

Health Consultation

Mercury Exposure Investigation

Caddo Lake Area

Harrison County, Texas

March 21, 2005



Prepared by:
The Texas Department of State Health Services
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary and Statement of Issues

The Texas Department of Health (TDH), now the Texas Department of State Health Services (DSHS), issued a consumption advisory for largemouth bass and freshwater drum from Caddo Lake in 1995 due to elevated levels of mercury in the fish. In 2003, DSHS began receiving anecdotal reports from a community group that people, possibly including subsistence fishers, continued to eat these species of fish from Caddo Lake. The purpose of this investigation, which was conducted from May 11, 2004 through May 15, 2004, was to assess whether people who eat fish from Caddo Lake were potentially being exposed to harmful amounts of methylmercury (MeHg).

Blood mercury levels were measured in 71 voluntary participants. At the time the blood was collected, each participant was asked about the types of fish they ate, how often they ate fish, and where the fish they ate were caught. The fish catch locations supplied by the participants were used to determine possible lake area sites for obtaining additional fish tissue samples.

The primary objectives of this exposure investigation were to:

- Provide people who consume fish taken from Caddo Lake the opportunity to have an assessment of their current exposure to mercury through confidential, independent laboratory testing of their blood.
- Obtain information regarding the types of fish consumed and the locations from which the fish were caught to identify fish sampling needs for laboratory analysis.
- Use blood mercury concentrations to determine whether the participants were being exposed to mercury at levels that have been associated with adverse health outcomes.
- If required, provide individuals with scientifically based guidance on how they might reduce their exposure to mercury.
- Assess whether additional efforts are needed in the community to reduce potential health risks.

Background

Site Description and History

Caddo Lake, located in the northeastern part of the state, is the only naturally occurring lake in Texas. The western part of the lake is in Texas and the eastern portion is in Louisiana [Figure 1]. The lake covers 26,810 acres, has a maximum depth of 20 feet and an average depth of 8-10 feet [1, 2]. The Caddo Lake habitat, described as a wetland having both bottomland hardwoods and bald cypress swamps, supports the largest populations of certain duck species and the most diverse fish fauna in Texas [3]. In October 1993, the Ramsar Convention on Wetlands designated the lake as a Wetlands of International Importance [4].

The communities nearest to the lake include the cities of Karnack (population 775) and Uncertain (population 150) [5]. On the southwestern side of the lake is the former Longhorn Army Ammunition Plant (LAAP), a 8,493 acre U.S. government-owned facility that operated intermittently from 1942 to 1997, producing 2,4,6-trinitrotoluene (TNT), pyrotechnic ammunition, rocket motors, and plastic explosive. LAAP was placed on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) on August 30, 1990. The Agency for Toxic Substances and Disease Registry (ATSDR) prepared a Health Assessment for LAAP in July 1999 and concluded that the site poses no apparent public health hazard because people are not likely to come in contact with site contaminants or because institutional controls are sufficient to protect human health [6]. Mercury was not used at LAAP and has not been detected in its permitted discharge [3]. On May 5, 2004, administrative control of approximately 5,000 acres of the LAAP site was granted to the U.S. Fish & Wildlife Service as the Caddo Lake National Wildlife Refuge. The U.S Army retains control of the remainder of the site [7].

On November 2, 1995, due to elevated levels of mercury in fish¹, the DSHS issued a consumption advisory for largemouth bass (*Micropterus salmoides*) and freshwater drum (*Aplodinotus grunniens*) taken from Caddo Lake. The consumption advisory states that eating bass or drum from the lake should be limited to two 8-ounce meals per month for adults and two 4-ounce meals per month for children [8]. More frequent consumption of fish or consumption of greater quantities of fish than recommended by the advisory may pose a potential human health risk, particularly to children and women of child bearing age.

Recently, the DSHS Exposure Assessment and Surveillance Group began receiving anecdotal reports from a community group that people, possibly including subsistence fishers, were eating the species of fish named in the advisory. In response to these reports, DSHS conducted an exposure investigation to evaluate current exposure to methylmercury through confidential laboratory testing of blood and updated fish sampling and tissue analysis. From May 11 to May 15, 2004, DSHS collected blood samples from 71 people (8 to 88 years of age) most of whom regularly eat fish from Caddo Lake. Additionally, from May 25 to May 27, the DSHS Seafood

¹ The mercury in the lake is believed to be from atmospheric deposition of non-point source emissions. Possible sources for the emission of mercury could be coal-fired power plants. Caddo Lake has conditions favorable for the uptake and biomagnification of methylmercury in the food chain. These include: low pH, high dissolved organic carbon, and high sulfate [3].

and Aquatic Life Group collected fish and frogs from Caddo Lake at locations identified by the participants in the Exposure Investigation as areas where they obtain their fish.

Rationale for an Exposure Investigation

Assessment of exposure usually is accomplished by looking at contaminant concentrations and pathways of exposure to construct exposure scenarios which are used to estimate the amount of the contaminant that gets into the body. The resulting exposure estimates often are made with considerable scientific uncertainty. When dealing with fish eating populations, this uncertainty is exacerbated by several factors; the mixture of fish species in the diet, the portion size of the fish meal, and the interaction of the frequency of fish consumption with the kinetics of mercury elimination from the body. Directly measuring the level of a substance of concern in the body is a more direct way to assess whether exposure is occurring. In the past, mercury was found in largemouth bass and freshwater drum at levels high enough to warrant issuing a consumption advisory for these species. The purpose of this exposure investigation was to assess individual exposure to mercury among people who regularly consume fish from Caddo Lake. Because long-term consumption of fish is the presumed exposure scenario, and blood mercury levels peak soon after exposure, DSHS tested for mercury in blood as a measure of recent exposure.

Methods

Participants

DSHS obtained a list of potential participants from a local minister and the Caddo Lake Institute (a private non-profit foundation). The DSHS also placed announcements in local newspapers, sent flyers to local government officials to post in their respective cities, and contacted local officials to help recruit volunteers. DSHS contacted potential participants by telephone to solicit participation. Participants either traveled to City Hall in Uncertain, Texas or received a visit from DSHS staff that traveled throughout the lake area to collect blood samples at private residences, businesses, boat docks, and highway right-of-ways.

