Methyl Mercury in Water and Fish Tissue in the Lower Yazoo Basin

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Mercury is a leading cause of fish consumption advisories in the United States and is the only metal with a fish consumption advisory in Mississippi. While none of the affected water bodies are within the Mississippi Delta, a 2001 ambient water quality criterion established by the EPA would lower Mississippi's fish tissue threshold from 1 mg mercury per kg of fish tissue to 0.3 mg methyl mercury per kg of fish tissue. Since studies have shown that most of the mercury that bioaccumulates in predator fish tissue is methyl mercury, the new fish tissue criterion would become 0.3 mg/kg mercury in fish tissue. Implementation of this criterion within the State of Mississippi will increase the number of water bodies with fish tissue consumption advisories within the State and within the Mississippi Delta in particular.

Recently the USACE Vicksburg District analyzed the potential for increases in methyl mercury concentrations in surface water and fish tissue based upon completion of the Yazoo Backwater Project's reforestation component. The analysis used a simple linear model that compared the potential for changes in methyl mercury production based upon changes in land use, flooded acres, and flood duration. The model predicted that completion of the Yazoo Backwater Project recommended plan and reforestation of up to 55,600 acres of currently farmed agricultural land could increase methyl mercury production by 3 percent over base conditions.

The Vicksburg District's mercury database includes surface water samples for methyl mercury collected between 2003 and 2008 and mercury in fish tissue samples collected between 1993 and 2008. Surface water samples were collected during flooded conditions in Delta National Forest greentree reservoirs, during flood and non-flood conditions in Delta Nation Forest wetlands, and during summer, non-flood conditions in streams and lakes in the lower Yazoo Backwater Area. The data show that methyl mercury production is highest in areas rich in easily accessible organic matter that undergo extended flooding. Fish tissue mercury concentrations appear to be related to flood duration and the number of acres flooded.

Key words: Floods, Nonpoint Source Pollution, Surface Water, Water Quality, Wetlands

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Introduction

Mercury contamination is an environmental concern in the United States. Nearly all fish and shellfish contain traces of mercury; however, some fish contain higher levels of mercury than others. Mercury is cited as a cause of fish consumption advisories in more than 42 states and is responsible for approximately 80 percent of such advisories in the country (Brigham et al., 2003). Mercury has also become an issue in the Gulf of Mexico where EPA and FDA advise susceptible sectors of the population to limit or avoid consumption of certain species of fish (FDA, 2004). Mercury has historically been used in its metallic and inorganic forms in a wide variety of industrial uses. Combustion of mercury containing fuels or waste is the source of most of the anthropogenic mercury entering the environment today (EPA, 2006). Some of the mercury emitted into the atmosphere can be transported over long distances where it can be deposited onto land or directly into waterways or the ocean (NSTC, 2004). In Mississippi, it is likely that atmospheric deposition is the source of mercury impairment in the Yazoo Basin (MDEQ, 2004; NADP, 2008). Inorganic mercury is generally not a health concern because it is poorly absorbed by the digestive tract. In contrast, methyl mercury is an organic form of mercury that is toxic to the nervous system (Brigham, et al., 2003). It is generally accepted that most of the mercury in fish tissue is methyl mercury (Grieb et al., 1990). Methyl mercury is passed through the food chain and eventually passed to man primarily through the consumption of fish.

The USACE Vicksburg District completed the Supplemental Environmental Impact Statement (SEIS) for the Yazoo Backwater Area Reformulation in 2007. The recommended plan included construction of a 14,000 cfs pump station with a year-round pump operation elevation of 87.0 feet, NGVD, at the Steele Bayou Structure; perpetual conservation easements and reforestation/conservation measures on up to 55,600 acres of agricultural land obtained from willing sellers; and modified operation of the Steele Bayou Structure to maintain water levels between 70.0 and 73.0 feet, NGVD, during low water periods.

