

Other (OT) - Any observation which does not fit above. Describe in remarks.

Pseudobranchs:

Normal (N) - The pseudobranch is located dorsally and anterior to the gills in the branchial cavity and can be easily observed under the operculum. The normal pseudobranch is quite "flat" or even concave in aspect and displays no aberrations.

Swollen (S) - The "swollen" pseudobranch is convex in aspect and not difficult to discern upon close examination.

Lithic (L) - Mineral deposits in pseudobranchs, manifested by appearance of white, somewhat amorphous spots or foci.

Swollen and Lithic (S&L) - Lithic pseudobranchs are often also swollen.

Inflamed (I) - This is a generic use of the term, inflamed, and would more appropriately be termed "redness" because it also includes observations of hemorrhage and any other cause of redness. The term, "inflamed" has been traditionally used to describe this condition and is thus continued for that reason.

Other (OT) - This term will cover any manifestation observed in the pseudobranch which is not covered in the categories. Be sure to describe in remarks.

Thymus:

Assessment of the thymus involves degree of petechial or "pinpoint" hemorrhage.

No Hemorrhage (0) - The thymus displaying no hemorrhage is considered to be a normal condition, although this assumption is still under investigation. Caution must be exercised here because when the thymus involutes or ceases to function there is no observable petechial hemorrhage. This happens normally as the fish mature. In salmonids, involution of the thymus is thought to happen at two or three years of age but there is considerable disagreement among investigators about that point.

Mild hemorrhage (1) - A few red spots or petechial hemorrhages in evidence. This might be only two or three small spots.

Moderate hemorrhage (2) - More than a few red spots.

Severe Hemorrhage (3) - Many "pin point" hemorrhages in evidence with some of them coalescing. The general area may also have a swollen tumescent appearance but that should be recorded in remarks.

Internal Examination

Once the external examination has been completed, position the fish "belly up" and, using sharp/blunt scissors, make a ventral cut from the anal vent forward to the pectoral girdle. Do not insert the scissors so far that the internal organs are damaged. In largemouth bass and other centrarchids carefully cut through the pectoral girdle to lay open the pericardial cavity and expose the heart and aorta. In catfish leave the pectoral girdle intact.

Liver:

Upon opening the fish, immediately inspect and record the color and condition of the liver. This must be done prior to collecting blood. Collecting blood and even minor hemorrhaging sustained during dissection can quickly drain color from the liver.

Normal (A). Good, solid red color.

Lighter-or less vivid red color. Not so pale as to be classed general discoloration. Still considered to be normal.

"Fatty" liver (C). Light tan color, such as "coffee with cream".

Nodules (NO) Nodules in the liver, i.e. white mycobacterial cysts and incipient nodules, such as those in hepatoma.

Focal discoloration (DF). Change of color in local areas or foci of the liver.

General Discoloration (DG). Color change in the whole liver.

Other (OT). Aberration or deviation in liver which does not fit into above scheme. Class as OT and describe in remarks.

Blood

Following inspection of the liver, collect blood. Blood is collected with a sharpened, heparinized microhematocrit tube via a cardiac puncture. In bass blood is tapped from the aorta. By inserting a finger into the buccal cavity and gently pressing upwards, the heart and aorta can be immobilized against the roof of the pericardial cavity, making cardiac puncture much easier. In catfish the same technique can be used to immobilize the heart and aorta, but, since the pericardial cavity is not open, the cardiac puncture is more difficult. Once the heart and aorta are immobilized between the floor and raised roof of the pericardial cavity, the sharpened capillary tube is thrust through the membrane separating the pericardial and coelomic cavities and into the pericardial cavity in the suspected location of the aorta. If the aorta is punctured, a spurt of dark red blood will partially fill the tube. If a clear yellow or pale red fluid enters the tube, the aorta was missed. Try again with a fresh hematocrit tube. When the aorta has been punctured, blood can be pumped into the tube by gently releasing and then reapplying pressure on the aorta with the finger still inserted in the buccal cavity. The tube once filled is sealed with hematocrit clay and placed in a numbered rack. Make every effort to ensure samples are matched with the appropriate fish. After collecting a blood sample, proceed with the autopsy as outlined below.

Note: After 30 minutes or the collection of 6 to 8 samples, whichever comes first, place tubes in a hematocrit centrifuge and spin for five minutes. Hematocrits should be read within 2 hours of collection or before the blood begins to coagulate. To read hematocrits:

Obtain an hematocrit reader and place the filled hematocrit tube so that the bottom of the red portion is at the 0 line and the meniscus of the clear plasma is at the 100% percent mark. The packed red cell volume of the blood is the hematocrit and is read as a percentage of the total blood volume.

The leucocrit is the buffy of gray zone which consist of the leucocytes or white blood cells an is also read as percent of the total volume on the hematocrit reader.

The protein content of the plasma is determined using a protein refractometer. Take the hematocrit tube and break it off just above the buffy, gray zone to obtain the clear plasma and express the plasma onto the clear glass surface of the protein refractometer. Avoid placing any glass fragments from the tube on the refractometer. Read the weight/volume percent of protein in the refractometer. The protein refractometer should be calibrated prior to use with distilled water.

After collecting a blood sample, proceed with the autopsy by examining, in order, the following tissues and organs, recording the condition of each tissue and organ with a number or letter code listed below:

Mesenteric Fat:

- 0 - No fat deposited around the pyloric caeca.
- 1 - Slight, where less than 50% of each cecum is covered with fat.
- 2 - 50% of each cecum is covered with fat.
- 3 - More than each cecum is covered with fat.
- 4 - Pyloric caeca are completely covered by a large amount of fat.

Spleen:

Black (B) - The "black" is actually a very dark red color of the spleen.

(Red coloration of the spleen. There is subjective variation among investigators as to whether the spleen is black or red, but both condition are considered normal.)

Granular (G) - Granular or "rough" appearance of the spleen. This is also considered normal.

Nodular (NO) - The spleen contains or manifests fistulas or nodules of varying sizes. These are often cysts, such as those encountered with mycobacterial infections.

Enlarged (E) - Spleens can, on occasion, be significantly and noticeably enlarged.

Other (OT) - Occasionally there are observable, gross aberrations which do no fit the above. There may be spleens with a gray mottling and some with very small spleens. These should be classed as "other" and described in remarks.

Hindgut:

A short distance of the hind gut should be "opened". This should, in fact, have been accomplished as mentioned above when the body cavity was incised. If not, it must be opened to expose the "inner lining" or mucosa. Using the handle of a forceps or some other appropriate blunt instrument, lightly "scrape" out the contents of the hindgut so that you can observe relative reddening or inflammation.

- 0 - No inflammation or reddening of the hindgut.
- 1 - Mild or slight inflammation or reddening of the hindgut
- 2 - Moderate inflammation of the hindgut.
- 3 - Considerable, severe inflammation or reddening of the hind gut.

Kidney:

Normal (N) - Good firm dark red color lying relatively flat dorsally in the visceral cavity along the length of the ventral surface of the vertebral column. It will be necessary to pull the swimbladder and some of the mesentery aside to expose the kidney to view.

Swollen (S) - Enlarged or swollen wholly or in part.

Mottled (M) - Gray discoloration, mottled or "patchy" in appearance ranging from scattered patches of gray to total gray discoloration. This is not to be mistaken with the superficial gray appearance induced by the mesenteric membranes on the surface of the kidney. This should be moved aside before observation is recorded.

Nodular (NO) - The kidney may have a "granular" or nodular appearance and texture. This may be induced by granulomatous concretions.

Urolithiasis (U) - This condition is also known as nephrocalcinosis and involve mineral material in the deposition of a white or "cream-colored" amorphous tubules of the kidney. it can range in appearance from very small white spots to severe involvement with very large "serpentine" deposits. These sites of deposition are not to be confused with the Stannius bodies corpora of Stannius which are present in salmonid kidneys and have endocrine function. The Stannius bodies are generally not associated with the tubules and usually occur at the "edges" in an area about midway along the kidney. They appear more globular than do the urolithic deposits.

Other (OT) - This is used to class any aberrations which do not fit into the above scheme. Record it as OT and describe it in the remarks.

Gall Bladder -

- 0 - Yellow, empty or partially full
- 1 - Yellow, full or distended

- 2 - Grass green
- 3 - Dark green

Sex:

Male (M) - Testes observed

Female (F) - Ovaries observed Note if "ripe" with eggs

Unknown (U) - immature or undeveloped gonads

General Observations and Remarks

Anything which appears to be abnormal should be noted. It is recommended that the mesenteric tissues in the visceral cavity be checked for hemorrhage and inflammation and if these conditions are present they should be so noted in general remarks.

D. Scoring

Once autopsies are completed, transcribe the number and letter codes assigned to the condition of each tissue/organ to a numerical score according to the table below. Note that no score is given to sex, fat deposits, and gall bladder. Conditions associated with these tissues/organs are not considered pathological but simply a physiological or nutritional state that varies on a seasonal or other periodic basis.

<u>Tissue or Organ</u>	<u>Condition</u>	<u>Score</u>	<u>Tissue or Organ</u>	<u>Condition</u>	<u>Score</u>
<u>Eyes</u>	N	0	<u>Spleen</u>	B	0
	E1,E2	30		GR	0
	H1,H2	30		NO	30
	B1,B2	30		E	30
	M1,M2	30		OT	30
	OT	30			
<u>Fins</u>	0	0	<u>Hind Gut</u>	0	0
	1	10		1	10
	2	20		2	20
				3	30
<u>Opercles</u>	0	0	<u>Kidney</u>	N	0
	1	10		S	30
	2	20		M	30
<u>Gill</u>	N	0		NO	30
	F	30		U	30
	C	30		OT	30
	M	30	<u>Liver</u>	A	0
	P	30		C	30
	OT	30		NO	30
<u>Pseudobranchs</u>	N	0		DF	30
	S	30		DG	30
	L	30		OT	30
	SL	30	Blood:		
	I	30		<u>Hematocrit</u>	≥ 31
	OT	30		< 31	30
<u>Thymus</u>	0	0	<u>Leucocrit</u>	< 4	0
	1	10		≥ 4	30
	2	20	<u>Plasma Protein</u>	$3 \leq x \leq 6$	0
	3	30		> 6	30
		< 3		30	

E. Calculations and Summary Data

The following calculations are useful in assessing the overall fish health. The specific calculations performed will be determined by the specific objectives of a given study. Many of the following calculations can be done by hand, but for most studies the use of a computer or at least pocket calculator with a function key for calculating mean and standard deviation is recommended.

Ktl:

The value for Ktl is a ratio of length to weight. It is routinely expressed as $Ktl \times 10^5$ to mitigate the problem of carrying so many decimal places in the records. Use the following equation to obtain a value:

$$Ktl = \frac{W \times 10^5}{L^3}$$

Where:

W = Weight in grams

L = Total length in millimeters

Mean and Standard Deviation:

The mean is determined by totaling all of the values for the observations and dividing by the number of the observations. In-depth discussion of the standard deviation is beyond the scope of this presentation. Again, a pocket calculator or computer is recommended for making this calculation. In each sample of fish examined calculate means and standard deviations for the following observations:

Length
Weight
Ktl
Hematocrit
Leucocrit
Plasma protein

These calculations are made on raw data from autopsy sheets, not from assigned scores.

Fish Health Index (FHI) Score:

Calculate an FHI score for each fish by totaling the numerical score for each tissue/organ. For a given sample or population of fish calculate the mean and standard deviation from the individual FHI scores for fish in that sample. The mean FHI scores between samples can be compared statistically.

Values as Percents of Total Sample

This calculation expresses as a percent the number of fish in a sample with a specific physical/pathological condition. As an example, consider the eyes. The number of fish with normal eyes in a given sample is divided by the total number of fish in the sample (x 100) to yield the percentage of normal-eyed fish in that sample. Similarly, the percentage of fish in a sample with one blind eye (B1) can be calculated. A percentage can be calculated for any or all physical/pathological conditions. It is particularly useful for pinpointing a high incidence of disease in any one particular tissue or organ.

F. Interpretation

The state-of-the-art in this area has not been refined. Normal and abnormal conditions for each tissue and organ have been fairly well defined, but measures of overall fish health based on FHI scores, for example, are still being evaluated. The interpretation of overall fish health is complicated by the varying sensitivity of different fish species to environmental stresses. A viable strategy for investigating potential hazardous waste sites is to statistically compare the mean FHI score for a fish sample from a suspected "impacted" site with the mean score for fish from an established or selected "unimpacted" reference or background site on a species to species basis. Other strategies may prove equally enlightening as more FHI studies are completed.

APPENDIX E
AUTOPSY FIELD DATA SHEETS

Catfish - Day 2
P# of 5

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 10/27/94 Unit _____ Strain _____ Hatch Date _____ Age _____
 Location Mobil, AL Fish Source Q Quality Control # _____ Case History # _____
 Investigator(s) DL, RL, MW Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Length mm	Weight gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks
1	332	275		N	N	N	OMU	O	R	O	N	AD	1	♂	27	27	4.2	0	0	
2	418	505		N	N	N	O	O	R	O	N	AD	1	♂	24	26	4.0	0	0	
3	424	637		N	N	N	O	O	O	O	N	AD	1	♂	18	18	2.0	0	0	
4	470	942		N	N	N	O	1	R	O	N	B	1	♂	19	19.2	2.5	0	0	
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Gonads _____

Other electroshocking

Fins _____

Skin _____

Cat fish - Day 3
p1 of 4

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 10/28/94 Unit _____ Strain _____ Quality Control # _____
 Location Michigan, AL Age _____ Case History # _____
 Investigator(s) JM, RW, MW Hatch Date _____ Tissue Collection # _____
 Reason for Autopsy _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	P-sbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks						
1	320	210		N	N	N	THY	0	R	0	N	AD	1	U	27.5	28.5	3.5	0	0							
2	444	796		N	N	N	0	1	R	0	N	AD	1	♀	29	30	4.9	0	0							
3																										
4																										
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										
13																										
14																										
15																										
16																										
17																										
18																										
19																										
20																										

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other electro shock

West Fish - Leu 3
P 3 of 4

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/28/94 Unit _____ Strain _____ Age _____ Quality Control # _____ Case History # _____
 Location Leb. 13, 15L Fish Source F Hatch Date _____ Tissue Collection # _____
 Investigator(s) _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	P-sbr	Thy	Fat	Spl	Hind Gut	Kgd	Lv	Blle	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks
1	395	458		N	N	N	0	0	B	0	N	A D	1	♀	27	28	3.7	0	0	Liver - paracetamol spl. - fluid-filled vesicle Liver - normal CP rest of liver
2	359	345		N	N	N	0	0	R	0	N	A D	1	♂	22	22.2	2.5	0	0	
3	354	325		N	N	N	0	0	R	0	N	B D	0	♀	38	39	4.3	0	0	
4	411	519		N	N	N	0	0	R	0	N	B D	1	♂	9	10	2.6	0	0	blood many DE Livers - normal Livers - paracetamol (100%) same as 2X
5	446	703		N	N	N	0	0	R	0	N	D	1	♀	28.5	28.5	3.6	0	0	
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other Electro shock

Catfish Day 4
PI of 5

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 10/29/94 Unit _____ Fish Source H Strain _____