To assess exposure to mercury, DSHS collected blood from 71 volunteer participants who signed a consent statement agreeing to the testing (Attachment A). Participants reviewed and signed a medical release form which allowed DSHS to collect a blood sample. Educational material containing information on how to reduce exposure was distributed to each participant.

During the blood sample collection, a brief questionnaire (Attachment B) was completed with each participant. Participants were asked questions about the length of time they had lived in the community, the types of fish they consumed from the lake, and how often they consumed fish from the lake. The participants also were asked where the fish they consumed were caught [Figure 2]. Information concerning the catch locations was given to the DSHS Seafood and Aquatic Life Group to help determine sampling sites for updated fish tissue analysis.

Blood samples were collected from 34 males (48 %) and 37 females (52 %). The age range of males was 8 to 86 years of age. The age of the females ranged from 18 to 88 years. The average

ages of male and female participants were 52 and 59 years old, respectively. Three of the participants indicated that they did not eat fish or had not eaten fish taken from Caddo Lake within approximately 4 years.

Collection of Blood Samples for Mercury Analysis

All blood draws were conducted using clinical standards. Public health nurses from the DSHS Region 4 office in Tyler, Texas collected venous blood samples using 7 milliliter (mL) Vacutainer[®] tubes containing heparin. DSHS Exposure Assessment and Surveillance staff maintained chain of custody during the labeling, packaging and shipping of the samples to Clinical Pathology Laboratory in Austin, Texas. Specialty Laboratories, Inc., Santa Monica, California analyzed the samples for total mercury (methyl and inorganic mercury).

Aquatic Sampling and Analysis

On May 25-27, 2004, the DSHS Seafood and Aquatic Life Group collected fish and frog from sample locations identified by the participants in the exposure investigation. They used electrofishing⁵, trap nets, and gill nets to collect the fish while bullfrogs (*Rana catesbeiana*) were collected by hand at night using spotlights. A total of 66 samples were collected and the tissue was analyzed for total mercury by the DSHS laboratory in Austin, Texas using EPA Method 245.6 (total mercury in tissues) [9]. Only the edible muscle tissue from each fish and frog was retained for analysis.

Bullfrog (n=6) and nine different types of finfish were collected to represent the types of aquatic life eaten by people in the area. The types of fish caught are largemouth bass (n=14), bream (n=8), catfish (n=9), pickerel (n=2), crappie (n=14), freshwater drum (n=6), gar (n=1), warmouth/goggle eye (n=4), and white bass (n=2). The data, by species, are shown in Table 1. The average total mercury concentration varied among the different species ranging from 0.116 parts per million (ppm) for bullfrog to 1.16 ppm for gar. The highest single total mercury level was found in a largemouth bass (1.77 ppm). The lowest single total mercury level was found in a catfish (0.0647 ppm).

Results

Individual test results and a written explanation of their meaning were provided to each participant. A DSHS physician and a toxicologist were available to discuss individual results by telephone. Recommendations for follow-up actions were made as appropriate. In accordance with state confidentiality law, individual test results were not made available to the general public.

² Electrofishing is a fish collection method in which electricity is generated and pulsed into the water. Any fish within the path of the electric field is temporarily stunned and floats to the surface.

⁵ Electrofishing is a fish collection method in which electricity is generated and pulsed into the water. Any fish within the path of the electric field is temporarily stunned and floats to the surface.

Total blood mercury (methylmercury and inorganic mercury) levels for the 71 participants ranged from less than ($<$) 2 to 15.9 $\mu\text{g/L}$ (micrograms per liter) [Table 2] and followed a lognormal distribution with a geometric mean of 2.63 $\mu\text{g/L}$ [Figure 3]. The geometric mean blood mercury levels for males and females were 2.98 $\mu\text{g/L}$ and 2.35 $\mu\text{g/L}$, respectively.

Sixty-eight participants (96 %) indicated they consume fish. Three participants indicated they do not eat fish or have not consumed fish in approximately four years. Participants reported eating various amounts of 11 different types of fish plus frog [Table 3]. Catfish and crappie were the most commonly eaten species [Table 3]. The average mercury content found in catfish and crappie was 0.219 ppm and 0.263 ppm, respectively [Table 1]. Freshwater drum, which had the highest average mercury content of 0.913 ppm, was consumed by approximately 13% of the participants. Largemouth bass, which had an average mercury level of 0.647 ppm, was consumed by approximately 48 % of the participants [Table 3].

Participants were asked how often they consumed fish and/or frog. Answers ranged from no consumption to seven times per week. The majority of participants (29%) indicated they consume fish two times a week. Five participants indicated that they consumed fish 7 times a week. We rank ordered the fish consumption data for all participants (male and female combined), males only, and females only and split the data for each group into (low, medium, and high consumption groups). For each tertile we then calculated the average number of fish meals eaten per week and the average blood mercury concentration. For all participants, the average number of fish meals eaten per week for the low, medium, and high consumption tertiles was 0.4, 1.7, and 4.0 meals, respectively [Figure 4]. For males, the average number of fish meals eaten per week for the low, medium, and high consumption tertiles was 0.6, 2.4, and 4.4 meals, respectively [Figure 5]. For females, the average number of fish meals eaten per week for the low, medium, and high consumption tertiles was 0.4, 1.5, and 3.7 meals, respectively [Figure 6]. When fish intake is consistent and prolonged, there is generally a well defined relationship between mercury in the blood and consumption of fish. There was considerable variability within each of the tertiles, likely the result of the uncertainties associated with dietary recall data. Average blood mercury levels did appear to increase with increasing weekly fish consumption [Figures 4, 5, and 6].