A possible impact of wetland reforestation within the Yazoo Backwater study area was the potential for increased methyl mercury production. This is because under flooded, anaerobic conditions, the large amounts of detritus on a forest floor are believed to provide the organic precursors for the methyl group in methyl mercury. While existing forests have been shown to produce methyl mercury during backwater flooding, agricultural fields that contain limited detritus under current conditions would provide substantially more detritus when converted into forests with trees, underbrush, and leaf litter. Given the necessary redox conditions, the amount of methyl mercury produced is dependent on the availability of precursors and the period of inundation. If inundated for extended periods of time, these newly created forests could increase the production of methyl mercury above current levels. Although the Yazoo Backwater Project (YBWP) would have some effect on the extent and duration of flooding, the net result would be an increase in the number of forested wetlands by up to 55,600 acres (shown in red in Figure 1). One of the issues the SEIS addressed was the potential increase in methyl mercury and its impact on fish tissue concentrations within the project area. To better understand mercury distribution within the YBWP area, the Vicksburg District began collecting surface water methyl mercury samples during flood and non-flood conditions and resumed its analysis of mercury in fish tissue.

Site Selection and Methods

Surface water samples were collected five times between March 2003 and May 2008 (Figure 1). In 2003, 2004, and 2005 samples were collected in the Delta National Forest, Mississippi, in greentree reservoirs, at the leading edge of flood waters and in two permanent water bodies, the Little Sunflower River and Cypress Bayou. In July 2006, nine summer background samples were collected in permanent lakes and rivers in and around the Delta National Forest (DNF) and in Steele Bayou. In May 2008, a more extensive flood, samples were collected in DNF, Cypress Bayou and the Little Sunflower River, and an adjacent flooded USDA Wetland Reserve

Program (WRP) forest. Samples were also collected from a young WRP field and an unharvested winter wheat field in Valley Park, Mississippi. These fields received flood waters from the Steele Bayou Basin. Fish samples were collected in 1993, 1994, 2005, 2007 and 2008. Fish used in this analysis were collected from the Big Sunflower River, the Little Sunflower River, Steele Bayou, and the Connecting Channel between the Big Sunflower River and Steele Bayou.

Mercury water samples used in this analysis were collected by the USGS, Louisiana Water Science Center and analyzed by the USGS Wisconsin Mercury Research Laboratory in Middleton, Wisconsin. Water samples were collected using clean sampling techniques outlined in USGS TWRI Book 9 Chapter 5.6.4.B. Total mercury (filtered and unfiltered) was analyzed using EPA Method 1631. Methyl mercury (filtered and unfiltered) was analyzed using USGS OFR 01-445 (De Wild et al., 2002). Flood water samples were collected by wading; summer background samples were collected mid-channel from a boat.

Fish tissue used in this analysis was collected by the Fish Ecology Team of the Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. All of the fish were collected with seines. Fish were identified by species, then weighed and measured before filleting. Skinless fillets were kept frozen until processed and analyzed. Fish tissue collected in 1993, 1994 and 2005 were analyzed (EPA Method 7471) by the Environmental Chemistry Branch at the ERDC, U.S. Army Corps of Engineers in Vicksburg, Mississippi. Fish tissue collected in 2007 and 2008 were analyzed (EPA Method 7471) by the Mississippi State Chemical Laboratory at Mississippi State University.

Factors Controlling Methyl Mercury Production

Although the factors controlling methyl mercury production are not fully understood, a correlation between methyl mercury and forested wetlands is well established in scientific journals. Studies by Canadian researchers have shown that water and fish tissue methyl mercury concentrations increase following inundation of forests surrounding newly formed reservoirs (St. Louis et al., 1994; and Jackson, 1991). Other researchers have shown that methyl mercury production can begin after 7 to 10 days of inundation or the time it takes for the newly inundated forest floor to become anaerobic (Wright and Hamilton, 1982; Kelly et al., 1997). A recent USGS report ties methyl mercury levels in the Gulf of Mexico to south Louisiana wetlands (Hall et al., 2008). Another study links methyl mercury production to the inundation of forest soils and leaf litter from an alluvial floodplain (Roulet et al., 2001). "The flooding of terrestrial surfaces and the inundation of vegetation appear to be important facilitating processes in the production of methyl-mercury in natural settings," (Balogh et al., 2005). Several studies have shown that natural settings are major sites of methyl mercury production (St. Louis et al., 1994; Hurley et al., 1995; Krabbenhoft et al., 1995; St. Louis et al., 1996; Branfireun et al., 1996; Babiarz et al., 1998; Galloway and Branfireun, 2004).