Location Mobile, AL Age _____ Quality Control # _____ Case History # _____

Investigator(s) _____ Hatch Date _____ Tissue Collection # _____

Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Fsbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks	
1	274	123		N	N	N	0	0	R	0	N ^{ADP}	D ^P	1	♀	25	26	3.7	0	0		
2	380	336		N	N	N	0	0	0	0	N ^{ADP}	DP	1	U	34	35	3.3	0	0		
3	391	443		N	N	N	0	0	R	0	N ^{OT}	D ^P	0	♀	25	26	2.4	0	0		
4	390	479		N	N	N	0	1	0	0	N	B ^{DP}	0	♂	36	37	4.4	0	0	system kidney	
5	494	885		N	N	N	0	0	0	0	N ^{ADP}	AD ^P	1	♂	26	27	4.2	0	0		
6	350	316		N	N	N	0	1	0	0	N	AD ^P	1	♀	31	33	4.0	0	0		
7	462	803		N	N	N	0	1	0	0	N	D ^P	1	♂	21	23	3.5	0	0		
8	370	320		N	N	N	0	0	R	0	N	AD ^P	1	♀	23	25	2.3	0	0		
9	358	317		N	N	N	0	1	0	0	N	AD ^P	1	♀	22	23	2.2	0	0		
10	358	311		N	N	N	0	0	R	0	N	AD ^P	1	♂	18	132	2.1	0	0		
11	325	326		N	N	N	0	0	0	0	N	B ^{DP}	1	U	28	28.3	2.1	0	0		
12	354	300		N	N	N	0	0	0	0	N	AD ^P	1	♀	29	30	2.8	0	0		
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

Fins _____

Skin _____

GENERAL REMARKS
Gonads _____

Other D = includes covered by parasites (nematodes) Electro

Catfish Day 4
P 2 of 5

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 10/29/94 Unit _____ Strain _____
 Location Mobile, AL Fish Source D Age _____
 Investigator(s) _____ Hatch Date _____ Quality Control # _____ Case History # _____
 Reason for Autopsy _____ Tissue Collection # _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks	
1	325	226		N	N	N	0	0	R	0	N	A	1	U	235	30	3.7	0	0		
2	391	455		N	F	N	0	0	R	0	N	B	0	F	29	30	4.1	2	0	Faint looks like 1 fin needed.	
3	495	1278		N	N	N	0	1	R	0	N	D ^P	1	M	37	38	4.3	0	0	injury	
4	345	281		B1	N	N	0	0	R	0	N	B ^{D^P}	1	M	31	32	4.4	0	0	Reingest on chow ~ 100%	
5	430	604		N	N	N	0	0	R	0	N	B ^{D^P}	0	M	32	34	4.6	0	0		
6	381	396		N	N	N	0	0	R	0	N	A ^{D^P}	1	F	32	33.5	3.9	0	0		
7	397	486		N	N	N	0	0	R	0	N	D ^P	1	F	38	39	4.2	0	0		
8	475	939		N	N	N	0	1	R	0	N	A ^{D^P}	1	F	39	41	7.5	0	0	3 lesions	
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					
20																					

GENERAL REMARKS

Fins _____ Gonads _____
 Skin _____ Other tra. ps.

Catfish Day 5
 # of -
 num p2 of 3

Wildlife Resources
 2/91 FES-25

FISH AUTOPSIES

Date 1.21.20/91 Unit _____ Strain _____ Quality Control # _____
 Location Mobile, AL Age _____ Case History # _____
 Investigator(s) JM, RW, MW Hatch Date _____ Tissue Collection # _____
 Reason for Autopsy _____ Fish Source G Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opt	Remarks	
1	335	261		N	N	N	0	0	R	0	N	AD ^p	1	1 ^{1/2} ♀	39	39	4.2	0	0		
2	344	279		N	N	N	0	0	R	0	N	A	1	♀	39 21 40	39 22 40	3.8 3.8	0	0	(2x spin)	
3	463	460		N	N	N	0	0	R	0	N	AD ^p	1	1 ^{1/2} ♀	39	40	5.2	0	0		
4	269	360		N	N	N	0	0	R	0	N	D ^p	1	♂	22	34	4.0	0	0		
5	432	913		N	N	N	0	0	R	0	N	AD ^p	1	♂	36	37	3.6	0	0		
6	458	724		N	N	N	0	0	0	0	N	D ^p	1	1 ^{1/2} ♀	38	39	4.8	0	0		
7	524	1320		N	N	N	0	0	0	0	N	D ^p	1	♂	34	34.5	3.7	0	0	(2x spin)	
8	560	1568		N	N	N	0	0	0	0	N	AD ^p	1	♂	35.5	37	3.9	0	0		
9	444	768		N	N	N	0	0	R	0	N	BD ^p	1	♂	37	37.5	4.5	0	0	Another gill arch	
10	436	660		N	N	N	0	1	0	0	N	AD ^p	1	1 ^{1/2} ♀	38	39	4.1	0	0		
11	398	490		N	N	A	0	0	R	0	N	AD ^p	1	1 ^{1/2} ♀				0	0		
12	424	524		N	N	N	0	0	0	0	N	D ^p	0	1 ^{1/2} ♀	29	30	3.0	0	0	Blue spots	
13	476	326		N	N	N	0	0	0	0	N	AD ^p	1	1 ^{1/2} ♀	29	30	2.9	1 ^{1/2} 0	0	erosion in anal gills	
14	382	379		N	N	N	0	0	0	0	N	AD ^p	1	1 ^{1/2} ♀	31	31.5	3.8	0	0		
15	328	218		N	N	N	0	0	R	0	N	BD ^p	1	♂	30	30	2.8	0	0	few nodules -	
16	293	154		N	N	N	0	0	0	0	N	BD ^p	1	1 ^{1/2} ♀	31	32	2.7	0	0		
17																					
18																					
19																					
20																					

as film
 liver

GENERAL REMARKS

Gonads empty - shocked
 Other _____

Fins _____

Skin _____

Catfish Day 6

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 10/31/94 Unit _____ Strain _____ Hatch Date _____
 Location Mobility, nr Quality Control # _____ Case History # _____
 Investigator(s) SJA, B.W., M.W. Fish Source F Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks
1	367	350		N	N	N	0	0	R	0	N	AD ^p	3	♀	38	39	6.1	0	0	Parasites under Opt. Sparse P. spiroch. Parasites on edge of liver.
2	380	443		N	N	N	0	0	R	0	N	BD ^p	0	♂	32	33	4.5	0	0	
3	410	462		N	N	N	0	0	R	0	N	AD ^p	2	♀	32	33	5.0	0	0	P-spirae on vert.
4	350	290		N	N	N	0	0	R	0	N	BD ^p	1	♀	31	32	3.9	0	0	P-spirae
5	337	276		N	N	N	0	0	R	0	N	BD ^p	1	♂	31	31.5	4.2	0	0	External disch. P-spirae
6	346	298		N	N	N	0	0	0	0	N	AD ^p	1	♂	41	41.5	4.7	0	0	P-spirae
7	362	333		N	N	N	0	0	R	0	N	BD ^p	1	♂	14	15	2.7	0	0	Stomach blood with cheese. P-spirae (Spin 2x)
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Gonads

Other Traps

Fins

Skin

Catfish Day 7
p 1 of 3

FISH AUTOPSIES

Wildlife Resources
2/91 FES-25

Date 11/1/94 Unit _____ Strain _____ Fish Source C Hatch Date _____ Age _____ Quality Control # _____ Case History # _____
 Location Mobilis AL Investigator(s) Jim, RW, MW Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hfnd Gut	Kid	Liv	Bile	Sex	Hern	Leu	Pl. Pro	Fin	Opl	Remarks
1	371	381		N	N	N	O	O	R	O	N	BD ^P	O	♀	32	33	5.9	O	O	
2	359	304		N	N	N	O	O	R	O	N	BD ^P	O	♂	34	37	4.4	O	O	bloater (2 chives)
3	403	404		N	N	N	O	O	R	O	N	FI ^P	O	♂	35	37	5.6	O	O	mean percaras, 1/2 S
4	384	413		N	N	N	O	O	R	O	N	BD ^P	O	♀	33	34	4.8	O	O	
5	335	280		N	N	N	O	O	R	O	N	BD ^P	O	♂	31	33	4.0	O	O	few percaras
6	324	244		N	N	N	O	O	R	O	N	BD ^P	O	♂	40	41	4.2	O	O	
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Gonads _____
 Other trap

Fins _____
 Skin _____

Coff Fish Day 7
p 2 of 3

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 11/1/94 Unit _____ Strain _____ Age _____ Quality Control # _____
 Location Mobile, AL Fish Source E Hatch Date _____ Case History # _____
 Investigator(s) _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hind Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pl. Pro	Fin	Opl	Remarks		
1	367	354		N	N	N	0	0	R	0	N	BDP	1	♂	34	35	4.8	0	0			
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						

GENERAL REMARKS

Gonads _____

Other Trop

Fins _____

Skin _____

1st fish Day 7
P 3 sf.3

Wildlife Resources
2/91 FES-25

FISH AUTOPSIES

Date 11/1/94 Unit _____ Strain _____ Quality Control # _____
 Location Mobile, AL Fish Source B Case History # _____
 Investigator(s) TM, RW, MW Hatch Date _____ Tissue Collection # _____
 Reason for Autopsy _____ Remarks _____

Smp no	Lgth mm	Wght gm	Kid	Eye	Gill	Psbr	Thy	Fat	Spl	Hfnd Gut	Kid	Liv	Bile	Sex	Hem	Leu	Pt. Pro	Fin	Opl	Remarks
1	366	342		N	N	N	0	1	R	0	N	AD ^p	1	♀	29	30	4.2	0	0	spouse p
2	431	658		N	N	N	0	1	R	0	N	AD ^p	1	♂	27	28	3.8	0	0	spouse p
3	362	328		N	N	N	0	0	R	0	N	BD ^p	1	♀	35.5	36.5	3.6	0	0	
4	515	1168		N	N	N	0	1	R	0	N	BD ^p	1	♂	35	36	4.4	0	0	
5	454	790		N	N	N	0	0	R	0	N	A	1	♂	34	35	4.6	0	0	
6	339	379		N	N	N	0	0	R	0	N	BD ^p	0	♂	40.5	42		0	0	
7	412	405		N	N	N	0	0	R	0	N	AD ^p	2	♂	31	32	3.2	0	0	
8	426	484		N	P	N	0	0	R	0	N	BD ^p	1	♂	23	25	3.8	0	0	very long parasite like 5, 10's
9	348	289		N	N	N	0	0	R	0	N	AD ^p	0	♂	30	31	3.3	0	0	spouse resident
10	346	273		N	N	N	0	0	R	0	N	AD ^p	1	♂	27	28	4.2	0	0	
11	335	231		N	N	N	0	0	R	0	N	AD ^p	2	♂	42	43	4.0	0	0	
12	370	318		N	N	N	0	0	R	0	N	BD ^p	1	♂	26	27	3.8	0	0	
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

GENERAL REMARKS

Gonads _____
 Other Trap. Parasites out of capsule; worms

Fins _____

Skin _____

EPA Region IV
AUTOPSY CLASSIFICATION KEY

Length: Total length in millimeters
Weight: Weight in grams

Ktl: = $\frac{W \times 10^5}{L^3}$

Sex: F F, note if ripe
M

EXTERNAL EXAMINATION

Eyes: Normal (N)
Exophthalmic (popeye) (E1, E2)
Hemorrhagic (H1, H2)
Blind (B1, B2)
Missing (M1, M2)
Other (OT)

Fins: No active erosion; previous erosion healed over (0)
Mild erosion with no bleeding (1)
Severe active erosion with hemorrhage and/or
secondary infection (2)

Opercles: No shortening (0)
Mild shortening (1)
Severe shortening (2)

Gills: Normal (N)
Frayed (F) Clubbed (C)
Marginate (M) Pale (P) Other (OT)

Pseudobranch: Normal (N)
Swollen (S) Lithic (L)
Swollen and Lithic (SL)
Inflamed (I) Other (OT)

Thymus: No hemorrhage (0)
Mild hemorrhage (1)
Moderate hemorrhage (2)
Severe hemorrhage (3)

INTERNAL EXAMINATION

Fat: None (0)
Slight, $\leq 50\%$ of each cecum is covered (1)
50% of each cecum is covered (2)
 $\geq 50\%$ of each cecum is covered (3)
100% of each cecum is covered (4)

Spleen: Black, red (B)

Granular (G)
Nodular (NO)
Enlarged (E)
Other (OT)

Hindgut: No inflammation (0)
Slight inflammation (1)
Moderate inflammation (2)
Severe inflammation (3)

Kidneys: Normal (N)
Swollen (S) Mottled (M)
Nodular (NO) Urolithic (U)
Other (OT)

Liver: Red, pale red (A)
Coffee & Cream (C)
Nodular (NO)
Discoloration, focal (DF)
Discoloration, general (DG)
Other (OT)

Gallbladder: Yellow, empty or partially full (0)
Yellow, full or distended (1)
Grass green (2)
Dark green (3)

Blood:

Hematocrit Volume of red blood cells (erythrocytes) expressed as percent of total blood volume. Centrifuged 5 minutes.

≥ 31 is normal < 31 is abnormal

Leucocrit Volume of white blood cells (leucocytes) expressed as percent of total blood volume. "Buffy" zone of the packed cell column.

< 4 is normal ≥ 4 is abnormal

Plasma protein Amount of protein plasma, expressed as gram percent (grams per 100 ml).

≥ 3 to ≤ 6 is the normal range
< 3 is abnormal
> 6 is abnormal

APPENDIX F

**SPREADSHEETS SUMMARIZING OF AUTOPSY DATA
AND CALCULATED FHI SCORES**

STATION D (00)

'River: MOBILE
 Station: D (00) 'Species: Channel Catfish
 'Gear: ELEC, TRAPS Samp. Size 13
 'Date: 10/27, 28, 29/94 Analyst: R, MW, JM

	Mean	Stand Dev
Length	405.00	66.95
Weight	597.77	371.21
Kil	0.79	0.12
Hematocrit	30.23	6.95
Leucocrit	1.25	0.38
Plasma Protein	4.51	1.15

Smp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond	
1	332	262	0.72	U	N	0	0	N	N	0	3	B	0	0	N	A	1	28	1	1	4.5	0	0
2	410	563	0.82	F	N	0	0	N	N	0	0	B	0	0	N	A	1	31	1.2		6	0	0
3	530	1275	0.86	M	N	0	0	N	N	0	1	B	0	0	N	NO	1	11	1	1	3	30	0
4	325	226	0.66	U	N	0	0	N	N	0	0	B	0	0	N	A	1	28.5	1.5		3.7	0	0
5	391	455	0.76	F	N	2	0	F	N	0	0	B	0	0	N	A	0	29	1	1	4.1	50	0
6	495	1278	1.05	M	N	0	0	N	N	0	1	B	0	0	N	NO	1	37	1	1	4.3	30	0
7	345	281	0.68	M	B1	0	0	N	N	0	0	B	0	0	N	NO	1	31	1	1	4.4	60	0
8	420	604	0.82	M	N	0	0	N	N	0	0	B	0	0	N	NO	0	32	2	2	4.6	30	0
9	381	396	0.72	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	32	1.5		3.9	30	0
10	397	486	0.78	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	38	1	1	4.2	30	0
11	475	939	0.88	F	N	0	0	N	N	0	1	B	0	0	N	NO	1	39	2	2	7.5	30	0
12	320	210	0.64	U	N	0	0	N	N	0	0	B	0	0	N	NO	1	27.5	1	1	3.5	30	0
13	444	796	0.91	F	N	0	0	N	N	0	1	B	0	0	N	NO	1	29	1	1	4.9	30	0
14																							
15																							
16																							
17																							
18																							
19																							
20																							

MEAN 26.92
 STD 17.97

STATION F (02)

'River MOBIE
 Station F (02) Species Channel Catfish
 'Gear ELEC. TRAPS Samp Size 12
 'Date 10/28, 10/31 94 Analyst RW, MW, JM

	Mean	Stand Dev
Length	376.42	32.76
Weight	400.17	123.78
Ktl	0.73	0.04
Hematocrit	28.63	9.58
Leucocrit	0.78	0.35
Plasma Protein	3.96	1.10