The laboratory which analyzed the Caddo Lake area samples indicated that the expected range of blood mercury is $<$ 5.0 $\mu\text{g/L}$. Fourteen participants (10 male and 4 female) had blood mercury levels greater than ($>$) 5.0 $\mu\text{g/L}$ with levels ranging from 5.1 $\mu\text{g/L}$ to 15.9 $\mu\text{g/L}$. Fish consumption rates for these participants ranged from once per month to seven times per week. Seven of the participants indicated that they ate largemouth bass and one of the seven participants indicated they also ate freshwater drum [Table 4].

Discussion

Public Health Implications

The Texas Department of State Health Services periodically makes risk management decisions regarding the public health implications associated with eating fish and shellfish contaminated with methylmercury (MeHg). These decisions can range from the issuance of fish consumption advisories to actual prohibitions on the taking of fish. The challenge to health officials is to balance the known health benefit of consuming more fish in the diet with the known health risks associated with excess MeHg exposure. Thus, it is important to ensure that risk management decisions pertaining to seafood are appropriate and do not do more harm than good. The purpose of this exposure investigation was to evaluate methylmercury exposure in the fish eating population around Caddo Lake.

The ability of fish and seafood to bio-accumulate MeHg is a complex process that involves both chemical and biological reactions. Small concentrations of inorganic mercury released to the atmosphere, through natural and human mechanisms, will cycle through the environment (air, soil, and water). Under the proper conditions in aquatic systems, inorganic mercury can undergo in-situ bacterial conversion to MeHg, an organic form of mercury. MeHg can move up the food chain into fish and since they do not readily eliminate MeHg from their bodies, it bio-concentrates in their tissues throughout the course of their lives. Older (longer lived) predator fish often have the highest concentrations of MeHg in their tissues.

Although fish are resistant to the toxic effects of MeHg, people are not. Thus, people who eat fish contaminated with MeHg could be at risk for adverse health effects. Clinical and epidemiological evidence indicates that ingestion of MeHg can result in paresthesias (tingling feeling), ataxia (loss of coordination), dysarthria (inability to articulate words), deafness, motor retardation, death, and brain damage in developing fetuses. The developing nervous system appears to be particularly sensitive to the toxic effects of MeHg and currently is considered the most sensitive endpoint with regard to MeHg toxicity.

Consumption of fish is one of the single most significant sources of human exposure to MeHg. Approximately 99 % of the mercury in fish is MeHg. In people, MeHg is easily absorbed through the gastrointestinal tract and rapidly enters the blood stream where it is transported to other parts of the body. Ingestion of too much MeHg can result in permanent damage to the brain and kidneys. In the blood of pregnant women, MeHg can pass into the blood of the fetus and enter the fetal brain. Some MeHg in a nursing mother can be passed to the child through her breast milk [10]. While the health effects of exposure to MeHg are well documented, there still is controversy with respect to how much is too much; the most recent “upper safe limit” for mercury in human blood is 5.8 µg/L [Table 5]. This is based on the 2001 revision of the US EPA’s reference dose (RfD) for MeHg. EPA’s revised RfD is based on data showing adverse effects of MeHg exposure on multiple tests of child development. EPA used benchmark dose (BMD) methodology to determine the lower limit on the 5 % response level (BMDL) for

multiple tests of neurobehavioral function. With the multiple endpoints they reported BMDLs in the range of 32 to 79 $\mu\text{g/L}$ in maternal blood for different neuropsychological effects in the offspring at 7 years-of-age. EPA used a one compartment model to estimate the daily doses associated with these blood levels and used an integrated approach to derive a daily dose equivalent to a maternal blood level of 58 $\mu\text{g/L}$. At 58 $\mu\text{g/L}$ there is a doubling of the prevalence of test scores (i.e., from 5 % to 10 %) in the clinically subnormal range. They then applied an uncertainty factor of 10 to account for pharmacokinetic and pharmacodynamic variability and uncertainty to derive the RfD which is equivalent to approximately 5.8 $\mu\text{g/L}$. Thus, with in utero exposure, the probability of below normal scores on neurodevelopmental tests increases as blood levels increase from 5.8 $\mu\text{g/L}$ to 58 $\mu\text{g/L}$.

All participants (male and female) had blood mercury levels below those normally associated with adverse health effects in adults. The five female participants (14 %) who were of child-bearing age (18-44 years) all had blood mercury levels below the 5.8 $\mu\text{g/L}$ level for developmental effects (Table 5). Based on these data we would not expect to see observable adverse effects in this population.

The blood mercury levels of the participants in this exposure investigation (<2.0-15.9 $\mu\text{g/L}$) are comparable to those of the general population (<5-20 $\mu\text{g/L}$) [10]. The geometric mean blood mercury level for women in this fish eating population (2.35 $\mu\text{g/L}$) is greater than the 1.02 $\mu\text{g/L}$ geometric mean reported for women ages 16-49 by the 1999-2000 National Health and Nutrition Examination Survey (NHANES) [11, 12] [Table 6]. The blood mercury levels at the 10th, 25th, 50th, 75th, 90th, and 95th percentiles for women in this investigation are also higher than those reported by NHANES [Table 5]. We note these findings because NHANES data are often used for comparison purposes. Caution is advised when comparing data from fish eating populations with NHANES data alone.

Although this is a fish eating population, the observed blood mercury levels are lower than we would have expected; the variety of fish eaten may be responsible for this observation. Based on the observed blood mercury levels and the participants self-reported frequency of fish consumption, eating a variety of fish types may be an effective way to manage exposure to mercury.

Conclusions

1. The geometric mean blood mercury levels measured in this fish eating population was higher than that reported by NHANES for the general population; however, it was lower than what we might have expected in people who regularly eat fish taken from a lake with a known fish mercury problem.
2. The five female participants who were of childbearing age all had blood mercury levels below the levels associated with adverse neurodevelopmental effects in children exposed

in utero. Additionally, all participants had blood mercury levels below those normally associated with adverse health effects in adults.

3. Eating a variety of fish, as reported by the participants may be an effective way to manage exposure to mercury.

Public Health Action Plan

Actions Completed

1. The DSHS Exposure Assessment and Surveillance Group mailed letters to participants concerning their blood mercury test sample results. An explanation of the findings, and if necessary, any recommendations to reduce mercury exposure were included in the letter.
2. Using information regarding the types of fish consumed and the locations from which the fish were caught, the DSHS Seafood and Aquatic Group, collected and analyzed Caddo Lake fish and frog tissue for mercury.