Most researchers agree that mercury methylation occurs within microbial 'hotspots' of organic carbon metabolism such as sediment pore water. DeLaune and others (2004) demonstrated the relationship between sediment redox conditions and methyl mercury production in surface sediment of Louisiana lakes. Many researchers believe that once the redox potential becomes low enough for sulfate reduction, naturally occurring sulfate-reducing bacteria become primary agents of the environmental production of methyl mercury. Some studies suggest that mercury methylation can occur in the water column (He et al., 2007). Under anoxic, low redox conditions in the water column, dissolved organic carbon can provide an energy source that stimulates microbial activity such as mercury methylation (Ullrich et al., 2001; Eckley and Hintelmann, 2005).

While the concentration of inorganic mercury is important for methyl mercury production, it is not the only factor nor is it necessarily the controlling factor. Other factors identified as important include the chemical form of mercury, temperature, the availability of organic substrate for sulfate-reducing bacteria, mercury demethylation activity, *in situ* redox conditions, and pH. In addition to these factors, researchers in the Everglades have found that sulfide concentrations can control methyl mercury production by affecting the species of mercury available to the sulfate-reducing bacteria (Benoit et al., 2003). Dissolved organic carbon can also bind with inorganic mercury making it less bioavailable (Ullrich et al., 2001). Seasonal temperature variations also affect methylation rates (Hall, et al., 2008). In their experiments, Guimarães and others (2006) reported that initial methylation rates can be up to four times higher at 35 degrees C than at 25 degrees C (the difference between a Yazoo Backwater flood occurring in May or June and a flood occurring in January or February). At both temperatures, rates were found to decrease over time as microbial production decreased.

In aquatic environments, especially flowing water, many of the above parameters vary temporally and spatially. Any of these factors can impact the concentration of methyl mercury in aquatic systems. Researchers in the Everglades found that the highest levels of methylation and methyl mercury in water and fish were associated with sediments showing intermediate levels of sulfate and sulfate reduction (Benoit et al., 2003). In their "National Pilot Study of Mercury Contamination of Aquatic Ecosystems," Brumbaugh and others (2001) found positive correlations between percentages of wetlands in a watershed and concentrations of dissolved organic matter to mercury fish tissue concentration.

Estimation of Potential Increases in Methyl Mercury Production from Reforestation Proposed in the Yazoo Backwater Project

For the Yazoo Backwater SEIS, the Vicksburg District estimated the potential increase in methyl mercury production by comparing the number of acres of existing forested wetlands to the total number of forested wetland acres in each alternative plan. Assuming the necessary conditions for methyl mercury production are present, if each acre of flooded wetland forest has the potential to produce a unit of methyl mercury per day of inundation, any increase or decrease in acres should also increase or decrease the amount of methyl mercury produced. The measure of the potential for methyl mercury production, then, becomes one methyl mercury unit for every day an acre of forest is flooded. Assuming methyl mercury production begins after 7 days of inundation as observed by Wright and Hamilton (1982), the worst-case measure of the potential for methyl mercury production becomes one methyl mercury unit for every day an acre of forest is flooded beyond the first 7 days.

Table 1 presents the results of the methyl mercury analysis used to determine YBWP impacts to water quality for the recommended plan and a non-structural alternative (alternatives 5 and 2). This analysis is based upon the Vicksburg District's 2005 land use analysis and uses the change in the acre-days of forest flooding during a typical 2-year frequency, 5 percent duration flood. The number of flooded existing forest acres (base) and the reforested acres are converted into the number of potential methyl mercury units that could be produced from implementation of each alternative. The number of preproject forested acres that would continue to be flooded after the pump station was in operation was multiplied by the estimated number of days of flooding minus 7 days. For example, lands within the 7.5 to 10 percent duration band would have been flooded a minimum of 20 days. Methyl mercury would then be produced for 13 days (20 days minus 7 days) on these acres. These numbers were summed to yield the maximum number of methyl mercury units produced annually from existing forests during backwater flooding (i.e., total from existing forests). Next, the total acres proposed for reforestation by the alternative plans were assumed to be flooded for at least 14 days (5 percent duration flood). Again, multiplying the number of reforested acres by 7 days (14 days minus 7 days) yielded the number of methyl mercury units produced from the proposed reforestation. Although agricultural fields targeted for reforestation may produce methyl mercury when flooded under base conditions (Rogers, 1976), the methyl mercury unit analysis assumed that current production in these fields was zero. This simplified analysis provided a method for estimating and comparing the potential for project induced methyl mercury production under predefined conditions and demonstrated that increasing the number of forested acres in areas subject to flooding has the potential to increase the amount of methyl mercury produced in the YBWP area. Completion of the recommended plan could have increased methyl mercury production by up to 3 percent. Completion of the nonstructural plan evaluated in Table 1 could have increased methyl mercury production by up to 32 percent.