Samp #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Splh	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond	
1	395	458	0.74	F	N	0	0	N	N	0	0	B	0	0	NO	1	27	1	1	37		30	
2	359	345	0.75	M	N	0	0	N	N	0	0	B	0	0	NO	1	22	0.3		25		30	
3	354	325	0.73	F	N	0	0	N	N	0	0	B	0	0	NO	0	38	1		43		30	
4	411	519	0.75	M	N	0	0	N	N	0	0	B	0	0	NO	1	9	1		26		30	
5	446	703	0.79	F	N	0	0	N	N	0	0	B	0	0	NO	1	28.5	0		36		30	
6	367	350	0.71	F	N	0	0	N	N	0	0	B	0	0	NO	3	38	1		61		30	
7	380	443	0.81	M	N	0	0	N	N	0	0	B	0	0	NO	0	32	1		45		30	
8	410	462	0.67	F	N	0	0	N	N	0	0	B	0	0	NO	2	32	1		5		30	
9	350	290	0.68	F	N	0	0	N	N	0	0	B	0	0	NO	1	31	1		39		30	
10	337	276	0.72	M	N	0	0	N	N	0	0	B	0	0	NO	1	31	0.5		42		30	
11	346	298	0.72	M	N	0	0	N	N	0	0	NO	0	0	NO	1	41	0.5		47		60	
12	362	333	0.70	M	N	0	0	N	N	0	0	B	0	0	NO	1	14	1		24		30	
13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							

MEAN 32.5
 STD 8.66

STATION H (03)

'River: MOBILE
 Station: H (03) 'Species: Channel Catfish
 'Gear: ELECTROFISHING Samp. Size 12
 'Date: 10/29/94 Analyst: RW,MW,JM

Mean	Stand Dev
375.50	57.68
404.92	224.58
0.70	0.07
26.50	5.35
1.13	0.60
3.25	0.76

Length
 Weight
 Ktl
 Hematocrit
 Plasma Protein

Samp. #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind		Kid	Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Spn				Value	Cond	Value	Cond	Value	Cond	
1	274	123	0.60	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	25	1	1	3.7	30		
2	380	336	0.61	U	N	0	0	N	N	0	0	NO	0	0	N	NO	1	34	1	1	3.3	60		
3	391	443	0.74	F	N	0	0	N	N	0	0	B	0	0	OT	NO	0	25	1	1	2.4	60		
4	390	479	0.81	M	N	0	0	N	N	0	1	NO	0	0	N	NO	0	36	1	1	4.4	60		
5	494	865	0.73	M	N	0	0	N	N	0	0	NO	0	0	N	NO	1	26	1	1	4.2	60		
6	350	316	0.74	F	N	0	0	N	N	0	1	NO	0	0	N	NO	1	31	2	2	4	60		
7	462	803	0.81	M	N	0	0	N	N	0	1	NO	0	0	N	NO	1	21	2	2	3.5	60		
8	370	320	0.63	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	23	2	2	3.3	30		
9	358	317	0.69	F	N	0	0	N	N	0	1	NO	0	0	N	NO	1	22	1	1	2.2	60		
10	358	311	0.68	M	N	0	0	N	N	0	0	B	0	0	N	NO	1	18	0.2	0.2	2.1	30		
11	325	226	0.66	U	N	0	0	N	N	0	0	NO	0	0	N	NO	1	28	0.3	0.3	3.1	60		
12	354	300	0.68	F	N	0	0	N	N	0	0	NO	0	0	N	NO	1	29	1	1	2.8	60		
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 52.5
 STD 13.57

STATION E (04)

'River: MOBILE
 Station: E (04)
 'Gear: ELEC, TRAP
 'Species: Channel Catfish
 Samp. Size: 4
 'Date: 10/26, 11/1 94
 Analyst: R.MW.JM

	Mean	Stand Dev
Length	386.00	40.97
Weight	440.25	97.16
Kil	0.77	0.14
Hematocrit	25.25	6.60
Leucocrit	0.88	0.25
Plasma Protein	3.58	0.93

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	SpIn	Hind Gut		Kid	Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Value	Cond				Value	Cond	Value	Cond	Value	Cond	
1	367	354	0.72	M	N	0	0	N	N	0	0	B	0	0	N	NO	1	34	1	1	4.8	30		
2	407	450	0.67	U	N	0	0	N	N	0	0	B	0	0	N	A	1	18	0.5	0	3.2	0		
3	431	573	0.72	F	N	0	0	N	N	0	0	E	0	0	N	DF	1	24	1	1	3.7	60		
4	339	384	0.99	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	25	1	1	2.6	30		
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 30
 STD 24.49

STATION I (05)

'River: MOBILE
 Station: I (05)
 'Gear: ELEC, TRAPS

'Species: Channel Catfish
 Samp. Size 14

'Date: 10/29/94 Analyst: RW, MW, JM

Stand

	Mean	Dev
Length	374.14	36.78
Weight	375.57	126.75
Kil	0.69	0.05
Hematocrit	29.14	7.62
Leucocrit	0.96	0.41
Plasma Protein	3.50	0.96

Fish #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	SpIn	Hind			Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Kid	N			Value	Cond	Value	Cond	Value	Cond	
1	392	412	0.68	F	N	0	0	N	N	0	0	B	0	0	NO	1	32	1	1	4.3	30	30		
2	422	563	0.75	M	N	0	0	N	N	0	0	B	0	0	NO	1	30	1	1	3.5	30	30		
3	322	262	0.78	F	N	0	0	N	N	0	0	B	0	0	NO	1	36	1	1	5	30	30		
4	340	238	0.61	F	N	0	0	N	N	0	0	B	0	0	NO	1	24	1	1	2.3	30	30		
5	420	569	0.77	U	N	0	0	N	N	0	0	B	0	0	NO	1	23	1	1	2.2	30	30		
6	405	445	0.67	F	N	0	0	N	N	0	0	B	0	0	NO	0	38	1	1	3	30	30		
7	430	577	0.73	M	N	0	0	N	N	0	0	B	0	0	NO	1	31	1	1	3.9	30	30		
8	351	295	0.68	F	N	0	0	N	N	0	0	B	0	0	NO	1	20	0	0	2.7	30	30		
9	345	249	0.61	U	N	0	0	N	N	0	0	B	0	0	NO	1	28	1	1	3.5	30	30		
10	377	359	0.67	F	N	0	0	N	N	0	0	B	0	0	NO	1	20	1	1	4.4	30	30		
11	330	243	0.68	M	N	0	0	N	N	0	0	B	0	0	NO	1	22	1	1	2.2	30	30		
12	370	366	0.72	M	N	0	0	N	N	0	1	B	0	0	NO	1	34	2	2	3.7	30	30		
13	340	254	0.65	F	N	0	0	N	N	0	0	B	0	0	NO	1	24	0.5	0.5	3.3	30	30		
14	394	426	0.70	M	N	0	0	N	N	0	0	NO	0	0	NO	1	46	1	1	5	60	60		
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 32.14
 STD 8.018

STATION I (05)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Channel Catfish														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Bile	Hem	Leu	Plsm Prot
N	14	0	14	N	14	0	13	0	N	14	0	1	N	0
E1	0	1	0	S	0	1	G	1	S	0	1	N	0	N
E2	0	1	0	L	0	0	NO	2	M	0	2	OT	0	OT
H1	0	2	0	C	0	0	E	3	NO	0	0	0	0	0
H2	0	0	0	M	0	3	OT	0	U	0	0	0	0	0
B1	0	0	0	P	0	4	0	0	OT	0	0	0	0	0
B2	0	0	0	OT	0	0	0	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	14	14	14	14	14	14	14	14	14	14	14	14	0	0
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	100	0	100	N	100	0	92.9	0	N	100	0	7.14	N	####
E1	0	1	0	S	0	1	G	1	S	0	1	92.9	OT	####
E2	0	2	0	L	0	2	NO	2	M	0	2	0	OT	####
H1	0	3	0	C	0	3	E	3	G	0	3	0	OT	####
H2	0	0	0	M	0	4	OT	0	U	0	0	0	OT	####
B1	0	0	0	P	0	0	0	0	OT	0	0	0	OT	####
B2	0	0	0	OT	0	0	0	0	0	0	0	0	OT	####
M1	0	0	0	0	0	0	0	0	0	0	0	0	OT	####
M2	0	0	0	0	0	0	0	0	0	0	0	0	OT	####
OT	0	0	0	0	0	0	0	0	0	0	0	0	OT	####
TOTAL	14	14	14	14	14	14	14	14	14	14	14	14	0	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
N	0	0	0	0	0	0	7.14	0	0	0	100	92.9	####	####

STATION C (07)

'River: MOBILE
 Station: C (07) Species: Channel Catfish
 'Gear: ELECTRO_TRAP Samp. Size 10
 'Date: 10/27, 11/1 94 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	372.00	67.14
Weight	438.50	213.50
Ktl	0.89	0.46
Hematocrit	29.30	7.15
Leucocrit	1.22	1.01
Plasma Protein	4.06	1.08

Samp. #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond	
1	332	275	0.75	M	N	0	0	N	N	0	0	B	0	0	N	1	27	0	0	4.2	4	30	
2	418	505	0.69	M	N	0	0	N	N	0	0	B	0	0	N	1	24	2	2	4	4	30	
3	424	637	0.84	M	N	0	0	N	N	0	0	NO	0	0	N	1	18	0	0	2	2	60	
4	470	942	0.91	M	N	0	0	N	N	0	1	B	0	0	N	A	19	0.2	0	2.5	0	0	
5	371	381	0.75	F	N	0	0	N	N	0	0	B	0	0	N	NO	32	1	1	4.9	4	30	
6	359	304	0.66	M	N	0	0	N	N	0	0	B	0	0	N	NO	34	3	3	4.4	4	30	
7	403	404	0.62	M	N	0	0	N	N	0	0	B	0	0	N	DF	35	2	2	5.6	5	30	
8	384	413	0.73	F	B2	0	0	N	N	0	0	B	0	0	N	NO	33	1	1	4.8	4	60	
9	335	280	0.74	M	N	0	0	N	N	0	0	B	0	0	N	NO	31	2	2	4	4	30	
10	224	244	2.17	M	N	0	0	N	N	0	0	B	0	0	N	NO	40	1	1	4.2	4	30	
11																							
12																							
13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							

MEAN 33
 STD 17.03

STATION C (07)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Channel Catfish														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind Gut	Kid	Liv	Bile	Hem	Leu	Plasm Prot
N	9	0	10	0	10	0	9	0	10	10	0	6	0	0
E1	0	1	0	0	1	0	1	0	0	0	1	0	0	0
E2	0	0	0	0	2	0	0	1	0	0	2	0	0	0
H1	0	2	0	0	0	0	NO	2	0	NO	8	0	0	0
H2	0	3	0	0	3	0	E	0	0	DG	0	0	0	0
B1	0	0	0	0	0	4	OT	0	0	DF	1	0	0	0
B2	0	0	0	0	0	0	0	0	0	OT	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10	10	10	10	10	10	10	10	10	10	10	10	0	0
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	90	0	100	0	100	0	90	0	100	100	0	60	0	0
E1	0	1	0	0	1	0	1	0	0	0	1	0	0	0
E2	0	2	0	0	2	0	0	10	0	0	2	0	0	0
H1	0	3	0	0	3	0	NO	2	0	NO	80	0	0	0
H2	0	0	0	0	0	3	E	0	0	DG	0	0	0	0
B1	0	0	0	0	0	4	OT	0	0	DF	10	0	0	0
B2	10	0	0	0	0	0	0	0	0	OT	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10	10	10	10	10	10	10	10	10	10	10	10	0	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
	10	0	0	0	0	0	10	10	0	0	90	40	###	###

STATION B (08)

'River: ALABAMA
 Station: A (10)
 'Gear: ELEC, TRAPS
 'Species: Channel Catfish
 Samp. Size 16
 'Date: 10/27, 11/1 94
 Analyst: RW, MW, JM

	Mean	Stand Dev
Length	403.50	52.94
Weight	498.81	276.33
Kil	0.70	0.10
Hematocrit	29.75	6.58
Leucocrit	1.09	0.27
Plasma Protein	3.71	0.51

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind			Liv	Bile	Hematocrit Value	Leucocrit Cond	Plasma Pro Value	Index
													Gut	Kid	Index						
1	420	506	0.68	U	N	0	0	N	N	0	0	B	0	0	NO	0	20	1	3.6	30	
2	362	286	0.60	F	N	0	0	N	N	0	0	B	0	0	NO	0	20	1	3	30	
3	430	510	0.64	F	N	0	0	N	N	0	0	B	0	0	NO	1	24	1	3	30	
4	490	1014	0.86	M	N	0	0	N	N	0	1	B	0	0	NO	1	32	1	3.2	30	
5	366	342	0.70	F	N	0	0	N	N	0	1	B	0	0	NO	1	29	1	4.2	30	
6	431	658	0.82	M	N	0	0	N	N	0	1	B	0	0	NO	1	27	1	3.8	30	
7	362	328	0.69	F	N	0	0	N	N	0	0	B	0	0	NO	1	35.5	1	3.6	30	
8	515	1168	0.86	M	N	0	0	P	N	0	1	B	0	0	NO	1	35	1	4.4	60	
9	454	790	0.84	M	N	0	0	N	N	0	0	B	0	0	NO	1	34	1	4.6	30	
10	389	379	0.64	M	N	0	0	N	N	0	0	B	0	0	NO	0	40.5	1.5		30	
11	412	405	0.58	M	N	0	0	N	N	0	0	B	0	0	NO	2	31	1	3.2	30	
12	426	484	0.63	M	N	0	0	N	N	0	0	B	0	0	NO	1	23	2	3.8	30	
13	348	289	0.69	M	N	0	0	N	N	0	0	B	0	0	NO	0	30	1	3.3	30	
14	346	273	0.66	M	N	0	0	N	N	0	0	B	0	0	NO	1	27	1	4.2	30	
15	335	231	0.61	M	N	0	0	N	N	0	0	B	0	0	NO	2	42	1	4	30	
16	370	318	0.63	M	N	0	0	N	N	0	0	B	0	0	NO	1	26	1	3.8	30	
17																					
18																					
19																					
20																					

MEAN 31.88
 STD 7.5

STATION B (08)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Channel Catfish														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Bile	Hem	Leu	Pism
N	16	0	16	15	0	16	12	16	16	16	0	4	N	0
E1	0	1	0	S	1	0	G	0	S	A	0	N	0	N
E2	0	1	0	L	0	1	4	0	0	C	1	10	0	0
H1	0	2	0	0	2	0	0	0	M	NO	2	2	0	0
H2	0	3	0	SL	0	3	0	0	NO	DG	0	0	0	0
B1	0	0	0	0	3	0	E	0	U	DF	0	0	0	0
B2	0	0	0	0	0	4	0	0	OT	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	16	16	16	16	16	16	16	16	16	16	16	16	0	0
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	100	0	100	93.8	0	100	75	100	100	100	0	25	N	###
E1	0	1	0	0	1	0	1	0	0	0	0	62.5	0	###
E2	0	2	0	0	2	0	0	0	0	0	0	12.5	0	###
H1	0	3	0	0	3	0	0	0	0	0	0	0	0	###
H2	0	0	0	0	0	4	0	0	0	0	0	0	0	###
B1	0	0	0	0	0	0	0	0	0	0	0	0	0	###
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	###
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	###
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	###
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	###
TOTAL	100	0	0	0	0	0	0	0	0	0	0	0	0	###
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
	0	0	0	0	0	0	25	0	0	0	100	75	###	###

STATION G (09)

'River: MOBILE
 Station: G (09) Species: Channel Catfish
 'Gear: ELECTROFISHING Samp. Size 16
 'Date: 10/30/94 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	417.88	74.05
Weight	587.13	398.50
Kil	0.72	0.19
Hematocrit	33.30	4.98
Leucocrit	0.87	0.52
Plasma Protein	3.80	0.73