Actions Recommended

1. Continue to post and maintain advisory signs around Caddo Lake indicating the consumption of largemouth bass and freshwater drum should be limited due to mercury contamination. These signs indicate that adults should consume no more than two meals (not to exceed 8 ounces of fish per meal) per month of largemouth bass or freshwater drum from Caddo Lake. Children should consume no more than two meals (not to exceed 4 ounces of fish per meal) per month combined of largemouth bass and freshwater drum from Caddo Lake.
2. Continue to periodically sample and analyze Caddo Lake fish, especially largemouth bass and freshwater drum, for mercury as funds permit.

Actions Planned

1. Through a Caddo Lake area community meeting, present and explain findings of the investigation and summarize results of the blood and fish testing.

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CERTIFICATION

This Caddo Lake Mercury Exposure Investigation/Health Consultation was prepared by the Texas Department of State Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was done in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.



Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with its findings.



Team Lead CAT, SPAB, DHAC, ATSDR

Appendices

Appendix A: - Acronyms and Abbreviations

Appendix B: - Figures

Appendix C: - Tables

Appendix A: - Acronyms and Abbreviations

Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BMD	Benchmark Dose
BMDL	Benchmark Dose Lower limit
DSHS	Texas Department of State Health Services
EPA	United States Environmental Protection Agency
Hg	Mercury
LAAP	Longhorn Army Ammunition Plant
MeHg	Methylmercury
mL	Milliliter
NHANES	National Health and Nutrition Examination Survey
NPL	National Priorities List
ppm	Parts per million
RfD	Reference Dose
TDH	Texas Department of Health
TNT	Trinitrotoluene
µg/L	Micrograms per liter

