

TEXAS DEPARTMENT OF HEALTH
SEAFOOD SAFETY DIVISION

ASSESSMENT OF RISK

FOR CONSUMPTION OF FISH TAKEN FROM

CADDO LAKE

AUGUST 1995

BACKGROUND

Caddo Lake is 25,400 acres in size and is located on the upper Texas Louisiana border in both Marion and Harrison Counties. It is noted for its marshy shoreline, dense stands of cypress trees and thick aquatic vegetation in places.

In the summer of 1992, the states of Louisiana and Arkansas discovered a mercury problem in bass taken from the Ouachita River. By the summer of 1993, several fish consumption advisories were in place for several south Arkansas rivers and lakes due to mercury contamination. Widespread atmospheric contamination was suspected, since no major point sources of mercury were found.

The conditions necessary for the uptake of methyl mercury by fish include low pH and substantial organic matter in water or sediment. Conditions in East Texas lakes were similar to those of Arkansas and Louisiana rivers and lakes. This prompted an investigation of fish taken from lakes located on or near the Texas-Louisiana border to determine whether mercury or other contaminants of public health concern may exist in these fish.

In the summer of 1994, Texas Department of Health collected 18 largemouth bass and 2 freshwater drum from Caddo Lake. Analyses included metals, pesticides, PCB's, and semi-volatile organic chemicals in 4 fish and mercury only in 16 fish. Results indicated mercury concentrations which increased with increasing size of fish. All other chemicals were found to near or below detection limits.

In January of 1995, a fish consumption advisory was issued for Caddo Lake recommending no consumption of freshwater drum or largemouth bass over 18 inches, and limiting consumption of freshwater drum under 14 inches to one meal per month for women of childbearing age and children under six. A slot limit exists for largemouth bass between 14 and 18 inches, making these fish illegal for taking.

In April of 1995, TDH expanded the collection of species to include crappie, white bass, channel catfish, sucker, pickerel, sunfish, and yellow bullhead. In all, 54 fish of a variety of sizes and species were collected. Six of the largemouth bass were of illegal size for taking and were therefore not used in a public health risk assessment. They were however included for information on mercury concentration as the size of largemouth bass increased.

MERCURY CONCENTRATIONS IN FISH TAKEN FROM CADDO LAKE

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED AUGUST 1994 - APRIL 1995			
CADDO LAKE	LARGEMOUTH BASS	11.1	0.208
		11.5	0.236
		11.8	0.314
		13.2	0.938
		13.2	0.707
		13.4	0.520
		13.6	0.632
		13.9	0.517
		14.2*	0.640
		14.3*	0.566
		15.2*	0.526
		15.3*	0.883
		15.6*	0.650
		15.6*	0.750
		18.1	1.363
		18.1	0.99
		18.3	1.17
		19.1	1.301
		19.3	0.68
		19.5	0.61
	20.1	1.101	
	21.1	1.181	
	23	1.63	
	BLACK CRAPPIE	10	0.11
		10.4	0.43
		10.8	0.76
		12.2	0.43
	WHITE CRAPPIE	11	0.63

*illegal size

MERCURY CONCENTRATIONS IN FISH TAKEN FROM CADDO LAKE (cont.)

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED AUGUST 1994 - APRIL 1995			
CADDO LAKE	FRESHWATER DRUM	17.3	0.92
		19.3	1.09
		19.5	1.255
		21.5	1.509
		22.4	1.53
		23.4	1.21
		24	1.34
		27.2	1.34
	WHITE BASS	13.4	0.27
		13.4	0.15
		14.6	0.46
		15.3	0.43
		16.1	0.36
		16.5	0.78
		16.9	0.66
		CHANNEL CATFISH	14.8
	15		0.099
	16.7		0.27
	17.3		0.14
	21.3		0.19
	SPOTTED SUCKER	16.5	0.46
		17.7	0.58

MERCURY CONCENTRATIONS IN FISH TAKEN FROM CADDO LAKE (cont.)

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED AUGUST 1994 - APRIL 1995			
CADDO LAKE	CHAIN PICKEREL	19.3	1.16
		20.5	0.75
	REDEAR SUNFISH	8.3	0.39
	YELLOW BULLHEAD	14.2	0.43