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Pnbr	Thy	Fat	Spln	Hind Gut		Kid	Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index Value
													Value	Cond				Value	Cond	Value	Cond	Value	Cond	
1	335	261	0.69	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	39	0	0	4.2	30		
2	344	279	0.69	F	N	0	0	N	N	0	0	B	0	0	N	A	1	21	1	1	3.8	0		
3	463	460	0.46	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	39	1	1	5.2	30		
4	369	360	0.72	M	N	0	0	N	N	0	0	B	0	0	N	NO	1	32	2	2	4	30		
5	432	913	1.13	M	N	0	0	N	N	0	0	B	0	0	N	NO	1	36	1	1	3.6	30		
6	458	724	0.75	F	N	0	0	N	N	0	0	NO	0	0	N	NO	1	38	1	1	4.8	60		
7	534	1320	0.87	M	N	0	0	N	N	0	0	NO	0	0	N	NO	1	34	0.5	0.5	3.7	60		
8	560	1568	0.89	M	N	0	0	N	N	0	0	NO	0	0	N	NO	1	35.5	1.5	1.5	3.9	60		
9	444	768	0.88	M	N	0	0	N	N	0	0	B	0	0	N	NO	1	37	0.5	0.5	4.5	30		
10	436	660	0.80	F	N	0	0	N	N	0	1	NO	0	0	N	NO	1	38	1	1	4.1	60		
11	398	480	0.76	F	N	0	0	N	N	0	0	B	0	0	N	NO	1					30		
12	434	524	0.64	F	N	0	0	N	N	0	0	NO	0	0	N	NO	0	29	1	1	3	60		
13	476	326	0.30	F	N	0	0	N	N	0	0	NO	0	0	N	NO	1	29	1	1	2.9	60		
14	382	379	0.68	F	N	0	0	N	N	0	0	NO	0	0	N	NO	1	31	0.5	0.5	3.8	60		
15	328	218	0.62	F	N	0	0	N	N	0	0	B	0	0	N	NO	1	30	0	0	2.8	30		
16	293	154	0.61	F	N	0	0	N	N	0	0	NO	0	0	N	NO	1	31	1	1	2.7	60		
17																								
18																								
19																								
20																								

MEAN 43.13
 STD 18.87

STATION D (00)

'River: MOBILE
 Station: D
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 15
 'Date: 10/28/94
 Analyst: RW_MW_JM

	Mean	Stand Dev
Length	302.67	47.42
Weight	342.40	178.81
Kil	1.14	0.08
Hematocrit	35.97	4.62
Leucocrit	0.59	0.92
Plasma Protein	3.94	0.59

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Pnbr	Thy	Fat	SpIn	Hind			Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Kid	Gut	SpIn			Value	Cond	Value	Cond	Value	Cond	
1	290	291	1.19	F	N	0	0	N	N	0	0	NO	0	NO	DF	1	39	N	0.2	N	5.2	N	90	
2	305	336	1.18	M	N	0	0	N	N	0	0	NO	0	NO	D	0	40	N	0	N	3.6	N	90	
3	307	355	1.23	M	B1	0	0	N	N	0	0	NO	0	NO	DF	2	39.5	N	0	N	3.7	N	120	
4	292	291	1.17	F	M1	0	0	N	N	0	0	B	0	N	A	1	24	OT	3	N	4.2	N	60	
5	326	395	1.14	F	N	0	0	N	N	0	1	B	0	NO	A	0	33	N	1	N	4.6	N	30	
6	376	593	1.12	F	N	0	0	N	N	0	1	NO	0	NO	D	1	33	N	1.4	N	4.2	N	90	
7	380	641	1.17	F	N	0	0	N	N	0	0	NO	0	NO	D	1	33	N	2	N	4.2	N	90	
8	382	713	1.28	F	B1	0	0	N	N	0	1	B	0	N	DF	2	42	N	0	N	4.6	N	60	
9	280	209	0.95	F	N	0	0	N	N	0	0	NO	0	S	N	1	31	N	1	N	2.9	OT	120	
10	274	219	1.06	F	N	0	0	N	N	0	0	B	0	NO	D	2	37	N	0	N	3.6	N	60	
11	325	391	1.14	F	N	0	0	N	N	0	1	B	0	N	DF	1	35	N	0.2	N	4	N	30	
12	260	207	1.18	F	N	0	0	N	N	0	0	B	0	N	A	1	36	N	0	N	3.5	N	0	
13	238	146	1.08	M	B1	0	0	N	N	0	0	B	0	N	A	1	39	N	0	N	3.7	N	30	
14	260	201	1.14	F	N	0	0	N	N	0	0	NO	0	NO	D	1	39	N	0	N	3.9	N	90	
15	245	148	1.01	F	N	0	0	N	N	0	0	NO	0	N	D	0	39	N	0	N	3.2	N	60	
16																								
17																								
18																								
19																								
20																								

MEAN 68
 STD 34.89

STATION F (02)

'River: MOBILE
 Station: F
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Smp. Size 13
 'Date: 10/28/94
 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	306.85	54.22
Weight	370.54	208.24
Kil	1.15	0.08
Hematocrit	36.54	3.28
Leucocrit	0.17	0.37
Plasma Protein	4.33	0.41

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Splin	Hind Gut	Kid	Liv	Bile	Hematocrit Value	Leucocrit Cond	Plasma Pro Value	Index				
1	272	211	1.05	F	N	0	0	N	N	0	0	NO	0	S	D	2	39	N	1	N	3.6	N	90	
2	228	135	1.14	M	N	0	0	N	N	0	0	NO	0	NO	D	1	35	N	0.2	N	4.6	N	90	
3	306	319	1.11	F	N	0	0	N	N	0	0	NO	0	NO	A	1	34	N	0	N	4.4	N	60	
4	225	123	1.08	F	N	0	0	N	N	0	0	N	0	NO	D	1	38	N	0	N	4	N	60	
5	295	283	1.10	F	N	0	0	N	N	0	0	NO	0	S	D	0	40	N	0	N	4.9	N	90	
6	287	276	1.17	F	N	0	0	N	N	0	0	N	0	N	DG	0	36	N	0	N	4.7	N	30	
7	254	189	1.15	M	N	0	0	N	N	0	0	B	0	NO	A	1	34	N	1	N	4.8	N	30	
8	313	355	1.16	F	N	0	0	N	N	0	0	NO	0	NO	D	0	30	OT	0	N	4	N	120	
9	365	565	1.16	F	N	0	0	N	N	0	0	NO	1	OT	D	0	39	N	0	N	4	N	100	
10	374	627	1.20	F	N	0	0	N	N	0	0	B	0	OT	DG	1	40	N	0	N	4.2	N	60	
11	366	587	1.20	M	N	0	0	N	N	0	0	NO	0	NO	D	1	36	N	0	N	4.4	N	90	
12	318	358	1.11	M	N	0	0	N	N	0	0	NO	0	OT	D	1	41	N	0	N	3.8	N	90	
13	386	789	1.37	F	N	0	1	N	N	0	0	B	0	N	DG	2	33	N	0	N	4.5	N	40	
14																								
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 73.08
 STD 28.4

STATION F (02)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Largemouth Bass														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Bile	Hem	Leu	Pism Prot
N	13	0	12	N 13	0	13	B 13	0	N 12	A 2	0	N 4	N 12	N 12
E1	0	1	1	S 0	1	0	G 0	1	S 1	C 0	1	OT 7	OT 1	OT 0
E2	0	2	0	L 0	2	0	NO 8	2	M 0	NO 0	2	OT 2	OT 0	OT 0
H1	0	3	0	SL 0	3	0	E 0	3	NO 6	D 8	3	0	0	0
H2	0	0	0	I 0	4	0	OT 0	0	U 0	DF 0	0	0	0	0
B1	0	0	0	OT 0	0	0	0	0	OT 3	DG 3	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	OT 0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13	13	13	13	13	13	13	11	13	13	13	13	13	12

PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	100	0	92.3	N 100	0	100	B 27.3	0	N 92.3	A 15.4	0	N 30.8	N 92.3	N 100
E1	0	1	7.69	S 0	1	0	G 0	1	S 7.69	C 0	1	OT 53.8	OT 7.69	OT 0
E2	0	2	0	L 0	2	0	NO 72.7	2	M 0	NO 0	2	15.4	0	0
H1	0	3	0	SL 0	3	0	E 0	3	NO 0	D 46.2	3	0	0	0
H2	0	0	0	I 0	4	0	OT 0	0	U 0	DF 0	0	0	0	0
B1	0	0	0	OT 0	0	0	0	0	OT 23.1	DG 23.1	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	OT 0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	100	13	13	13	13	13	13	11	13	13	13	13	13	12

PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
100	0	0	7.69	0	0	0	0	72.7	7.69	84.6	84.6	69.2	7.69	0

STATION H (03)

'River: MOBILE
 Station: H
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 16
 'Date: 10/29/94
 Analyst: RW.MW.JM

Stand

Mean	Dev
327.63	60.35
496.44	281.16
1.25	0.14
35.00	3.63
0.35	0.59
4.34	0.77

Samp. #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index	
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond		Value
1	240	167	1.21	F	N	0	0	N	N	0	0	B	0	NO	D	2	31	N	1	N	4.3	N	60	
2	348	508	1.21	F	B1	0	0	N	N	0	1	B	0	NO	D	2	34	N	0	N	4.5	N	90	
3	261	195	1.10	M	B1	0	0	N	N	0	1	B	0	N	A	2	37	N	0	N	5.2	N	30	
4	414	919	1.30	F	B2	0	0	N	N	0	3	B	0	N	D	0	41	N	0.5	N	5.5	N	60	
5	390	963	1.62	F	N	0	0	N	N	0	3	B	0	OT	A	2	39	N	0	N	5	N	30	
6	395	829	1.35	F	N	0	0	N	N	0	0	B	0	NO	D	2	31	N	1	N	5.3	N	60	
7	379	757	1.39	F	N	0	0	N	N	0	3	B	0	OT	DG	2	30	OT	0	N	4	N	90	
8	390	746	1.26	F	N	0	0	N	N	0	3	B	0	NO	DG	2	34	N	0	N	4.7	N	60	
9	364	585	1.21	F	N	0	0	N	N	0	3	NO	0	NO	D	2	35	N	2	N	5	N	90	
10	351	573	1.33	M	N	0	0	N	N	0	1	NO	0	NO	D	2	34	N	0	N	4.2	N	90	
11	334	425	1.14	F	N	0	0	N	N	0	0	B	0	N	DF	2	37	N	1	N	4.3	N	30	
12	312	370	1.22	F	B2	0	0	N	N	0	0	NO	0	N	D	0	41	N	0.1	N	3.2	N	90	
13	297	340	1.30	F	B1	0	0	N	N	0	0	NO	0	NO	D	0	30	OT	0	N	4	N	150	
14	257	193	1.14	M	B1	0	0	N	N	0	0	B	0	N	D	0	37	N	0	N	3.6	N	60	
15	278	240	1.12	F	N	0	0	N	N	0	0	B	0	NO	A	1	32	N	0	N	2.8	OT	60	
16	232	133	1.07	F	N	0	0	N	N	0	0	NO	0	NO	D	0	37	N	0	N	3.8	N	90	
17																								
18																								
19																								
20																								

MEAN 71.25
 STD 30.74

STATION E (04)

'River: MOBILE
 Station: E
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 15
 'Date: 10/26/94
 Analyst: RW.MW.JM

	Mean	Stand Dev
Length	330.20	34.98
Weight	436.80	153.89
Ktl	1.16	0.08
Hematocrit	40.33	4.87
Leucocrit	0.30	0.65
Plasma Protein	4.53	0.62

Samp. #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	SpIn	Hind Gut		Kid	Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index	
													Gut	SpIn				Value	Cond	Value	Cond	Value	Cond		Value
1	330	403	1.12	F	N	0	0	N	N	0	0	B	0	0	N	DG	2	43	N	0	N	5.4	N	30	
2	330	431	1.20	F	B1	0	0	N	N	0	0	B	0	1	N	DG	2	39	N	0.2	N	5	N	70	
3	347	479	1.15	F	N	0	1	N	N	0	0	NO	0	0	NO	DF	2							100	
4	370	599	1.18	F	N	0	0	N	N	0	1	G	0	0	NO	DG	2							60	
5	310	336	1.13	F	N	0	0	N	N	0	0	B	0	0	N	D	0	40	N	0	N	4	N	30	
6	330	433	1.20	F	N	0	0	N	N	0	0	NO	0	0	NO	DG	2	42	N	0.1	N	4.2	N	90	
7	320	379	1.16	F	N	0	0	N	N	0	0	B	0	0	NO	DF	1	34	N	0	N	4	N	60	
8	326	432	1.25	F	N	0	0	N	N	0	0	B	0	0	N	A	0	36	N	2	N	4.8	N	0	
9	311	348	1.16	F	N	1	0	N	N	0	0	E	0	0	NO	DG	2	50	N	0	N	5.4	N	100	
10	245	159	1.08	F	N	0	0	N	N	0	0	B	0	0	N	A	1	36	N	0.4	N	4	N	0	
11	320	334	1.02	F	N	0	0	N	N	0	0	B	0	0	NO	DF	2							60	
12	300	287	1.06	F	B1	0	0	N	N	0	0	NO	0	0	NO	DG	2	43	N	0	N	4	N	120	
13	396	811	1.31	F	N	0	0	N	N	0	1	NO	0	0	OT	D	2							90	
14	366	556	1.13	F	N	0	0	N	N	0	0	G	0	0	OT	DG	1							60	
15	352	565	1.30	F	N	0	2	N	N	0	0	B	0	0	S	D	1							80	
16																									
17																									
18																									
19																									
20																									

MEAN 63.33
 STD 35.79

STATION E (04)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS																					
Largemouth Bass																					
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Lv	Bile	Hem	Leu	Pism Prot							
N	13	0	13	N	15	0	13	B	8	0	14	N	5	A	2	0	2	N	9	N	9
E1	0	1	1	F	0	1	2	G	2	1	1	S	1	C	0	1	4	OT	0	OT	0
E2	0	2	1	C	0	2	0	NO	4	2	0	M	0	NO	0	2	9	0	0	0	0
H1	0	3	0	M	0	3	0	E	1	3	0	NO	7	D	3	3	0	0	0	0	0
H2	0	0	0	P	0	4	0	OT	0	0	0	U	0	DF	3	0	0	0	0	0	0
B1	2	0	0	OT	0	0	0	0	0	2	0	OT	2	DG	7	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	OT	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	9	9	9	9
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE																					
N	86.7	0	93.3	0	86.7	0	86.7	0	53.3	0	93.3	0	33.3	A	13.3	0	13.3	N	100	N	100
E1	0	1	6.67	1	6.67	0	13.3	G	13.3	1	6.67	0	S	6.67	C	0	26.7	OT	0	OT	0
E2	0	2	0	2	0	2	0	NO	26.7	2	0	M	0	NO	0	2	60	0	0	0	0
H1	0	3	0	M	0	3	0	E	6.67	3	0	NO	46.7	D	20	3	0	0	0	0	0
H2	0	0	0	P	0	4	0	OT	0	0	0	U	0	DF	20	0	0	0	0	0	0
B1	13.3	0	0	OT	0	0	0	0	0	0	0	OT	13.3	DG	46.7	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	OT	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13.3	6.67	13.3	0	0	0	13.3	6.67	6.67	6.67	6.67	6.67	6.67	6.67	86.7	86.7	86.7	0	0	0	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS																					
N	86.7	0	93.3	0	86.7	0	86.7	0	53.3	0	93.3	0	33.3	A	13.3	0	13.3	N	100	N	100
E1	0	1	6.67	1	6.67	0	13.3	G	13.3	1	6.67	0	S	6.67	C	0	26.7	OT	0	OT	0
E2	0	2	0	2	0	2	0	NO	26.7	2	0	M	0	NO	0	2	60	0	0	0	0
H1	0	3	0	M	0	3	0	E	6.67	3	0	NO	46.7	D	20	3	0	0	0	0	0
H2	0	0	0	P	0	4	0	OT	0	0	0	U	0	DF	20	0	0	0	0	0	0
B1	13.3	0	0	OT	0	0	0	0	0	0	0	OT	13.3	DG	46.7	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	OT	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13.3	6.67	13.3	0	0	0	13.3	6.67	6.67	6.67	6.67	6.67	6.67	6.67	86.7	86.7	86.7	0	0	0	0