Appendix B: - Figures

Figure 1 - General Location of Exposure Investigation

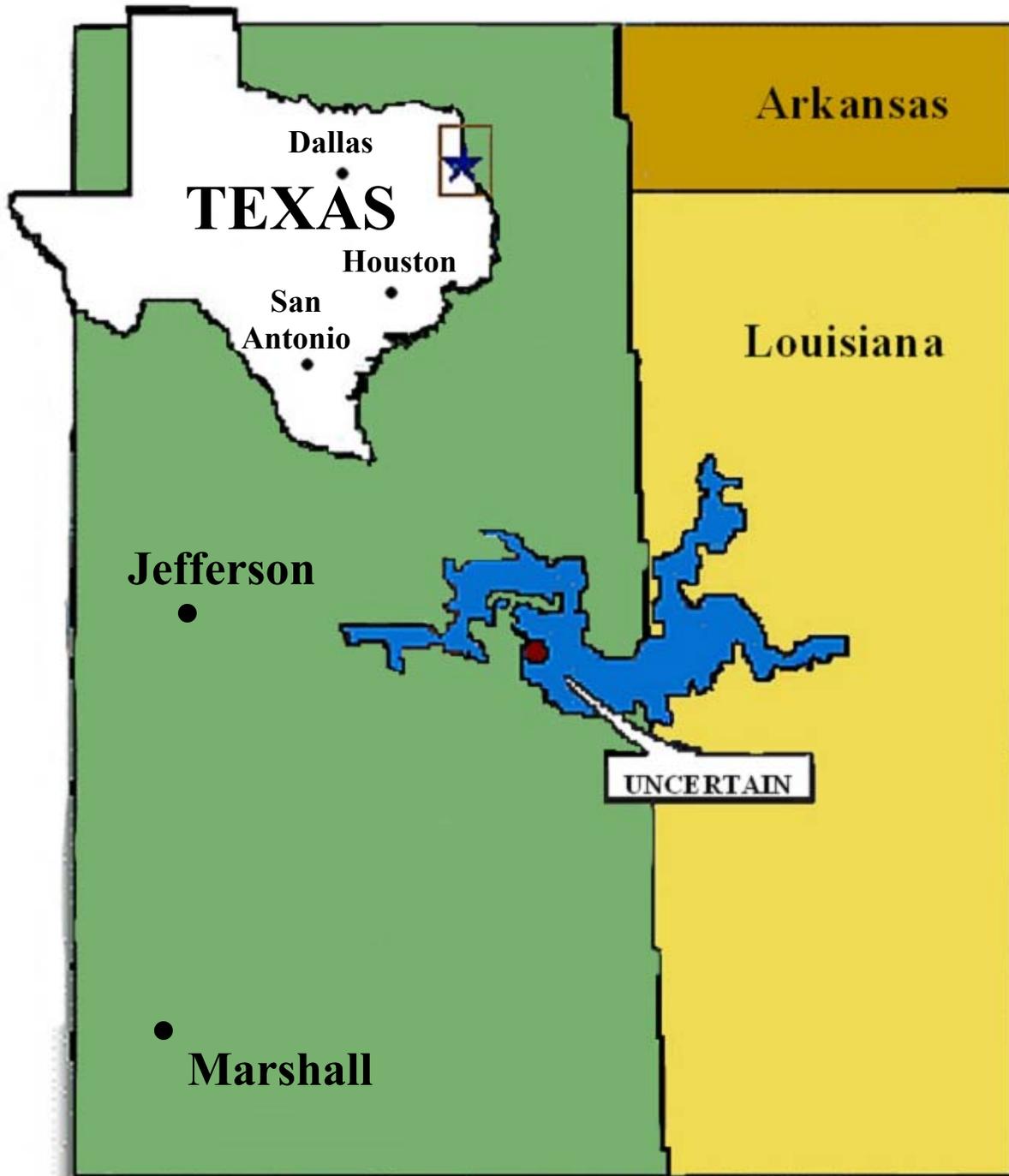


Figure 2 - Caddo Lake Map

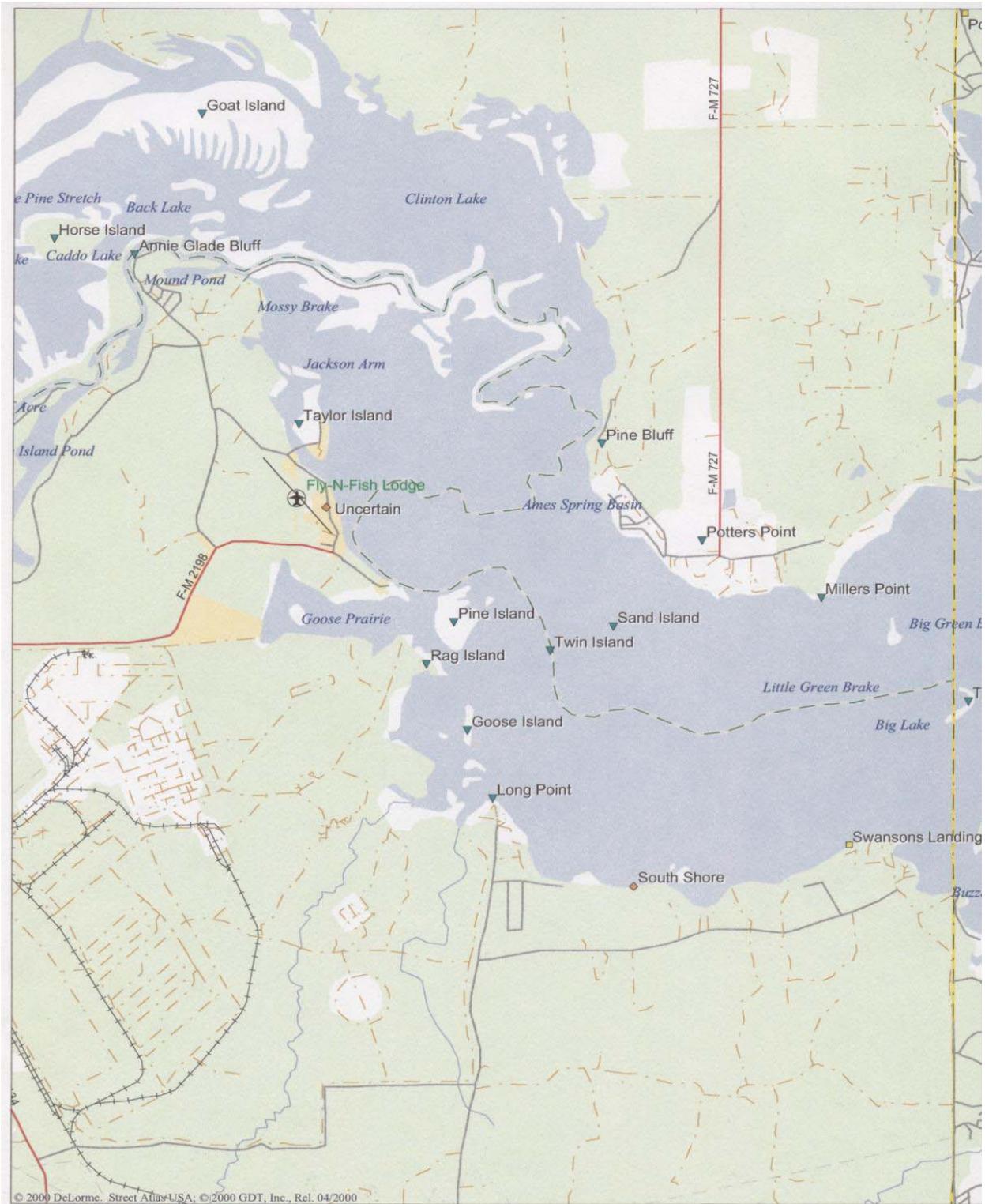


Figure 3 - Frequency Distribution for Blood Mercury Levels in Caddo Lake Fish Consumers

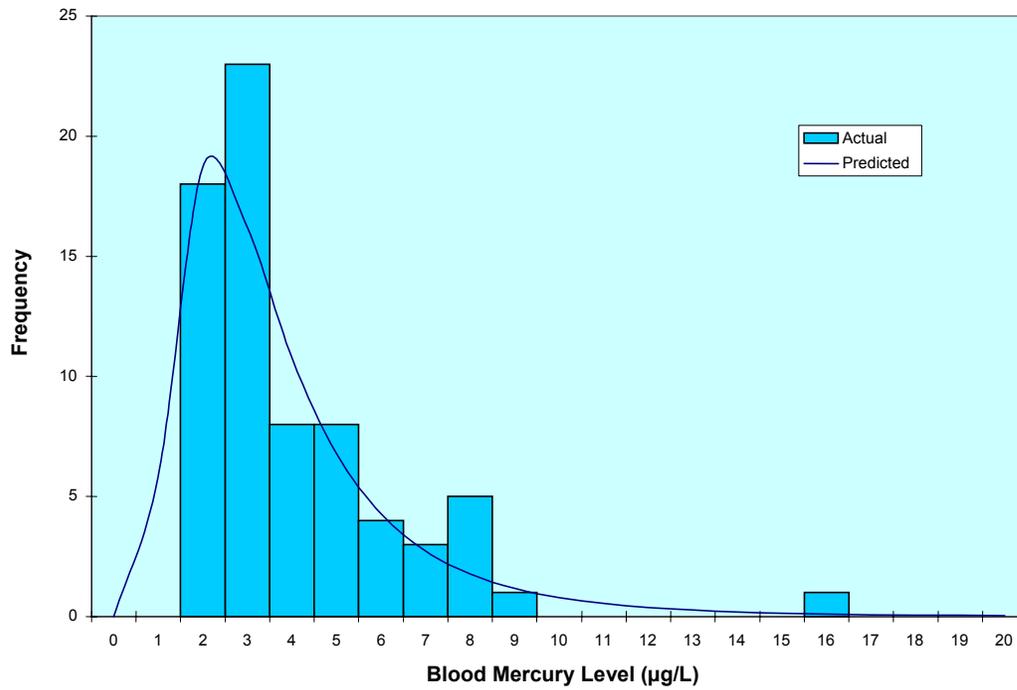


Figure 4 - Blood Hg Level as a Function of Fish Meals Eaten Per Week - All Participants