Existing Methyl Mercury Surface Water Concentrations

Subsequent to completing the methyl mercury reforestation analysis for the SEIS, the Vicksburg District asked the USGS to assist in the collection of surface water mercury samples. Table 2 shows the results of discrete methyl mercury samples collected during late winter and early spring flooding over a 4 year period. During late winter floods in February and March, the highest methyl mercury concentrations were found in the greentree reservoirs that had been flooded up to 3 months. Lowest concentrations were in the receiving waters, the Little Sunflower River and Cypress Bayou. During a late spring flood in May 2008, the highest concentration was in a WRP forest that had been flooded for 50 days out of a 130 day flood. The Valley Park wheat field sample was collected from an unharvested field of winter wheat that had been flooded for 2 weeks. Surprisingly, with a concentration of 0.65 ng/L, methyl mercury in this field was as high as concentrations found in greentree reservoirs in previous years. Methyl mercury concentrations in the DNF flood water and adjacent water bodies were fairly uniform (from 1.3 ng/L to 1.7 ng/L), but considerably higher than in previous years. Overall, concentrations of methyl mercury collected in the May 2008 flood were higher than samples collected in February or March of the previous years. These observations can be explained by the much longer duration of the 2008 flood; however, the timing of the flood may have also played a role. Hall and others (2008) suggested that seasonal temperature differences may impact methyl mercury production. In-stream water temperature in the Yazoo Backwater Area is typically 10 degrees C in early March and 20 degrees C in early May. In shallow edge of field flooding, water temperatures can be higher than in-stream temperatures. For example at Valley Park the 24 hour mean water temperature was 23 degrees C (less than 1 foot deep), while nearby in-stream water temperature means were around 17 degrees C (4 feet deep). Samples collected during flood events were collected from water 3 feet deep or less. It is possible that the water and sediment around the periphery of the flood could warm enough to increase biological activity and methylation rates during late spring floods.

Water samples were also collected from nine permanent water bodies during July 2006 to show representative summer background concentrations in the Yazoo Backwater area. Methyl mercury concentrations were 0.15 ng/L or less for all water bodies (Table 3).

Fish Tissue Mercury Concentrations

The Vicksburg District has analyzed 292 fish from the lower Yazoo Basin for mercury since 1993. Table 4 summarizes the results for three of the most frequently collected groups (buffalo, catfish and gar) and the totals for all fish sampled. Fish were collected during four sampling efforts: fish collected in the fall of 1993 and 1994; fish collected in 2005 before and after Hurricane Rita caused extensive fish kills in the Yazoo Basin; fish collected in 2007 and February 2008 before spring flooding; and fish collected in 2008 after flood waters had receded.

Mean concentrations of mercury were higher in the early 1990s. Although maximum concentrations for buffalo and catfish exceeded the existing fish consumption advisory limit of 1.0 mg/kg mercury, 90 percent of all fish had concentrations less than 0.8 mg/kg. Since 2005 very few fish have had mercury concentrations greater than 1.0 mg/kg; and for most, the mean concentration was around 0.3 mg/kg with 90 percent of the samples at 0.5 mg/kg or less. In 2001, the EPA recommended a methyl mercury water quality criterion for the protection of human heath (EPA, 2001). The criterion, based on advances in the understanding of toxicology, bioaccumulation, and exposure, set the concentration of methyl mercury in fish tissue at 0.3 mg/kg. Under the current advisory limit of 1 mg/kg mercury in fish, Mississippi Delta waters are not under a fish consumption advisory; once the new EPA limit is adopted it is likely that some Delta waters could become listed for mercury fish tissue consumption.