STATION I (05)

'River: MOBILE
 Station: 1
 'Gear: ELECTROFISHING
 'Date: 10/29/94
 'Species: LMB
 Samp. Size: 13
 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	341.46	69.49
Weight	555.54	340.12
Kil	1.22	0.15
Hematocrit	34.23	3.98
Leucocrit	0.32	0.47
Plasma Protein	4.78	0.81

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Pnbr	Thy	Fat	SpIn	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index	
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond		Value
1	325	459	1.34	F	N	0	0	N	N	0	1	NO	0	NO	DG	0	37	N	0.2	N	5.6	N	90	
2	361	625	1.33	M	N	0	0	N	N	0	1	NO	0	S	D	2	25	OT	0	N	5.8	N	120	
3	472	1118	1.06	F	N	0	0	N	N	0	0	NO	0	N	D	2	34	N	0	N	5.6	N	60	
4	440	1153	1.35	F	N	0	0	N	N	0	2	B	0	NO	DG	0	38	N	1	N	5	N	60	
5	396	938	1.51	M	N	0	0	N	N	0	0	B	0	N	DG	0	39	N	1	N	5.3	N	30	
6	325	411	1.20	F	N	0	0	N	N	0	0	B	0	N	A	2	35	N	0	N	4.7	N	0	
7	344	490	1.20	M	N	0	0	N	N	0	0	NO	0	N	D	1	33	N	0	N	4	N	60	
8	378	713	1.32	F	N	0	0	N	N	0	1	B	0	N	A	0	36	N	1	N	5.2	N	0	
9	342	488	1.22	M	N	0	0	N	N	0	0	NO	0	NO	A	0	34	N	1	N	5.3	N	60	
10	290	272	1.12	M	N	0	0	N	N	0	0	B	0	N	A	1	38	N	0	N	4.6	N	0	
11	275	239	1.15	F	N	0	0	N	N	0	0	B	0	N	D	1	28	OT	0	N	3.8	N	60	
12	261	198	1.11	F	N	0	0	N	N	0	0	B	0	N	A	0	35	N	0	N	3.2	N	0	
13	230	118	0.97	M	N	0	0	N	N	0	0	B	0	N	A	1	33	N	0	N	4	N	0	
14																								
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 41.54
 STD 39.76

STATION C (07)

'River: MOBILE
 Station: C
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 10
 'Date: 10/27/94
 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	306.70	61.12
Weight	408.80	276.14
Kil	1.23	0.12
Hematocrit	33.90	1.97
Leucocrit	0.35	0.46
Plasma Protein	4.34	0.74

P. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind Gut		Kid	Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index Value	
													NO	0				Value	Cond	Value	Cond	Value	Cond		Value
1	260	215	1.22	F	B1	0	0	N	.N	1	0	NO	0	NO	0	NO	0	0	34	N	1	N	4.7	N	130
2	334	398	1.07	F	N	0	0	N	N	0	0	NO	0	NO	0	NO	0	2	33	N	1	N	4.6	N	90
3	305	359	1.27	F	N	0	0	N	N	0	0	B	0	NO	0	NO	0	0	33	N	0.1	N	5.1	N	60
4	385	825	1.45	F	N	0	0	N	N	0	1	B	0	NO	0	NO	DF	0	35	N	0	N	5.3	N	60
5	400	875	1.37	F	N	0	0	N	N	0	1	NO	0	NO	0	NO	DF	0	30	OT	0.2	N	4.2	N	120
6	367	653	1.32	F	N	0	0	N	N	0	2	NO	0	NO	0	NO	DF	2	33	N	1	N	5	N	90
7	253	180	1.11	F	N	0	0	N	N	0	0	B	0	NO	0	NO	0	0	36	N	0	N	3.9	N	60
8	230	148	1.22	M	N	0	0	N	N	0	0	NO	0	NO	0	NO	0	2	37	N	0.2	N	4	N	90
9	277	252	1.19	F	N	0	0	N	N	0	0	NO	0	NO	0	N	A	2	35	N	0	N	3.7	N	30
10	256	183	1.09	F	N	0	0	N	N	0	0	NO	0	NO	0	N	A	0	33	N	0	N	2.9	OT	60
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

MEAN 79
 STD 30.71

STATION C (07)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS																	
Largemouth Bass																	
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Blle	Hem	Leu	Plsm Prot			
N	9	0	10	N	10	0	7	3	0	10	2	A	2	0	6	N	9
E1	0	1	0	F	0	1	2	0	1	0	C	0	0	1	0	N	10
E2	0	2	0	C	0	0	1	7	0	0	NO	0	0	2	4	OT	0
H1	0	3	0	M	0	3	0	0	0	8	D	5	3	0	0	0	1
H2	0	0	0	P	0	4	0	0	0	0	DF	3	0	0	0	0	0
B1	1	0	0	OT	0	0	0	0	0	0	DG	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	OT	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTA	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE																	
N	90	0	100	N	100	0	70	30	0	100	20	A	20	0	60	N	90
E1	0	1	0	F	0	1	20	0	1	0	C	0	0	1	0	OT	10
E2	0	2	0	C	0	0	10	70	0	0	NO	0	0	2	40	0	10
H1	0	3	0	M	0	3	0	0	0	80	D	50	3	0	0	0	0
H2	0	0	0	P	0	4	0	0	0	0	DF	30	0	0	0	0	0
B1	10	0	0	OT	0	0	0	0	0	0	DG	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	OT	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS	10	0	0	0	0	0	30	70	0	0	80	80	40	10	40	10	10

STATION B (8)

'River: MOBILE
 Station: B
 'Gear: ELECTROFISHING
 'Date: 10/27/94
 'Species: Largemouth Bass
 Samp. Size 11
 Analyst: RW, MW, JM

	Mean	Stand Dev
Length	341.00	46.43
Weight	526.55	213.65
Ktl	1.25	0.09
Hematocrit	36.64	3.14
Leucocrit	0.23	0.41
Plasma Protein	4.00	0.55

Samp. #	Lgth	Wght	Ktl	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spin	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index	
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond		Value
1	345	466	1.13	M	N	0	0	N	N	0	0	NO	0	NO	DF	2	40	N	0	N	4.6	N	90	
2	356	576	1.28	F	N	0	0	N	N	0	0	NO	0	NO	D	2	39	N	1	N	4.8	N	90	
3	346	486	1.17	F	N	0	0	N	N	0	0	NO	0	NO	D	0	38	N	0	N	3.9	N	90	
4	377	650	1.21	F	N	0	0	N	N	0	0	B	0	B	D	2	39	N	1	N	4.2	N	60	
5	336	458	1.21	F	N	0	0	N	N	0	0	B	0	B	DF	2	34	N	0.5	N	4.4	N	30	
6	351	588	1.36	F	B1	0	0	N	N	0	0	NO	0	NO	DF	2	34	N	0	N	4	N	120	
7	335	500	1.33	U	B1	0	0	N	N	0	0	B	0	B	DF	2	35	N	0	N	3.7	N	90	
8	409	938	1.37	F	N	0	0	N	N	0	2	B	0	B	DF	0	42	N	0	N	4.4	N	60	
9	378	729	1.35	F	N	0	0	N	N	0	0	B	0	B	D	0	36	N	0	N	3.6	N	30	
10	273	234	1.15	F	N	0	0	N	N	0	0	NO	0	NO	A	1	34	N	0	N	3	N	60	
11	245	167	1.14	F	N	0	0	N	N	0	0	B	0	B	A	1	32	N	0	N	3.4	N	30	
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								

MEAN 68.18
 STD 30.27

STATION B (8)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Largemouth Bass														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	SpIn	Hind Gut	Kid	Liv	Bile	Hem	Leu	Pism Prot
N	9	0	11	0	11	0	10	6	11	2	2	0	11	11
E1	0	1	0	1	0	1	0	0	0	0	0	1	0	0
E2	0	2	0	0	2	2	1	5	0	0	0	2	0	0
H1	0	3	0	0	3	3	0	0	0	0	4	6	0	0
H2	0	0	0	0	0	4	0	0	0	0	5	0	0	0
B1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTA	11	11	11	11	11	11	11	11	11	11	11	11	11	11
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	81.8	0	100	0	100	0	90.9	54.5	100	18.2	18.2	27.3	100	100
E1	0	1	0	1	0	1	0	0	0	0	0	1	0	0
E2	0	2	0	0	2	2	9.09	45.5	0	0	0	2	0	0
H1	0	3	0	0	3	3	0	0	0	0	3	54.5	0	0
H2	0	0	0	0	0	4	0	0	0	0	0	0	0	0
B1	18.2	0	0	0	0	0	0	0	0	0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
18.2	0	0	0	0	0	0	9.09	45.5	0	81.8	81.8	72.7	0	0

STATION G (09)

'River: MOBILE
 Station: G
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 13
 'Date: 10/30/94
 Analyst: RW, MW, JM

Stand
 Dev

	Mean	Stand Dev
Length	305.08	52.50
Weight	382.31	196.59
Kil	1.21	0.10
Hematocrit	37.45	5.15
Leucocrit	0.11	0.28
Plasma Protein	4.02	0.81

Samp. #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind		Liv	Bile	Hematocrit		Leucocrit		Plasma Pro		Index
													Gut	Kid			Value	Cond	Value	Cond	Value	Cond	
1	290	283	1.16	M	B1	0	0	N	N	0	0	B	0	N	A	1	35	N	1	N	3.5	N	30
2	346	514	1.24	F	B1	0	0	N	N	0	0	NO	0	NO	D	0	31	N	0	N	3.8	N	120
3	370	685	1.35	M	N	0	0	N	N	0	1	NO	0	NO	DG	0	34	N	0.2	N	5	N	90
4	331	500	1.38	F	N	2	0	N	N	0	0	NO	0	NO	D	1	29.8	OT	0	N	4.5	N	140
5	353	561	1.28	F	N	0	0	N	N	0	1	B	0	N	D	1	38	N	0	N	3.8	N	30
6	356	573	1.27	F	N	0	0	N	N	0	1	NO	0	NO	D	1	41	N	0	N	4.4	N	90
7	358	570	1.24	M	B1	0	0	N	N	0	1	B	0	N	D	0	41	N	0	N	3.6	N	60
8	286	256	1.09	F	N	0	0	N	N	0	0	NO	0	N	D	1	36	N	0	N	3.5	N	60
9	256	195	1.16	F	N	0	0	N	N	0	1	NO	0	NO	D	1	47	N	0	N	5.9	N	90
10	320	411	1.25	M	B1	0	0	N	N	0	0	NO	0	NO	D	2	32	N	0	N	3.2	N	120
11	237	143	1.07	F	N	0	0	N	N	0	0	NO	0	NO	D	2	43	N	0.2	N	4.6	N	90
12	240	156	1.13	F	N	0	0	N	N	0	1	NO	0	NO	D	2	42	N	0	N	3.3	N	90
13	223	123	1.11	F	N	0	0	N	N	0	0	NO	0	NO	D	1	37	N	0	N	3.2	N	90
14																							
15																							
16																							
17																							
18																							
19																							
20																							

MEAN 84.62
 STD 32.82

STATION G (09)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Largemouth Bass														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Bile	Hem	Leu	Plsm Prot
N	9	0	13	N 13	0	0	7	0	N 13	4	1	3	N 12	N 13
E1	0	1	0	S 0	1	1	6	1	S 0	C 0	0	7	N 13	N 13
E2	0	2	0	L 0	2	2	0	2	M 0	NO 0	2	OT	OT 0	OT 0
H1	0	3	0	SL 0	3	3	0	3	NO 9	D 11	3	0	0	0
H2	0	0	0	P 0	0	4	0	0	U 0	DF 0	0	0	0	0
B1	4	0	0	OT 0	0	0	0	0	OT 0	DG 1	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	OT 0	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13	13	13	13	13	13	13	13	13	13	13	13	13	13

PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	69.2	0	92.3	0	100	0	53.8	0	100	30.8	7.69	23.1	92.3	100
E1	0	1	0	0	1	1	46.2	1	0	0	0	53.8	0	0
E2	0	2	0	0	2	2	0	2	0	0	2	23.1	0	0
H1	0	3	0	0	3	3	0	3	0	NO 69.2	3	0	0	0
H2	0	0	0	0	0	4	0	0	0	D 84.6	0	0	0	0
B1	30.8	0	0	0	0	0	0	0	0	DF 0	0	0	0	0
B2	0	0	0	0	0	0	0	0	0	DG 7.69	0	0	0	0
M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
30.8	7.69	0	0	0	0	0	46.2	76.9	0	69.2	92.3	76.9	7.69	0

STATION A (10)

'River: MOBILE
 Station: A
 'Gear: ELECTROFISHING
 'Species: Largemouth Bass
 Samp. Size 16
 'Date: 10/30/94
 Analyst: RW,MW,JM

	Mean	Stand Dev
Length	330.50	53.85
Weight	490.69	274.15
Kil	1.24	0.11
Hematocrit	39.88	5.60
Leucocrit	0.24	0.54
Plasma Protein	4.07	0.68

Tip #	Lgth	Wght	Kil	Sex	Eyes	Fin	Opl	Gill	Psbr	Thy	Hind Fat	Spin	Gut	Kid	Liv	Bile	Hematocrit Value	Hematocrit Cond	Leucocrit Value	Leucocrit Cond	Plasma Prot Value	Plasma Prot Cond	Index Value	
1	266	228	1.21	M	B1	0	0	N	N	0	0	NO	0	NO	DF	0	39	N	0.2	N	3.8	N	120	
2	271	240	1.21	M	B1	0	0	N	N	0	0	B	0	NO	D	2	47	N	1	N	4.5	N	90	
3	345	488	1.19	M	N	0	0	N	N	0	0	B	2	NO	DF	2	26	OT	0	N	4.5	N	90	
4	328	464	1.31	F	N	0	0	N	N	0	0	NO	0	N	D	2	45	N	0	N	4.2	N	60	
5	379	675	1.24	M	N	0	0	N	N	0	1	NO	0	NO	D	2	31	N	0	N	4.1	N	90	
6	428	1150	1.47	F	N	0	0	N	N	0	3	G	0	NO	DF	2	42	N	2	N	5.9	N	60	
7	445	1009	1.15	F	B1	0	0	N	N	0	1	B	0	N	D	2	46	N	0	N	4.7	N	60	
8	295	337	1.31	F	N	0	0	N	N	0	1	B	0	NO	D	2	40	N	0	N	4.6	N	60	
9	361	656	1.39	F	N	0	0	N	N	0	3	B	0	N	DF	2	40	N	0	N	4.1	N	30	
10	297	308	1.18	F	B1	0	0	N	N	0	0	B	0	N	A	2	33	N	0.2	N	3.7	N	30	
11	349	558	1.31	F	N	0	0	N	N	0	1	NO	0	NO	DF	2	43	N	0	N	3.3	N	90	
12	289	311	1.29	M	N	0	0	N	N	0	1	NO	0	NO	D	2	41	N	0.5	N	3.3	N	90	
13	304	353	1.26	F	N	0	0	N	N	0	1	NO	0	NO	D	2	39	N	0	N	3.6	N	90	
14	357	563	1.24	F	N	0	0	N	N	0	1	NO	0	NO	D	2	42	N	0	N	3.3	N	90	
15	282	228	1.02	F	N	0	0	N	N	0	0	NO	0	NO	D	2	43	N	0	N	3.5	N	90	
16	292	283	1.14	F	N	0	0	N	N	0	0	NO	0	NO	D	0	39	N	0	N	4	N	90	
17																								
18																								
19																								
20																								