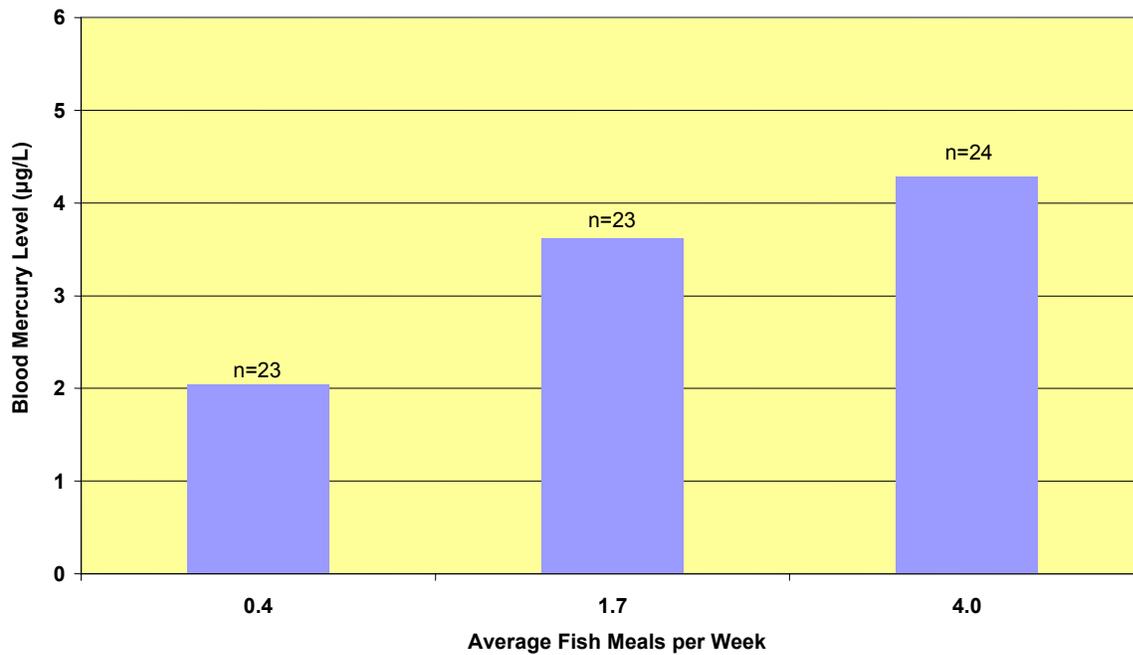


Figure 5 - Blood Mercury as a Function of Fish Meals per Week - Males

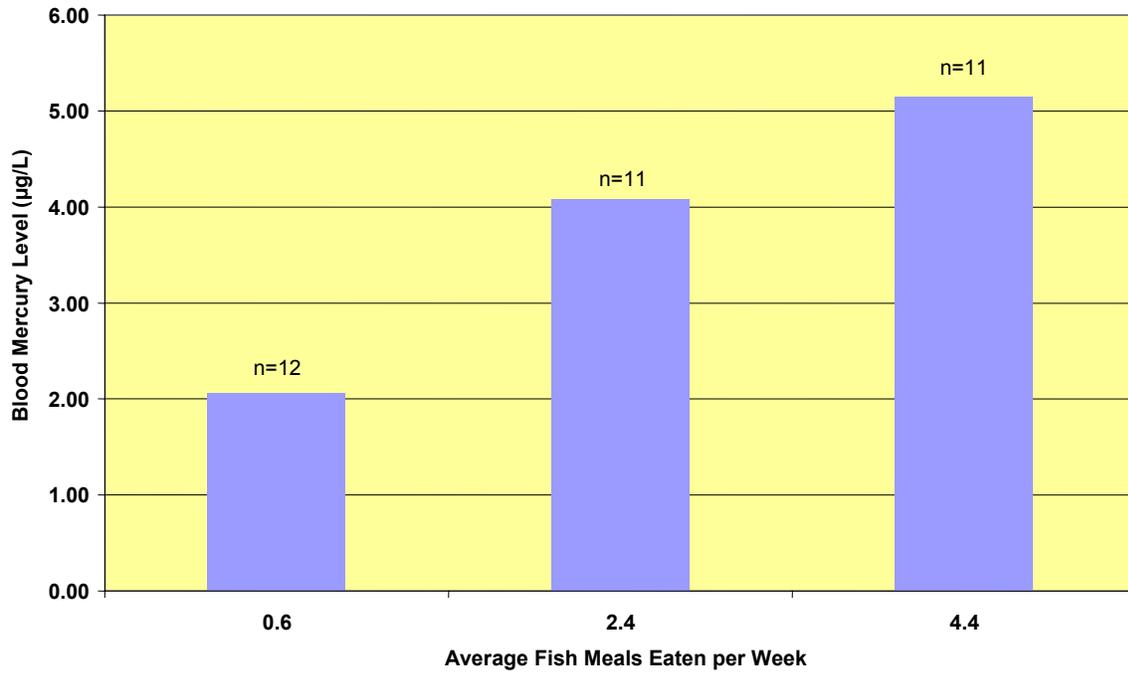
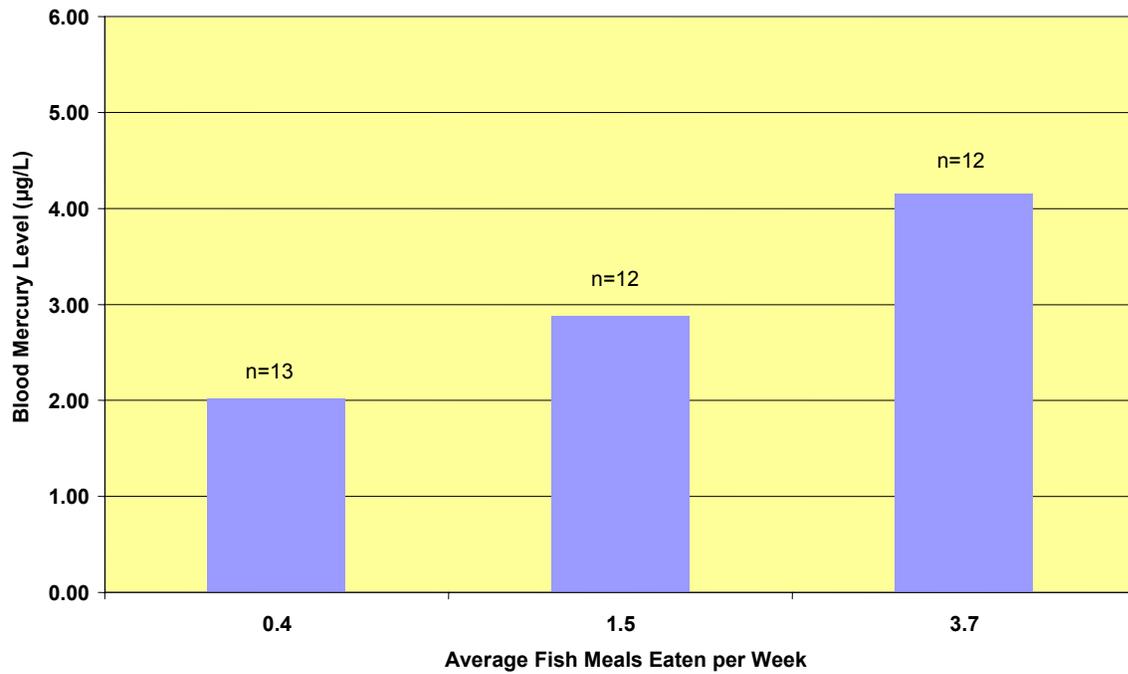