Potential Changes in Fish Tissue Mercury Concentrations

Grieb and others (1990) showed that 99 percent of the mercury in the fish tissue in their study was methyl mercury. While one can assume an increase in potential methyl mercury production would lead to an increase in mercury fish tissue concentrations, it is impossible to estimate the resulting increase in fish tissue concentration from the YBWP reforestation analysis. Just as the amount of methyl mercury produced depends on mercury concentration, flood duration, and limiting factors, so does methyl mercury bioaccumulation in the aquatic food chain. In their "National Pilot Study of Mercury Contamination of Aquatic Ecosystems", which analyzed data collected between June and October, 1998, Brumbaugh and others (2001) found a positive correlation between mercury in fish tissue and the percent of wetlands in a watershed. They also found that methyl mercury in water was a better predictor of fish tissue mercury concentrations than was methyl mercury in sediment. In a seasonal wetland system such as the Yazoo Backwater where out-of-bank floodwaters can last from a few weeks to a few months on a given year, fish tissue concentrations are probably more related to year-round ambient concentrations of methyl mercury in permanent water bodies than the total amount of methyl mercury produced in the system during short duration backwater flooding. There is also some evidence that fish exposure during long duration floods may be limited. Unpublished data collected by the Vicksburg District and ERDC show that during extended floods the water column becomes anoxic to less than 1 foot below the surface. Attempts to sample fish populations during these periods have yielded relatively few adult fish. It may be that larval fish make up the majority of the flood plain population exposed to maximum methyl mercury concentrations in long duration floods.

Backwater floods in 2003, 2004 and 2005 occurred during late winter and were relatively short events. The 2008 flood was a late spring flood (March to July). Once the floodwaters recede and forested wetlands lose connectivity to the river, methyl mercury concentrations become diluted and move out of the system with the effect of moderating aquatic biota exposure in the study area. The period of longest fish exposure to methyl mercury in the study area would be during summer and fall months when seasonal flow is reduced, but methyl mercury concentrations are lowest. The eutrophic nature of streams and lakes in the basin may be a factor that further reduces summer exposure to methyl mercury. Warner and others (2005) found a weak negative correlation between concentrations of Chlorophyll A and mercury concentrations in large mouth bass in the Mobile River Basin. Other researchers (Lange, et al., 1993 and Cizdziel, et al., 2002) show that the trophic status of lakes affects methyl mercury bioaccumulation with eutrophic systems tending toward lower concentrations in predatory fish.

Algae and zooplankton have been identified as important intermediates in the trophic uptake of methyl mercury (Plourde, et al., 1997 and Westcott and Kalff, 1996). Pickhardt and others (2002) found that increases in algal biomass decreased the concentration of mercury per algal cell. This results in a lower dietary input to zooplankton grazers feeding on algae and reduced bioaccumulation in algal-rich systems. This result has important implications for the transfer of methyl mercury. Uptake of methyl mercury remaining in project area streams after backwater floods recede would be diluted (bloom dilution) by the increase in algal biomass that begins in June and July and lasts into October. The more algae cells there are, the authors found, the lower the methyl mercury concentration in each cell. The authors show that increasing the number of algae cells reduced the body concentration of methyl mercury in the zooplankton that feed on these algae. This, in turn, has the potential to decrease methyl mercury body concentrations in planktivorous fish that feed on the zooplankton. Fish uptake of methyl mercury is driven by concentration and exposure. These data suggest that during the period of longest exposure (i.e., summer and fall when the Steele Bayou Structure is operated to hold water to benefit aquatic life) the concentration of methyl mercury available to the food chain would be at its most dilute. Thus, uptake of methyl mercury by omnivorous and piscivorous fish could also be reduced during this period.