MEAN 76.88
 STD 24.42

STATION A (10)

SUMMARY OF PHYSICAL/PATHOLOGICAL CONDITIONS														
Largemouth Bass														
Eye	Fin	Opl	Gill	Psbr	Thy	Fat	Spln	Hind Gut	Kid	Liv	Bile	Hem	Leu	Plsm Prot
N	12	0	16	N	16	0	7	6	N	4	1	2	N	16
E1	0	1	0	S	1	1	G	1	S	0	0	0	N	16
E2	0	2	0	L	2	2	NO	9	M	0	2	14	OT	0
H1	0	3	0	SL	3	3	E	0	NO	12	3	0		
H2	0	0	0	I	0	4	OT	0	U	0	5	0		
B1	4	0	0	OT	0				OT	0	0			
B2	0													
M1	0													
M2	0													
OT	0													
TOTAL	16	16	16	16	16	16	16	16	16	16	16	16	16	16
PERCENT OF PHYSICAL/PATHOLOGICAL CONDITIONS IN TOTAL SAMPLE														
N	75	0	100	N	100	0	43.8	37.5	N	25	6.25	12.5	N	100
E1	0	1	0	S	0	1	43.8	6.25	S	0	0	0	OT	0
E2	0	2	0	L	0	2	0	56.3	M	0	0	87.5	OT	0
H1	0	3	0	SL	0	3	12.5	E	NO	75	3	0		
H2	0	0	0	I	0	4	0	0	U	0	31.3	0		
B1	25	0	0	OT	0				OT	0	0			
B2	0													
M1	0													
M2	0													
OT	0													
TOTAL	25	0	0	0	0	0	56.3	56.3	0	75	93.8	87.5	6.25	0
PERCENT OF TOTAL SAMPLE EXHIBITING PATHOLOGICAL CONDITIONS														
	25	0	0	0	0	0	56.3	56.3	0	75	93.8	87.5	6.25	0

APPENDIX G

**Human Health Risk Evaluation of
Fish Data, Mobile River Study**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

345 COURTLAND STREET N.E.
ATLANTA GEORGIA 30365

January 30, 1995

4WD-OHA

MEMORANDUM

SUBJECT: Human Health Risk Evaluation of Fish Data, Mobile River Study

FROM: Kevin P. Koporec, Toxicologist
Office of Health Assessment *KPKoporec*

THRU: Elmer W. Akin, Chief
Office of Health Assessment *EWA*

TO: Joanne Benante, RPM
South Superfund Remedial Branch

Per your request, I have evaluated the **health risks associated with potential human consumption of fish from the Mobile River.**

The data forwarded to me for evaluation report levels of mercury and DDT/DDE/DDD in fish obtained by EPA for the Mobile River Study project. From observing the fillet fish data, mercury and DDT/E/D are reported at higher concentrations in the largemouth bass than in the catfish fillet samples. In both catfish and largemouth bass, the fish classified in the "large" category had the highest concentrations of each of the reported chemicals.

Rather than attempt to estimate the risks from fish ingestion for each sampling station, I have used exposure assumptions and toxicity values to backcalculate risk-based concentrations which can then be compared to the chemical concentrations found at the various sampling stations.

Exposure Assessment- Fish Ingestion

From personal communication with officials at the Alabama Department of Public Health it was determined that, as an estimate of reasonable maximum exposure, an individual subsistence fisherman could consume up to two fish meals per week from this area of the Mobile/Tombigbee Rivers. While many individuals may not consume this quantity of Mobile/Tombigbee River fish, the purpose of this assessment is to evaluate the potential health risk in a conservative (health-protective) manner. This ingestion rate for an adult of 2 fish meals (145 g

per meal) per week from the contaminated source is assumed to occur 52 weeks per year for a total of 30 years. The exposure assumptions, other than the ingestion rate, are EPA baseline risk assessment default values for fish ingestion. All exposure assumptions are listed in Table 1.

Table 1. Exposure Parameters

Exposure Parameter	Assumed Value
Fish Ingestion Rate (IR)	0.145 kg/meal
Exposure Frequency (EF)	104 meals/year
Exposure Duration (ED)	30 years
Body Weight (BW)	70 kg
Averaging Time (AT)	ED x 365 d/y (noncarcinogens) 70 y x 365 d/y (carcinogens)

Toxicity Assessment- Chemicals detected in Fish

EPA has classified DDT, DDE, and DDD as B2 (probable human) carcinogens, and has verified cancer slope factors for each of these compounds. Mercury is class D (not classifiable as to human carcinogenicity). From the available noncarcinogenic toxicity data EPA has established oral reference doses (RfDs) for mercury (both inorganic and methyl) as well as for DDT. The available toxicity values are listed in Table 2.

Table 2. Toxicity Values

Chemical	Reference Dose (mg/kg-d) [Source]	Slope Factor (kg-d/mg) [Source]
Mercury ^a	3E-4 [HEAST/IRIS] ^a	NA
DDT	5E-4 [IRIS]	3.4E-1 [IRIS]

^aMercury is class D for carcinogenicity; therefore, the slope factor is not applicable. The reference dose used is the same for inorganic [HEAST] and methyl [IRIS] mercury.

^b The *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories* (EPA 1994) recommends adding the concentrations of DDT, DDE, and DDD and comparing to the health based values for DDT.

Derivation of Risk-Based Concentrations for Fish Ingestion

The risk-based concentration is determined by appropriately combining parameters from the exposure assessment and toxicity assessment along with selected target risk values.

The following equations result in chemical concentrations in fish for the carcinogenic and noncarcinogenic endpoints, respectively.

$$CF_{\alpha} = \frac{TCR \times BW \times AT}{IR \times EF \times ED \times SF}$$

$$CF_{nc} = \frac{THQ \times BW \times AT \times RfD}{IR \times EF \times ED}$$

- where:
- CF_α = carcinogenic risk-based concentration in fish
 - CF_{nc} = noncarcinogenic risk-based concentration in fish
 - TCR = target carcinogenic risk
 - THQ = target hazard quotient (noncarcinogenic endpoint)
 - SF = carcinogenic slope factor
 - RfD = reference dose

All exposure parameters are defined in Table 1.

The resultant risk based values are listed in Table 3.

Table 3. Risk-based fish concentrations for chemicals detected in Mobile River Study (mg/kg)

Target Risk Level	Chemical	
	DDT	Mercury
TCR = 1E-6	0.01	NA
TCR = 1E-5	0.1	NA
TCR = 1E-4	1.0	NA
THQ = 0.1	0.08	0.05
THQ = 1.0	0.8	0.5
THQ = 10.0	8	5

TCR = target carcinogenic risk (Upperbound)
 THQ = target hazard quotient (noncarcinogenic endpoint)
 NA- carcinogenic endpoint not applicable for mercury

Risk Characterization- Fish Ingestion

Note: The Upperbound risk values given in the following text assume a consumption rate as stated in Table 1 of fish which are all contaminated to the level stated.

Of the reported mercury concentrations for large channel catfish fillets, station 2 had the highest concentration. The

average of the reported mercury concentrations at station 2 (0.28 ppm) corresponds to an hazard quotient (HQ) between 0.1 and 1.0, based on the exposure assumptions used in this assessment. The maximum fillet mercury concentration reported in the study (0.54 ppm) is approximately equal to an HQ of 1.0. For the samples of largemouth bass samples classified as large, station 2 also had the highest reported concentrations of mercury. Both the average and maximum levels at this station (0.36, 0.41 ppm, respectively) correspond to an HQ between 0.1 and 1.0.

The sum of the DDE/DDD/DDT concentrations are highest at station 7 for both the large channel catfish and the large largemouth bass. In large catfish, the total of the DDE/DDD/DDT averages at station 7, 0.302 ppm, corresponds to an upper-bound carcinogenic risk between $1E-5$ and $1E-4$, and to a HQ between 0.1 and 1.0. The total of the maximum DDE/DDD/DDT concentrations in catfish at station 7, 0.409 does not differ noticeably from the average concentration in terms of estimated risk. For ingestion of largemouth bass, the total of the DDE/DDD/DDT averages at station 7, 0.517 ppm, also corresponds to an upper-bound carcinogenic risk between $1E-5$ and $1E-4$, and to a HQ between 0.1 and 1.0. The total of the maximum DDE/DDD/DDT concentrations in large fillet bass at station 7, 1.35 ppm corresponds to an upper-bound carcinogenic risk of approximately $1E-4$, and to a HQ between 1.0 and 10.0.

If an adolescent were to consume this fish at a comparable rate to the adult, the total dose for the noncarcinogenic endpoint would be higher (up to 2-fold) due to lower assumed body weight for the adolescent. For the carcinogenic endpoint (DDT/DDE/DDD), however, this difference is negated by the lower exposure duration for the adolescent (9 yrs) being averaged out over the lifetime (70 yrs).

Surface Water/Sediment

The surface water and sediment chemical data show detections of mercury and a few pesticides. The concentrations reported indicate no significant additional health risk under any foreseeable exposure scenarios.

Conclusions/Considerations

In considering risk management decisions for this site, I would emphasize the conservative (health protective) approach used in deriving the health-based concentrations for DDT and mercury. The assumption is made in this assessment that a 70 kg adult regularly eats fish from the same contaminated source, twice per week, 52 weeks per year, for 30 years and that all fish eaten have the given level of contamination. Adjustment of exposure values based on better additional site-specific information would alter the risks estimates accordingly, most likely downward.

FDA has set action levels for edible fish for both mercury (1.0 ppm) and DDT (5.0 ppm). The maximum concentrations of both mercury and DDT (including metabolites) reported for the Mobile River Study are below these FDA levels. It should be noted, however, that FDA's action levels assume that the individual will consume no more than 1.2 lb per year of contaminated fish (10% of the total fish diet from the marketplace). FDA action levels are not meant to protect the local recreational or subsistence fisherman. In contrast, the subsistence-type fisherman assessed in this report is assumed to consume more than 33 lb of contaminated fish per year.

If further questions arise, I can be reached at 347-3555, vmx 6364.

K.P.Koporec/kpk:4WD-OHA:1586/01/30/95/C:\WP51\MRSFSH.RA1

APPENDIX H
RESPONSIVENESS SUMMARY

MOBILE RIVER STUDY
RESPONSIVENESS STUDY
FOR MAJOR COMMENTS

Human Health Risk Evaluation

Comment 1: The report says that a subsistence fisherman is at risk from eating large largemouth bass from Station MT-7. This conclusion is based on some very conservative and highly unlikely assumptions. It is highly probable that a person consuming 0.145 kg of fish at each of 2 meals per week for 30 years would fish at only a single location (such as MT-2 or MT-7), or would catch and eat only the largest largemouth bass. Fish tissue concentrations should be evaluated, and potential risk estimated, on the basis of area, or multiple-station, means. Since the presence of a boat launch near MT-7 presumes that subsistence fishermen are in the area, and would not be likely to fish the entire 53-mile study area, we (ADEM) calculated Hazard Quotients and Cancer Risk based on the average of all fillets from MT-7, MT-8, and MT-9. Using these data, the HQ would be 0.108, and the cancer risk would be 1.7×10^{-5} .

Response 1: EPA's risk assessment guidance establishes protocol for an individual, as having an average cancer risk of 1.0×10^{-6} or a 1 in a million chance of developing cancer. In the MRS Report a subsistence fisherman scenario was evaluated which yielded a cancer risk between 1.0×10^{-4} and 1.0×10^{-5} . Both the MRS evaluation and the evaluation noted in the comment, show that a subsistence fisherman as an increased risk of developing cancer, (e.g. a range between 1 in 100,000 to 1 in 10,000). Therefore, that ADEM's calculations are consistent with MRS regarding the increased risk to a subsistence fisherman. Regarding the comment relating to the probability of a subsistence fisherman eating fish from only a single location (such as MT-2 or MT-7), EPA is aware of numerous fish camps along the 53 mile study area. The Walker Fish Camp, is located immediately down gradient from station MT-7. A newspaper article in the May 2, 1995 edition of the Mobile Register (attached) reports that there are individuals and families that live in trailers at the Walker Fish Camp, some of whom have lived there for 20 years. It seems highly feasible that these individuals may fish and eat fish from that location on a consistent basis. It is reasonable to assume that if a fisherman finds a good location to fish he/she will consistently return to that location to fish.

Comment 2: EPA has greatly overestimated potential human health risks in the study area. Even so, the risk estimate is still within the acceptable risk range of 1×10^{-4} to 1×10^{-6} .

Response 2: For clean up actions under the remedial program of CERCLA, the NCP establishes a risk range of 1×10^{-4} to 1×10^{-6} . The NCP states that EPA's preference is to select remedies that are at the more protective end of the risk range. Therefore when developing its preliminary goals, EPA uses 1×10^{-6} as a point of departure. This means that a cumulative risk level of 1×10^{-6} is used as the starting point (or initial protectiveness goal) for determining the most appropriate risk level that alternatives should be designed to attain. The use of 1×10^{-6} expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range, but this does not reflect a presumption that the final remedial action should attain such a risk level. The 1×10^{-6} point of departure may be revised to a different risk level within the acceptable risk range based on the

consideration of appropriate factors including, but not limited to: exposure factors, uncertainty factors, and technical factors.

For the MRS, the risk assessment calculations yielded a current risk from carcinogens between 1×10^{-4} to 1×10^{-5} . This equates to some increased risk of developing cancer. The Mobile and Tombigbee rivers are bodies of water that not only are recreational, for swimming, boating, and fishing, but are commercial fisheries. Protectiveness is of the utmost concern. Based on numerous factors, the MRS Report did not conclude that a remedial action was necessary for all or part of the study area, but merely recommended additional monitoring of the river to verify that contaminant levels continue to decrease to more acceptable levels. The study also emphasized that the four Superfund site must continue to address their contaminated wetlands and full fledged ecological and human health risk assessment be completed on those sites. EPA does not believe the potential human health risk has been greatly overestimated, but was a well balanced study based on sound scientific practices and protocols.

Comment 3: EPA only used large fish fillets in their calculation of human health risk for mercury. Use of medium-sized fish fillets in calculating the concentration term yields a exposure point concentration below the maximum value for catfish fillets so that in fact the health risks are even lower than estimated by EPA. EPA did not state whether inorganic, organic, or total mercury was used in estimates for human health risk.

Response 3: As part of the MRS, EPA determined a size range for fish specimens. For largemouth bass, 170 to 225 mm was considered a small size, 226 to 300 mm was medium, and 301 to 400 mm was large. For channel catfish, 200 to 275 mm was considered a small size, 276 to 375 mm was medium, and 376 to 500 mm was large. The MRS human health risk assessment followed the guideline of the Risk Assessment Guidance for Superfund; the highest contaminant concentrations were used in the calculation, because it is reasonable that an individual could continue to eat fish from the same location, and because the data set was not excessively large. This concentration was from a fish composite sample and not an individual fish and therefore represented an average concentration of the contaminant for five fish. This is in accordance with the Agency's directive toward protectiveness. It is important to note here that EPA collected fish greater in size than was determined as "large" for MRS. These extra-large fish, not used in the concentration term, had higher concentration of DDT and mercury than the large fish specimens. It would seem likely that a fisherman would keep and eat the largest fish captured and throw back the smaller specimens.