Figure 6 - Blood Mercury as a Function of Fish Meals per Week - Females



Appendix C: - Tables

Table 1
Fish/Frog Samples Collected From Caddo Lake - May 2004
Mercury Analysis Results (ppm)

Bass (largemouth)	Bream (bluegill) (red ear)	Bullfrog	Catfish (channel) (flathead)	Chain Pickerel	Crappie (black)	Drum (freshwater)	Gar (spotted)	Warmouth	White Bass
1.77	0.324	0.157	0.533	0.608	0.630	1.62	1.16	0.423	0.278
1.04	0.271	0.111	0.332	0.0706	0.402	1.42		0.417	0.090
0.900	0.246	0.109	0.246		0.399	0.717		0.414	
0.802	0.220	0.107	0.238		0.375	0.716		0.186	
0.711	0.219	0.105	0.170		0.363	0.703			
0.635	0.196	0.104	0.144		0.316	0.302			
0.607	0.179		0.135		0.283				
0.566	0.158		0.112		0.212				
0.566			0.0647		0.174				
0.429					0.134				
0.397					0.106				
0.275					0.105				
0.187					0.089				
0.169					0.0985				
average = 0.647	average = 0.227	average = 0.116	average = 0.219	average = 0.339	average = 0.263	average = 0.913	average = 1.16	average = 0.360	average = 0.184

bold value = mercury levels of 0.700 ppm or greater in fish are cause for consideration of a potential consumption advisory by the Texas Department of State Health Services

	Females	Males
Total participants	37	34
Age range (years)	18 - 88	8 - 86
Average age (years)	59	52
Blood Hg range ($\mu\text{g/L}$)	< 2.0 [†] - 15.9	< 2.0 [†] - 8.0
Blood Hg average ($\mu\text{g/L}$)	2.98 [◇]	3.71 [◇]
Blood Hg - geometric mean ($\mu\text{g/L}$)	2.35	2.98

† = results of < 2.0 $\mu\text{g/L}$ Hg were below the laboratory analysis detection limit

◇ = 1 $\mu\text{g/L}$ ($\frac{1}{2}$ the detection limit) was used for blood Hg results which were < 2.0 $\mu\text{g/L}$.

Fish/frog type	# of participants indicating consumption per total # of participants	Percentage (%) of participants who consume fish type
Catfish - (channel, yellow)	60/68 [✕]	88.24
Crappie - (white, white perch)	58/68	85.29
Bream - (bluegill, red ear)	46/68	67.65
Bass - (largemouth)	33/68	48.53
Warmouth - (goggle-eye)	14/68	20.59
Frog legs - (bullfrog)	11/68	16.17
Drum - (freshwater drum)	9/68	13.24
Gar - (alligator)	4/68	5.88
Buffalo	4/68	5.88
White bass - (sand bass)	2/68	2.94
Pike - (chain pickerel)	1/68	1.47
Yellow bass	1/68	1.47

✕ = 68 of 71 participants indicated they consumed fish or frog

Table 4
Caddo Lake Area Participants with Blood Mercury Results > 5.0 µg/L

sample result (µg/L)	sex	# of fish meals	fish types consumed							
15.9	female	4/week	bass			catfish	crappie			
8.0	male	7/week		bream		catfish	crappie			warmouth
7.7	male	3-4/week		bream			crappie			
7.7	male	3-4/week		bream		catfish	crappie			
7.5	male	2/week	bass	bream		catfish	crappie			warmouth
7.3	male	2/week	bass			catfish	crappie			
7.1	female	4/week		bream		catfish	crappie			warmouth
6.6	male	3-4/week		bream		catfish	crappie			
6.4	male	2/week		bream		catfish	crappie		frog	
6.0	male	2/week	bass	bream		catfish	crappie			
5.8	female	1/week		bream			crappie			
5.8	male	1/month	bass	bream			crappie			
5.2	female	2/week	bass	bream	buffalo	catfish	crappie			warmouth
5.1	male	3/week	bass	bream		catfish	crappie	drum		warmouth

bass = largemouth
 bream = sunfish family: bluegill, red ear
 catfish = channel catfish, yellow catfish
 crappie = white crappie, white perch
 drum = freshwater drum
 frog = frog legs
 warmouth = goggle-eye

Blood Mercury Concentration	Adverse Health Effect
< 5.8 µg/L	Without measurable effect – Upper safe limit” of total mercury in human blood.
≈ 5.8 to 58 µg/L	Following in utero exposure increasing probability of subnormal scores on neuro-developmental tests as blood levels increase from 5 to 58 ug/L. At BMDL of 58 ug/L doubling of the prevalence of test scores (i.e., from 5% to 10%) in the clinically subnormal range.
≈ 58 µg/L to 200 µg/L	Increased likelihood of subnormal scores on neurodevelopmental tests following in utero exposures. Adults experience visual and motor problems. At 200 ug/L ≈ 5% of adults experience paresthesias.