Figure 2 shows a relationship between flood duration, flood extent, and fish tissue mercury concentration. Bar heights and numbers show the number of days flooded greater than 83.5 ft, NGVD, at the Steele Bayou structure; while the color indicates the flood frequency or acres flooded. Navy blue bars represent floods that were less than or equal to the 1-year flood frequency elevation of 87.0 ft, NGVD, (75,882 acres). Maroon bars represent floods that were less than or equal to the 2-year flood frequency elevation of 91.0 ft, NGVD, (109,491 acres). The figure shows that the 1993/1994 fish (mean concentration of 0.422 mg/kg) were collected in a cluster of extended floods followed by 10 years of shorter duration floods during which no fish were collected. Fish collected in 2005 (mean concentration of 0.175 mg/kg) had the lowest mercury concentrations in the period studied. After Hurricane Rita made landfall in late September 2005 (shown by the dotted vertical line in Figure 2) water in the Mississippi Delta turned dark, black in color from the large amount of organic carbon washed into the system. Dissolved oxygen concentrations immediately plummeted as the microbial system processed this material. This same organic carbon source may also have stimulated methylation processes. Fish sampled in 2007 after Hurricane Rita showed that mean mercury concentrations had increased (0.263 mg/kg) despite 2 years with 15 days of flooding or less. Following a 130 day late spring flood in 2008, mean fish tissue concentrations increased to 0.310 mg/kg. While the study area fish were not collected frequently enough to determine whether the data are anything more than normal variation in a long-term trend, there does seem to be a delayed relationship between fish tissue concentration, the extent and duration of flooding, and organic loading.

Conclusions

An examination of stage data at the Steele Bayou structure suggests some periodicity in flood extent and duration. It is possible that methyl mercury concentrations decreased throughout the basin during a period with several years of reduced flooding. This reduction in flooding might account for the decrease in fish tissue mercury concentrations between 1993/1994 and 2005. Fish tissue concentrations increased in 2007 and 2008 following years with high organic loading or increased flood extent and duration. Contrary to the assumption made in the methyl mercury model for the SEIS, spring flooding of unharvested crops (winter wheat) or young plants (early corn or soybeans) cannot be discounted as sources of methyl mercury. The limited data suggest that young forests and flooded crops can be sources of high organic loading that could result in localized increases in methyl mercury during extended, warm weather flooding. Additional data need to be collected to examine the methyl mercury contribution from unplanted fields in both winter and spring. Despite the uncertainty of the current methyl mercury contribution from agricultural land, it is clear that reforestation would provide a reliable, continuous source of organic material on these lands. Therefore, it is likely that reforestation of large tracts of frequently flooded agricultural land, such as proposed in the YBWP, would increase methyl mercury production in the lower Yazoo Basin.

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Table 1. Potential Increase in Methyl Mercury Units from Proposed Reforestation

Alternative Plans	Total from Existing Forests	Total from Project Reforestation	Total from Both Sources	% Increase from Reforestation
Base	2,722,837	0	2,722,837	-
Recommended Plan	2,414,684	389,200	2,803,884	+ 3 %
Non-Structural				
Plan	2,722,837	870,800	3,593,637	+ 32 %

Table 2. Total Methyl Mercury (ng/L)

	Late Winter Flood			Late Spring Flood
	3/11/03	2/26/04	3/03/05	5/08/08
Long Bayou GTR	0.90	0.40	0.54	-
Green Ash GTR	-	-	0.64	-
Sunflower GTR	-	-	0.94	-
DNF Flood Water	0.44	-	-	1.7
Little Sunflower River	-	0.20	0.11	1.5
Cypress Bayou	-	0.21	0.25	1.4
Little Sunflower WRP Forest	-	-	-	6.2
Valley Park Wheat Field	-	-	-	0.65
Valley Park WRP Forest	-	-	-	1.3

Table 3. Total Methyl Mercury (ng/L) in Summer Background Samples

	7/19/06
Big Sunflower River – Big Bend	0.11
Steele Bayou	0.10
Black Bayou	0.14
Main Canal	0.05
Little Sunflower River	0.14
Cypress Bayou	<0.04
Blue Lake (DNF)	0.12
Fish Lake (DNF)	0.14
Lost Lake (DNF)	0.15

Table 4. Mercury (mg/kg) in Fish Tissue in the Lower Yazoo Basin

		Buffalo	Catfish	Gar	All Fish
1993-1994	No.	24	10	10	49
	Mean	0.430	0.494	0.495	0.422
	90th %	0.787	1.18	0.724	0.807
	Max	1.14	1.56	0.858	1.56
2005	No.	29	13	8	70
	Mean	0.214	0.153	0.237	0.175
	90th %	0.340	0.293	0.407	0.320
	Max	1.10	0.618	0.407	1.10
2007*	No.	36	53	8	106
	Mean	0.358	0.160	0.237	0.263
	90th %	0.550	0.270	0.407	0.500
	Max	0.700	0.550	0.560	1.60
2008 post-flood	No.	24	12	14	67
	Mean	0.288	0.255	0.381	0.310
	90th %	0.540	0.420	0.550	0.500
	Max	0.620	0.500	0.650	0.650
All Years	No.	113	88	40	292
	Mean	0.322	0.210	0.368	0.279
	90th %	0.568	0.419	0.568	0.517
	Max	1.14	1.56	0.858	1.60
* Includes Pre-flood February 2008					
No Consumption Criteria: MDEQ = 1.0 mg/kg; EPA Proposed = 0.3 mg/kg					