Preliminary Risk Evaluation

- Comment 4a:** For ecological risk, the conclusions in the MRS that a potential for ecological risk is clearly demonstrated is questionable at best. Assumptions for the ecological effects appear excessively conservative, and the additive effect of overly conservative assumptions paints an unrealistic picture of the risk to piscivorous birds.
- Comment 4b:** EPA's Summary and Conclusions overstates the ecological risks that are indicated by the data, unnecessarily raising public concerns regarding ecological risks. For example, the assumption that a kingfisher ingests food at a rate of 1.75 times its body weight is excessively conservative.
- Comment 4c:** Exposure assumptions for ecological risk assessment are inconsistent with information published in the scientific literature and with documentation issued by EPA to support risk characterization. For the MRS EPA has chosen an unjustifiably high rate, which significantly inflates risk estimates.
- Response 4:** EPA did not conduct a comprehensive ecological risk assessment as part of the MRS. Rather, we produced a limited preliminary ecological risk evaluation with the purpose of determining if data produced by this study showed any indication of whether a more information to determine detailed ecological risk assessment may be warranted. Moreover, EPA believes any risk assumptions used in the MRS Report are reasonable, protective of human health and the environment, and consistent with preliminary ecological risk evaluations EPA has developed for Sites in Region IV and nationwide. We do not believe our assessment is "excessively or overly conservative," "unrealistic," or "inconsistent with published information." For example, when evaluating the risk to a piscivorous avian, the MRS preliminary risk assessment assumed a feeding range throughout the 53 mile study area. In fact, the feeding range for the wood stork is 20 miles and the range for the kingfisher is smaller at 1.4 miles. If an ecological risk assessment was undertaken using the smaller feeding ranges and focusing around the contaminated areas (e.g. the floodplain wetland of the four Superfund sites), the calculated risk might be much higher than reported in the MRS.

The documented ingestion rate for a kingfisher is 1.00 - 1.75 times body weight. EPA's use of the 1.75 factor in the risk calculations is consistent with the Agency's mission of protectiveness and necessary to eliminate any potential for false negative results. It is within the range documented in the literature and therefore is not "excessively conservative," nor does it "significantly inflate risk estimates." In fact, a recalculation using the 1.00 factor instead of the 1.75 factor still shows a potential risk to the kingfisher and an HQ > 1. EPA believes the MRS is a well balanced study based on sound scientific practices and protocols.

- Comment 5:** The POS states that "for ecological risk assessment a weight of evidence approach will be followed." EPA's ecological risk assessment is based totally on calculation of a hazard quotient.
- Response 5:** The preliminary ecological risk evaluation relied not only on HQ, but also on ER-L and ER-M. Moreover, the preamble to the NCP mentions the "weight of scientific evidence" as a factor relating to setting preliminary remediation goals. The weight of scientific evidence concerning exposure is one factor among many

that EPA weighs in making a decision to deviate from the 1×10^{-6} risk level for remediation. The remedial decision or recommendations made in the MRS relied on the "weight of scientific evidence" as is envisioned in the NCP. For the Tombigbee and Mobile river channel, this remedial decision is for no further action with continued monitoring to determine that contaminants continue to decrease to more acceptable levels. For the backwater wetlands associated with the four NPL sites, the remedial decision is to address or continue to address these areas as operable units of the NPL Sites. Since these wetlands are a potential contaminant source to the river, appropriate remedial action will be addressed through the CERCLA process. It is evident that these decisions relied on factors including the weight of scientific evidence and did not strictly rely on the hazard quotients as calculated in the MRS ecological risk assessment.

Comment 6: Fish samples collected at each of the stations were composited at three size ranges; no discrete specimens were analyzed. It would have been useful to analyze some of the larger specimens of large mouth bass and channel catfish separately. It is suspected that the concentrations of mercury and total DDTs may be higher in larger specimens, perhaps to a point where larger adults may experience reproductive impacts or other health problems.

Response 6: As mentioned in response 3, EPA did collect fish larger than what was designated as "large" in the MRS POS. Subsequent to drafting the MRS report, this "extra large" fish tissue was analyzed for mercury and DDT. The results showed higher concentrations of contaminants in the tissue samples of some of these "extra large" fish compared to the "large" fish designated in the MRS Report (Figures attached). EPA believes that this analysis supports our conclusions regarding the human health risk assessment, especially for a subsistence fisherman, and our ecological risk assessment.

NOAELs

Comment 7a: The rationale for establishing a NOAEL for mercury made reference to studies done on goshawks, red-tailed hawks, and loons, all with varying results. The loon data suggests that when the mercury concentration in the prey was 0.3 to 0.4 mg/kg, a reduction in egg laying and nesting site and territorial fidelity occurred. The lower end of this range, 0.3 mg/kg, is equated to a NOAEL of 0.1 mg/kg body weight/day. No rationale is provided for an order of magnitude change to a NOAEL of 0.01 mg/kg/day for use with the wood stork.

Also the rationale for establishing a NOAEL for DDT and metabolites used data associated with studies on kestrel. ADEMS calculations equate to a NOAEL between 0.054 and 0.55 mg/kg BW/day rather than the 0.054 value used in the MRS. It should be noted that the kestrel, unlike the belted kingfisher, is not a piscivorous bird.

Comment 7b: EPA's effect level for mercury of 0.01 mg/kg/day is a "no observed adverse effect level" (NOAEL), it is not a toxicity threshold, but rather an absolute safe level and therefore is inappropriate.

Comment 7c: The DDE NOAEL selected by EPA underestimates the true avian NOAEL. EPA selected an avian NOAEL of 0.3 ppm based upon a study in kestrels. A LOAEL of 3 ppm was also reported in that study. The true NOAEL is probably between 0.3 and 3 ppm. Therefore, the NOAEL used in the MRS overestimates the risk.

Comment 7d: The EPA's ecological risk assessment conclusions are not consistent with available toxicity data. In general, a Hazard Quotient (HQ) that compares the dose received by the organism in the environment to a known toxic effect level indicates a risk threshold. In marked contrast, in the MRS, an assumed NOAEL of 0.01 mg mercury/kg BW/day was used to estimate HQ. As demonstrated in Section 3, there is a large "safety factor" inherent in this method, possibly an order of magnitude, when considered against the toxicity LOAEL. Thus, the HQ in the MRS are not risk thresholds. They are safe exposure levels.

Response 7: A LOAEL is defined as the lowest observed adverse effect level. A NOAEL is defined as a no observed adverse effect level. Therefore, by definition, a LOAEL is an effect level. In other words, an adverse effect is existent at a LOAEL. On the other hand, a NOAEL is a non-effect level; or no adverse effect is evident at a NOAEL. Since the mission of EPA is protection human health and the environment, the only acceptable level would be one with no adverse effect. Use of a LOAEL would not be protective of the environment. As far as a "risk threshold", neither a NOAEL nor a LOAEL are risk thresholds. Since a LOAEL is an effect level and a NOAEL is a non-effect level, the risk threshold lies somewhere between the NOAEL and the LOAEL. Therefore use of a LOAEL to determine protectiveness is inappropriate and EPA's use of a NOAEL is appropriate and adequately estimated the potential risk to the species evaluated.

Regarding the loon data presented in comment 7a, a mercury concentration in prey ranging from 0.3 to 0.4 mg/kg yields a LOAEL of 0.1 mg/kg/day because these concentrations equate to an observed effect in the loon. For calculation of a NOAEL, EPA use a dietary level of 0.03 mg mercury per kg in prey. This concentration yielded a NOAEL of 0.01 mg/kg/day. The order of magnitude difference between a LOAEL and a NOAEL is a common

scientific default value based upon years of historical data and consistent with human health evaluations of acute versus chronic exposure. Regarding the 0.054 value used in the MRS, the Lincer 1995 study revealed that egg shell thickness was significantly different at 0.054 mg/kg BW/day from archived egg shell thickness. Therefore, 0.054 is not a NOAEL because an observed effect was noted, however, it was the lowest available data point that could be used to estimate protectiveness. Use of any value above 0.054 would not be protective.

EPA's use of 0.01 mg/kg/day for mercury was based upon a study where this value yielded an endpoint resulting in a reproductive reduction in egg laying, nesting, and terrestrial fidelity. The NOAEL was not based on toxicity.

In the preliminary ecological risk evaluation, EPA, in the absence of having information on the precise toxicity threshold, has chosen to NOAELs in calculating HQs. We feel this is appropriate and the most protective approach.

Use of Non-Detects

Comment 8a: Eliminating from analysis those samples below the limit of detection inappropriately increases mean values. Including less than detection samples as either zero or one-half the minimum quantification limit results in a mean mercury concentration for station MT-0 to MT-8 of 0.02 mg/kg rather than the 0.03 mg/kg used in Tables 33 and 35.

Comment 8b: The decision to exclude from calculation of mean tissue concentrations those samples which were at or below the MDL is contrary to EPA policy in most other areas of statistical evaluation. It is not clear what the authors mean when they say that the data represents "a conservative treatment of results." It would be more appropriate if it was an "accurate" treatment of the data following the Guidance documents cited in the POS.

Comment 8c: At a minimum, EPA should have included all of the study area fish in order to address the mobility of both fish and fisherman over a 30 year exposure period.

In calculating the means for the data set, the values reported as a minimum detection levels (MDLs) were not included in the mean. These means should be calculated with the (MDLs) since this is still valid data.

Comment 8d: Statistical analysis conducted by EPA did not include non-detect values. Ignoring values at or below the detection limit when statistically comparing reference and site locations artificially increases the chances of finding a difference. Because the statistical tests used rely on the variance in each of the data sets being compared, ignoring non-detects artificially reduces the variance in one or both data distributions such that distributions that may have overlapped and been statistically indistinguishable are collapsed such that the distribution no longer overlap and spurious conclusions are drawn from these mis-applied statistical tests.

Response 8: EPA has reevaluated the MRS Report and the decision regarding the elimination of non-detects from the calculation of mean tissue concentrations. In response to the comments submitted from review of the draft report, a re-analysis of the data was performed to include the non-detects in the calculations. The final report was revised to include the re-analysis and inclusion of non-detects in the fish mean tissue concentration. Revised conclusions on the re-calculations are included in the final report.

Statistical Treatment of Fish Tissue Data

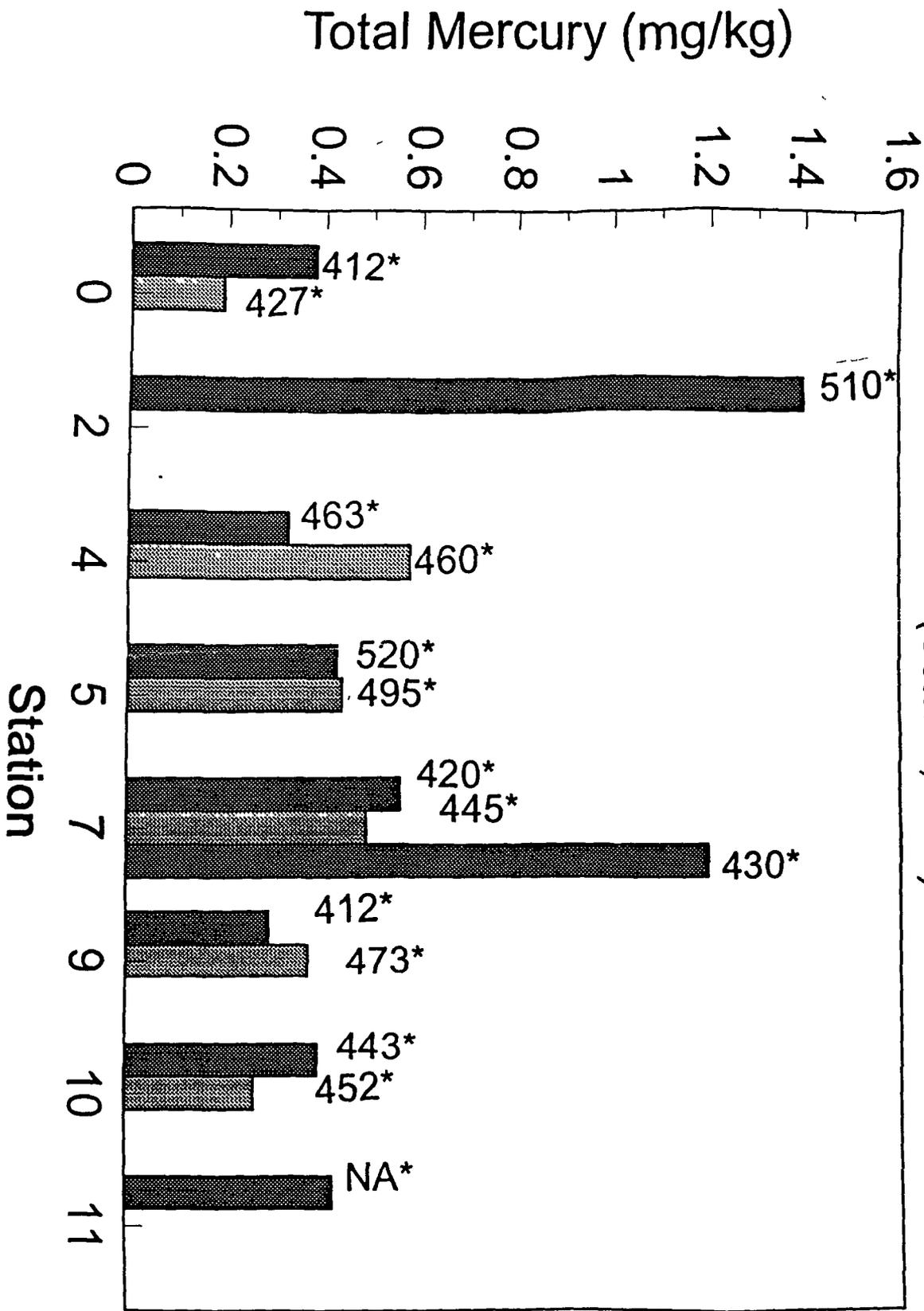
Comment 9: The use of Duncan's Multiple Range test was not rationalized in the text of the report. Since the background sites represent sections of the river rather than experimental controlled variate, a model I ANOVA technique would be more appropriate. A more concise rationalization for the use of Duncan's test is necessary.

An analysis of the bass DDT_r data reveal that the data set does not satisfy the assumptions of normality or homogeneity of variances required for ANOVA techniques. It is never stated within the report whether the data were assessed for either normality or equal variances. The cumulative frequency figures presented strongly suggest that the data are skewed. A histogram of the data and its distribution pattern would be more enlightening.

Response 9: Data used in the statistical determinations were examined for normal distribution characteristics and homogeneity of variances. Where necessary, transformation of the data sets was accomplished and re-examined to assure normality and homogeneity of variances. Additional analyses included examination of confidence bounds for skewness and kurtosis. A model I ANOVA was followed by an unplanned multiple comparison procedure. Duncan's multiple range test was selected because of its power to discern differences between means. The report now reflects these procedures.