* Modified from Mahaffety – Methylmercury 2001 Reference Dose, Mercury Forum in Mobile on May 20-21, 2002 and Mahaffety – Methylmercury Epidemiology Update Fish Forum – San Diego, 2004.

Source	Sample Size	Geometric Mean	Percentiles					
			10 th	25 th	50 th	75 th	90 th	95 th
NHANES 1999-2000 Women Ages 16-49	1709	1.02	0.17	0.42	0.94	2.07	4.84	7.13
Current[#] Investigation Women Ages 18-88	37	2.35	0.99	1.49	2.35	3.70	5.58	7.13
Current[#] Investigation Men Ages 8-86	34	2.98	1.21	1.85	2.98	4.80	7.38	9.54
Current[#] Investigation Males and Females Ages 8-88	71	2.63	1.08	1.65	2.63	4.21	6.42	8.27

[#] Percentile calculated from lognormal distribution

Attachments

Attachment A—Participant Consent for Blood Specimen Testing

Attachment B—Caddo Lake Fish Consumption Survey

Attachment A—Participant Consent for Blood Specimen Testing

Participant Consent for Blood Specimen Testing Exposure Investigation for Mercury due to Fish Consumption

The Texas Department of Health Environmental Epidemiology and Toxicology Division (TDH) is investigating mercury exposure for people who eat the fish from the Caddo Lake area.

- We are offering **free, voluntary blood mercury testing** for residents who eat fish from Caddo Lake.
- Along with the free testing, we would like to **collect information** on what kinds of fish and how much by asking a few questions.

This investigation will let you know the levels of mercury in your blood and will help identify if further public health actions are needed to reduce exposure.

Participation

I understand that by participating I, or my child, will learn if we have had exposure to mercury. If mercury is found outside acceptable levels, I will receive information about mercury exposure and how to reduce current and future exposures.

I understand that my **participation is voluntary**. Furnishing any information is voluntary and even if I agree to participate and sign this form, I can stop my participation or my child's/ward's participation at any time. I understand and agree that there is no provision for compensation or medical treatment offered by TDH based upon the test results or in the event of injury from participation. I understand that I must sign this form to participate.

Procedure/Tests:

I understand that:

- I am providing a **blood sample to test for mercury only**.
- A representative of the Texas Department of Health will provide instructions to me.
- I understand that a representative of the Texas Department of Health will collect the blood sample.

Results

I understand that every effort will be made to provide the results of my tests in writing to me within approximately 2 months. I will receive an actual test result in addition to laboratory reference values with an explanation of their significance. Results that are of immediate health concern will be reported to me as soon as they are known. If my results reveal an elevated value of mercury, I understand that I should notify my personal physician.

Confidentiality

I understand that confidentiality will be protected to the fullest extent possible according to state and federal laws. Forms containing my name or address will be kept in locked cabinets at the Texas Department of Health. Any reports produced from this investigation will give only group information and not identify specific individuals.

Contact

If I have any additional questions about this investigation or the test, I may contact TDH at 1(800)588-1248.

Consent

The risks and benefits of this exposure investigation have been explained to me. All of my questions have been satisfactorily answered. I hereby freely and voluntarily give my signed consent for participating in the testing described above.

I, (please print) _____, the undersigned, agree to blood sampling and completing questionnaires for:

() Myself.

() My child/ward, _____, age - _____

Signature: _____ Date: _____

Address: _____

Phone # : _____

Witness: _____ (print name) _____ (signature)

Attachment B—Caddo Lake Fish Consumption Survey

CADDO LAKE FISH CONSUMPTION SURVEY
May 2004

Control Number

1. What is your current address:

Address: _____ Age _____
 City _____ State _____ Zip _____ Sex _____

Mailing Address: _____

2. How long have you lived in this community?

- (a) less than a year (c) 6 to 10 years
 (b) 1 to 5 years (d) More than 10 years

3. If you fish in Caddo Lake where do you fish from:

Please give the name(s) of the area(s) of shore, or of a nearby landmark(s).

4. How often do you eat fish from Caddo Lake?

- (a) more than once a week (d) once a month
 (b) once a week (e) twice a month
 (c) twice a week (f) few times a year

5. What types of fish do you eat? And what is the portion size, in ounces, (i.e. how much of the fish) do you normally eat at a meal?

6. How many people live in your house? _____

Please list sex, age and relationship, types of fish eaten, and amounts of fish eaten, for all persons living in your household.

<u>Sex</u>	<u>Age</u>	<u>Relationship</u>	<u>Types of Fish eaten</u>	<u>How much</u>	<u>How Often</u>

7. Do you eat waterfowl from the area on and/or around Caddo Lake?

- (a) Never
- (b) A few days a year
- (c) A few days a month
- (d) A few days a week
- (e) Every day

If yes, what types of waterfowl do you eat? _____

8. Do you eat any other game from around Caddo Lake?

- (a) Never
- (b) Every Day
- (c) A few days a week
- (d) A few days a month
- (e) A few days a year

If yes, what types of other game do you eat? _____

9. Have you seen or heard of the fish advisories that TDH has posted about eating certain fish (Largemouth Bass and Freshwater Drum) from Caddo Lake?

- (a) Yes
- (b) No

If yes, please tell us where you saw/heard it _____

10. How would you rate your overall health?

- (a) Excellent
- (b) Good
- (c) Fair
- (d) Poor
- (e) Very poor
- (f) Don't know/Declined to answer

Comments: _____