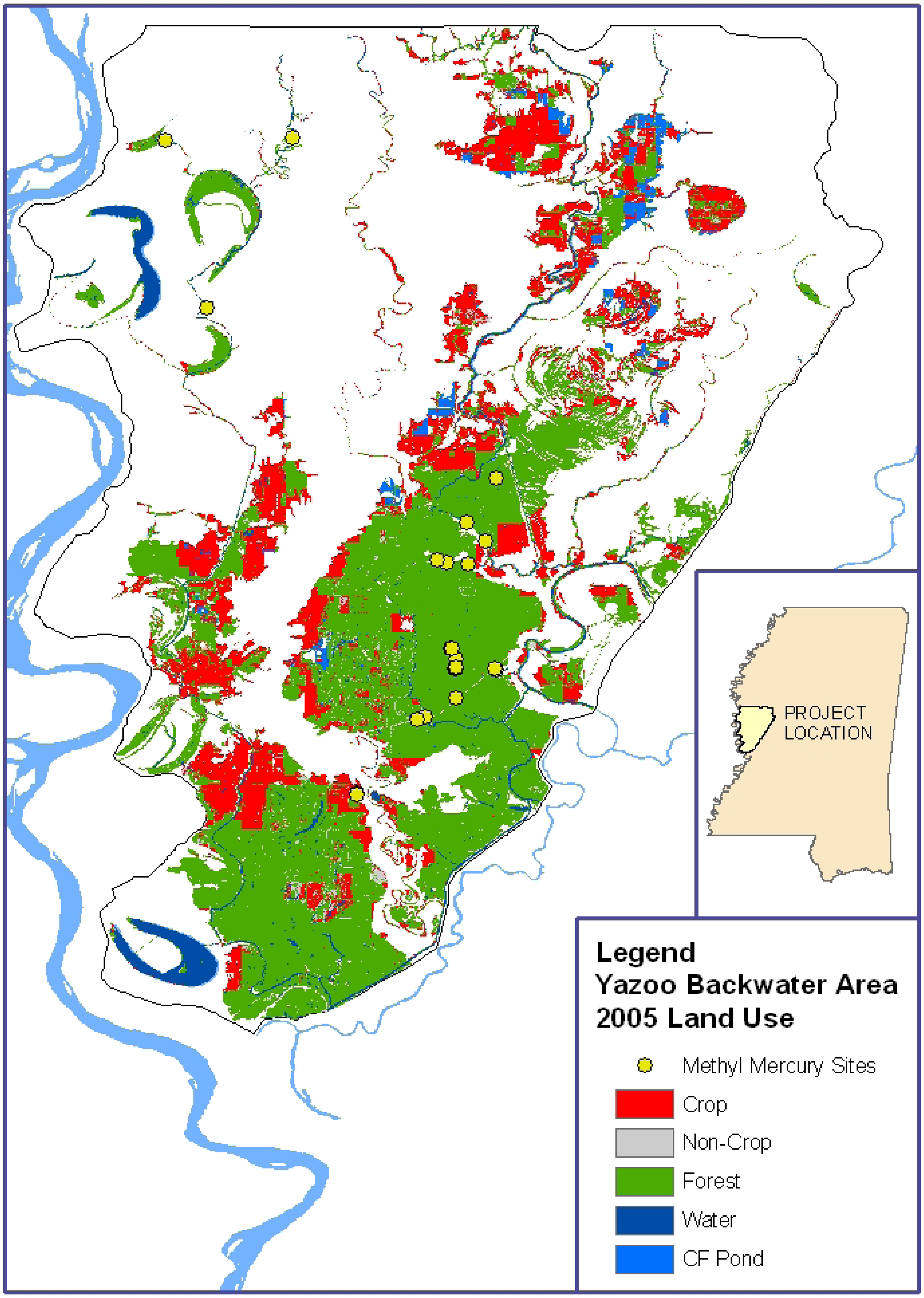

Figure 1. Yazoo Backwater Area 2005 land use with location of methyl mercury surface water sample sites.