Largemouth Bass- Station vs Total Mercury

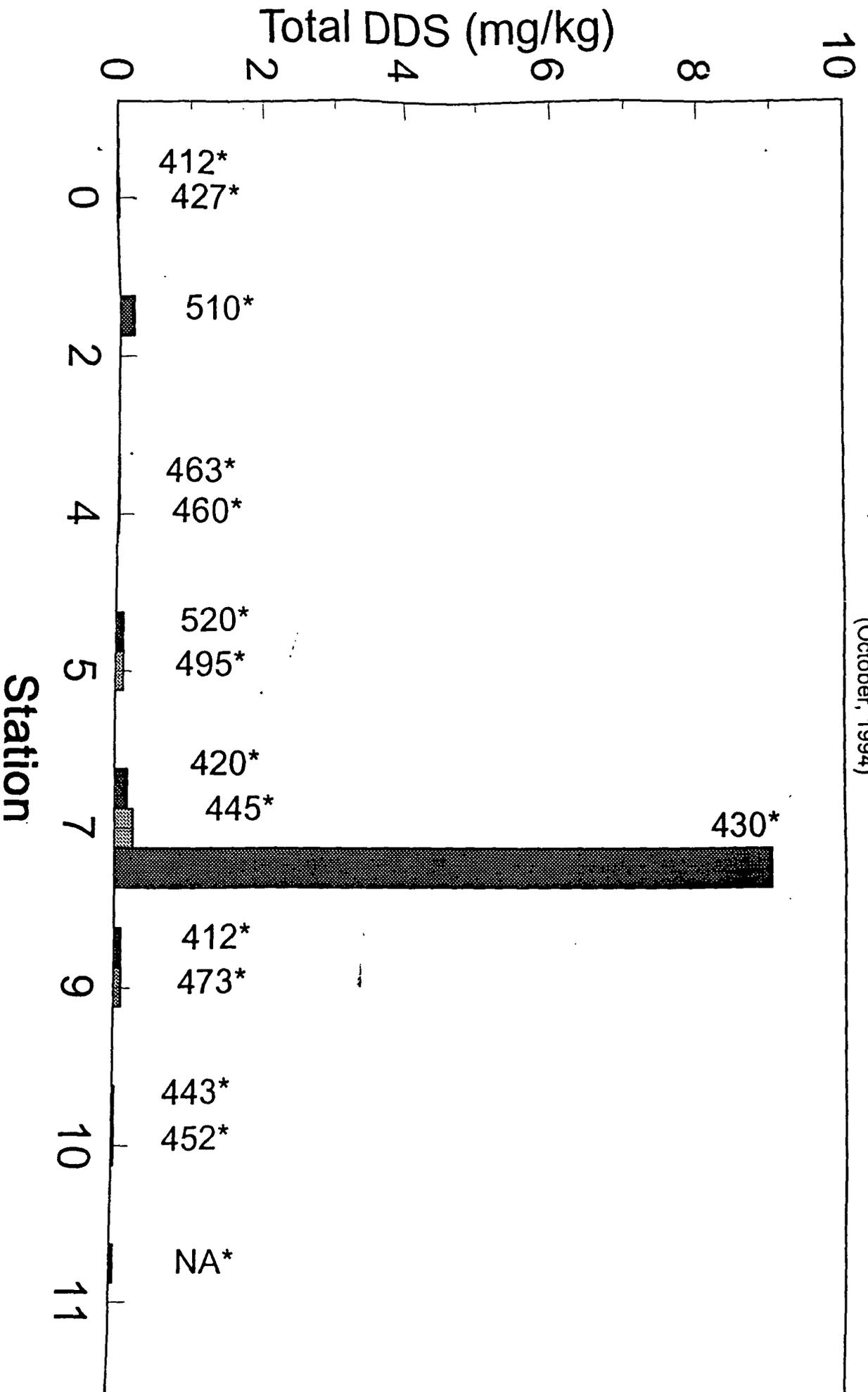
(October, 1994)



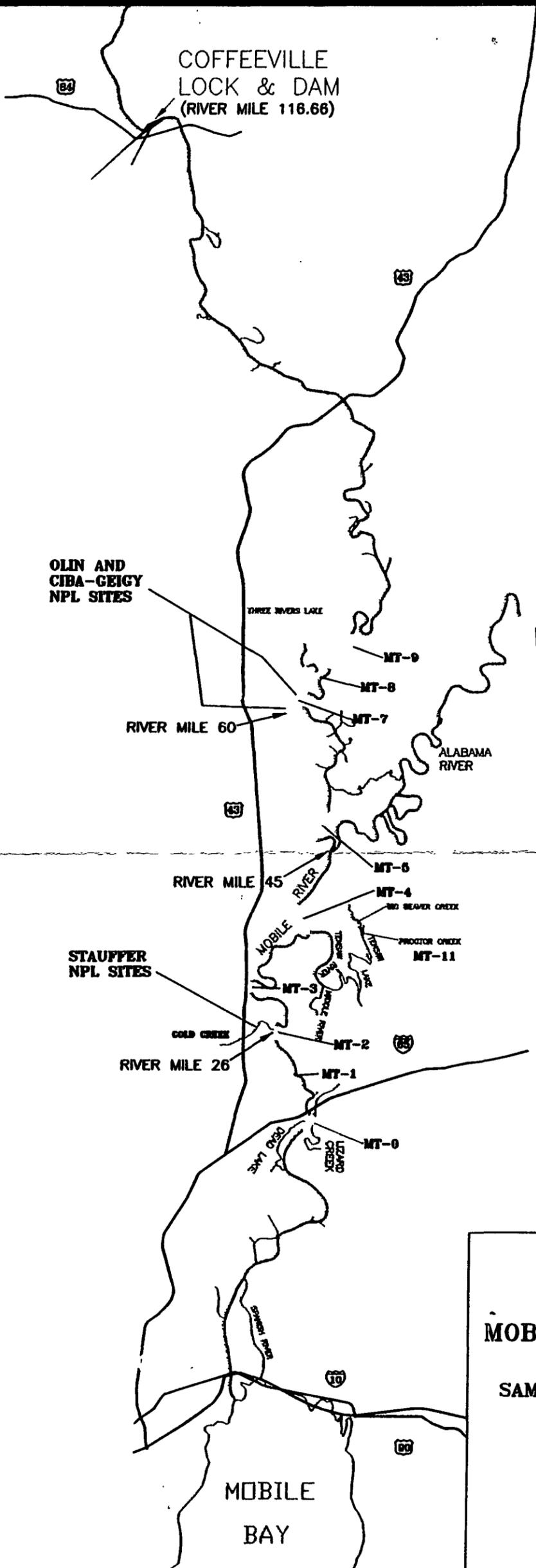
* Fish total length in mm

Largemouth Bass- Station vs Total DDS

(October, 1994)

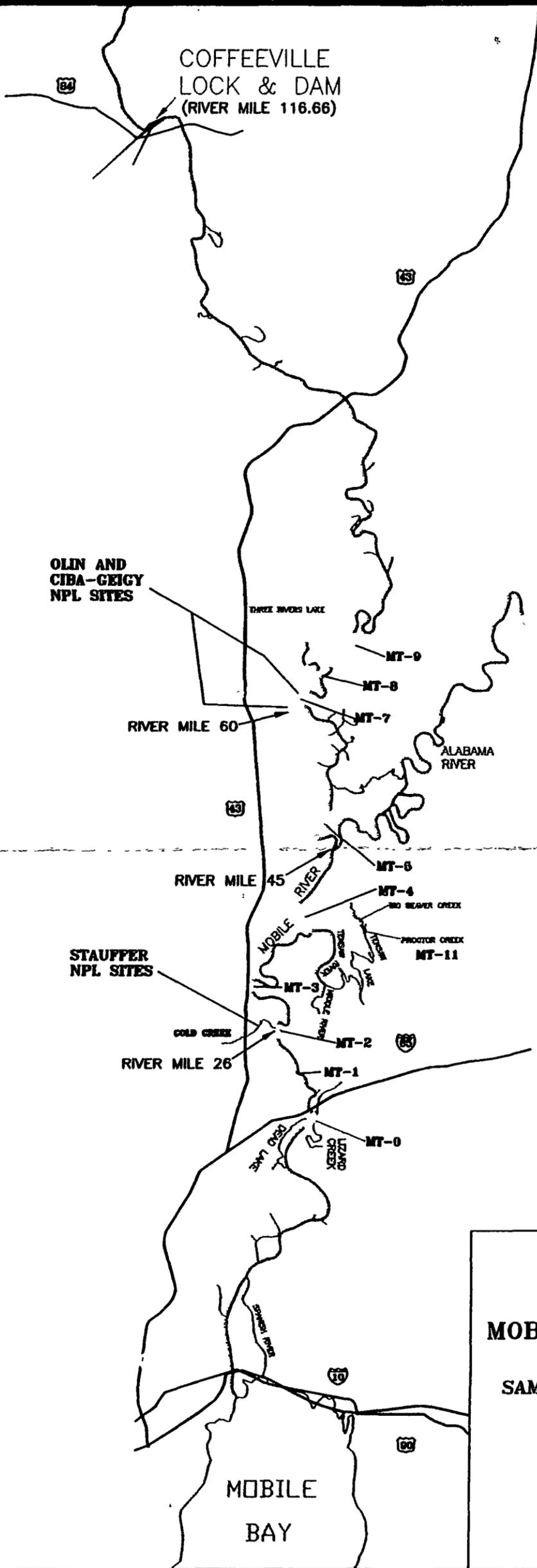


* Fish total length in mm



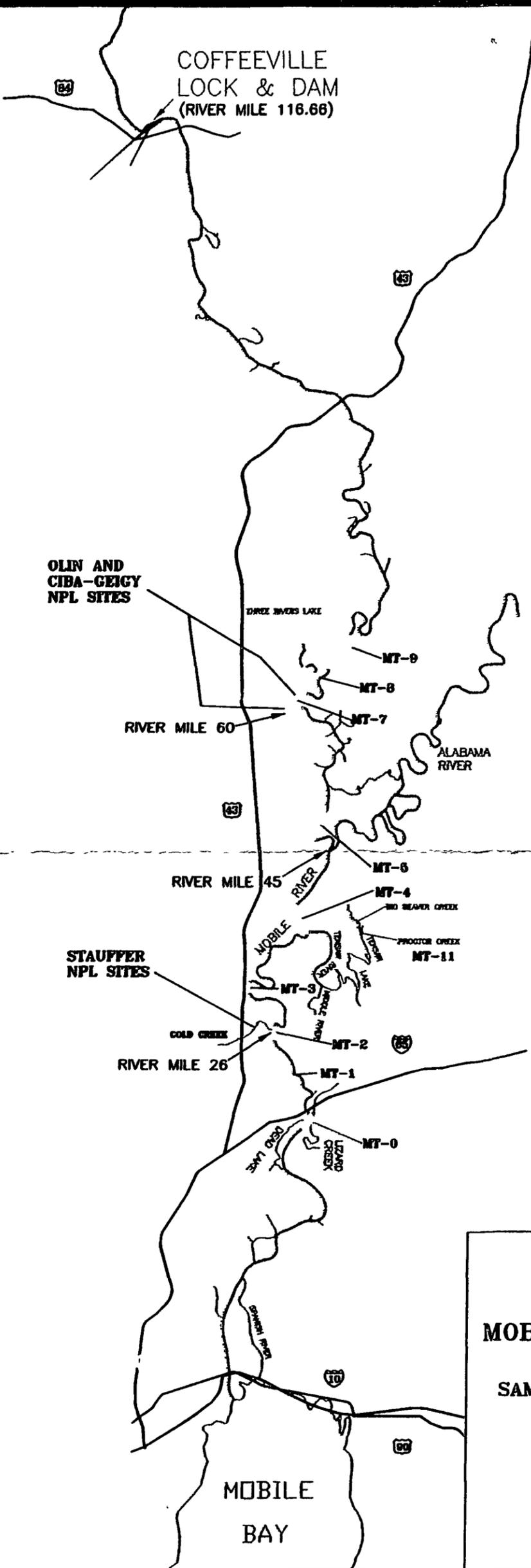
AREA OF RIVER SAMPLED FOR FISH

FIGURE 1
MOBILE/TOMBIGBEE RIVERS
SAMPLING STATIONS AND AREAS
MOBILE RIVER STUDY
1993-1994
SCALE IN MILES
0 5 10



AREA OF RIVER SAMPLED FOR FISH

FIGURE 1
MOBILE/TOMBIGBEE RIVERS
SAMPLING STATIONS AND AREAS
MOBILE RIVER STUDY
1993-1994
SCALE IN MILES
0 5 10



AREA OF RIVER SAMPLED FOR FISH

OLIN AND CIBA-GEIGY NPL SITES

STAUFFER NPL SITES

DIXIE LANDING NEAR CHRYSLER, AL

FIGURE 1
MOBILE/TOMBIGBEE RIVERS
SAMPLING STATIONS AND AREAS
MOBILE RIVER STUDY

1993-1994
SCALE IN MILES
0 5 10

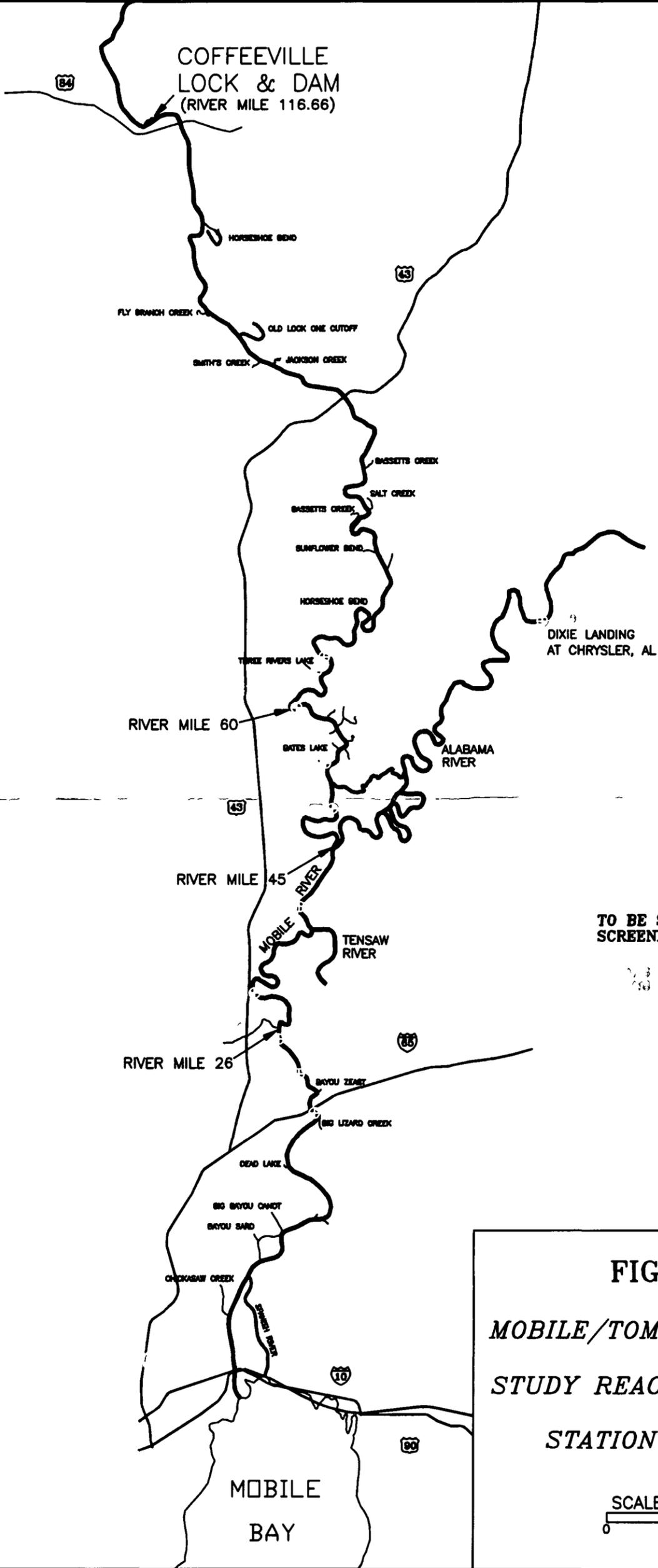


FIGURE 1.
*MOBILE/TOMBIGBEE RIVERS
STUDY REACH AND SAMPLE
STATION LOCATIONS*

SCALE IN MILES
0 5 10