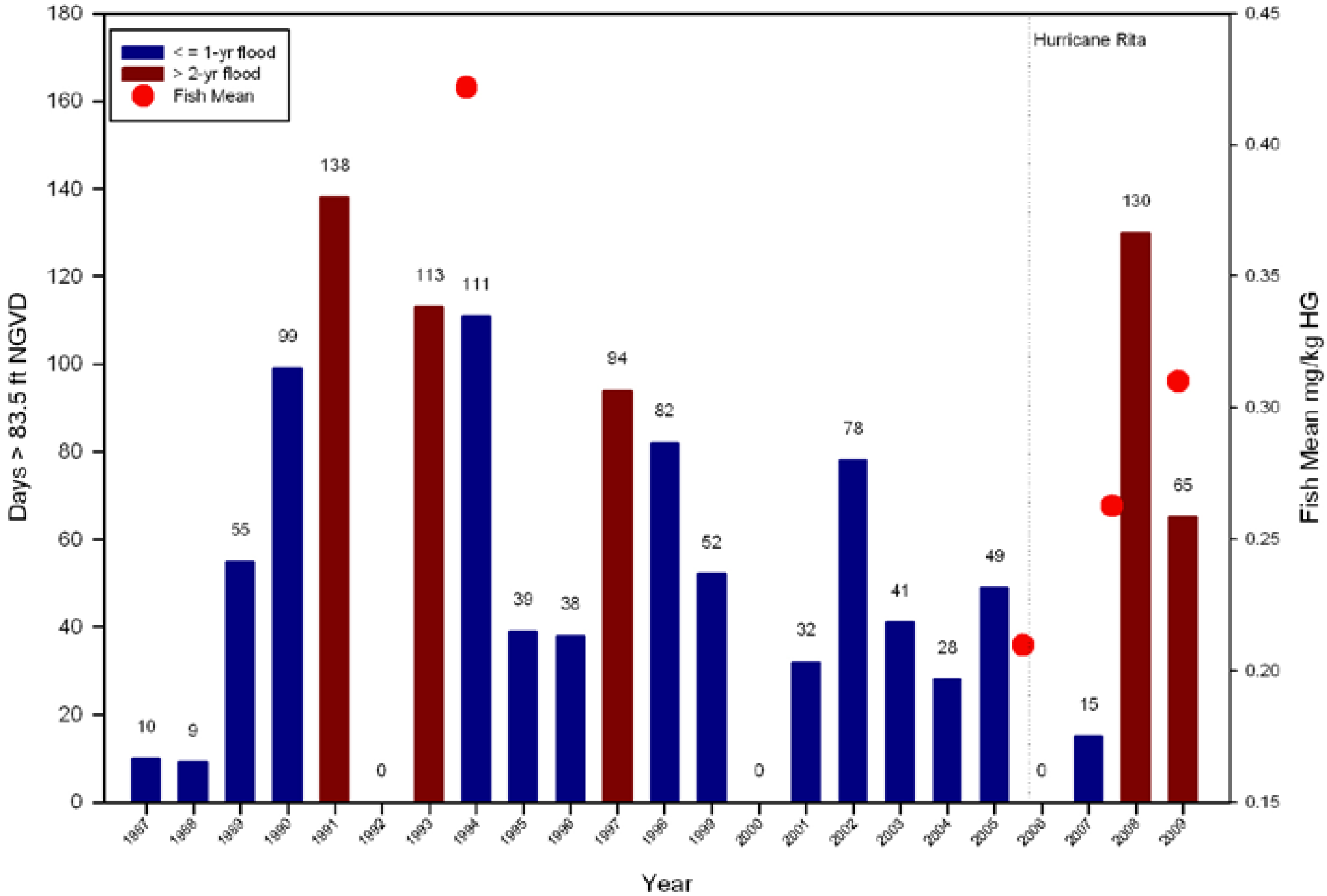

Figure 2. Fish tissue concentrations compared to flood extent and duration based on stage at the Steele Bayou structure.