SUMMARY OF RESULTS - CADDO LAKE

FISH SPECIES(n)	AVG. SIZE	RANGE	MERCURY (ppm)	
			AVERAGE	RANGE
LARGEMOUTH BASS(6)(ILLEGAL)	15"	(14-18")	0.67	0.526-0.883
LARGEMOUTH BASS(ALL LEGAL)	16.3"	(11-23")	0.83	0.208-1.63
LARGEMOUTH BASS(8)	12.7"	(<14")	0.509	0.208-0.938
LARGEMOUTH BASS(9)	19.6"	(>18")	1.110	0.61-1.63
CRAPPIE(5)	10.9"	(10-12")	0.470	0.11-0.76
FRESHWATER DRUM(8)	21.8"	(17-27")	1.27	0.92-1.53
WHITE BASS(7)	15.2"	(13-17")	0.44	0.15-0.78
CHANNEL CATFISH(5)	17"	(14-21")	0.21	0.099-0.36
SPOTTED SUCKER(2)	17.1"	(16-18")	0.52	0.46-0.58
CHAIN PICKEREL(2)	19.9"	(19-21")	0.96	0.75-1.16
REDEAR SUNFISH(1)	8.3"	(8")	0.39	0.39
YELLOW BULLHEAD(1)	14.2"	(14")	0.43	0.43

ALL FISH
n=48 0.72 ppm mercury

TOXICOLOGICAL EFFECTS OF MERCURY

Methylmercury is the most important form of mercury in terms of toxicity and health effects from environmental exposure. The amount of mercury in the body is largely dependent on the amount of seafood in the diet. The major source of mercury is natural degassing of the earth's crust. Sources of environmental contamination in the past have been coal burning, municipal incinerators, loss in water effluent from chlor-alkali plants, refining of petroleum products, mining, and smelting.

Clinical manifestations of mercury poisoning include paresthesia (tingling of skin), ataxia (incoordination), dysarthria (difficulty with words) and visual and hearing impairment, in that order.

Methylmercury easily crosses cell membranes and preferentially binds in the nervous system and brain.

Since there is no placental barrier to mercury, the fetus is at a particular risk for methylmercury poisoning. Severe derangement of the central nervous system can be caused by prenatal exposure. Methylmercury inhibits the growth of the fetal brain, possibly by destroying microtubules necessary for cell division occurring primarily during normal development (Clarkson, 1987). Effects range from personality changes (shyness, irritability) to a severe neurological syndrome similar to cerebral palsy (ATSDR, 1994). In previous outbreaks of severe mercury contamination, children exposed prenatally had permanent cerebral involvement whereas their mothers had mild manifestations or none.

HUMAN HEALTH RISK EVALUATION

ADULTS

In the general adult population, blood methylmercury concentrations of 200 ug/L (corresponding to approximately 50 ug/g in hair) have been associated with a 5% increased risk of parasthesia. Applying a ten fold margin of safety to adjust the lowest observable adverse effects level (LOAEL) to what is expected to be a no observable adverse effects level (NOAEL), an oral reference dose (RfD) of 0.0003 mg/kg per day was determined to be equivalent to a daily dose ten times below the LOAEL. The LOAEL is associated with a 5% chance of central nervous system effects such as incoordination in walking and tingling of the extremities and is based on sensitive individuals for chronic exposure (IRIS, 1994).

The EPA reference dose of 0.0003 mg/kg/day is calculated with a ten fold margin of safety below the LOAEL and is associated with a 5 ppm hair level of mercury. The resulting screening value for mercury in fish is 0.65 ppm for women of childbearing age consuming 30 grams per day.

INFANTS

The minimum risk level (MRL) used by the Agency for Toxic Substances and Disease Registry (ATSDR) for mercury was derived based on protection of the infant exposed prenatally to methylmercury. A summary of effects of 81 mother/infant pairs exposed prenatally to methylmercury from contaminated grain in Iraq was used as a basis for deriving the ATSDR minimum risk level. The lowest observed hair concentration during pregnancy in mothers whose children were reported to have symptoms (delayed onset of walking) was 14 ppm.

The estimated dose that would result in a hair level of 14 ppm is 0.0012 mg/kg/day. Considering this data is derived from actual studies of mother/infant pairs, an uncertainty factor of four is considered appropriate for deriving a reference dose for protection of infants exposed prenatally. The resulting dose of 0.0003 mg/kg/day by mothers would be associated with hair levels less than 5 ppm methylmercury.

For the fetus, a 5% risk of neurological and developmental abnormalities is associated with peak mercury concentrations of 10-20 ug/g in maternal hair (WHO, 1990). Chronic ingestion of mercury at a dose equivalent to EPA's reference dose of 0.0003 mg/kg/day is associated with a steady state hair level of 5 ug/g. This reference dose allows a 2-4 fold margin of safety below both the Lowest Observable Adverse Effects Level and the estimated 5% risk level, and should be adequate to protect infants exposed prenatally.

The EPA reference dose of 0.0003 mg/kg/day was used for protection of the public from the levels of mercury in Caddo Lake fish. This is a documented and widely used exposure level that allows ample protection of the public, including prenatally exposed infants from mercury in fish and which results in reasonable screening values for determining health risks.

ACCEPTABLE DAILY LIMIT OF METHYLMERCURY IN CADDO LAKE FISH

SPECIES	NUMBER OF MEALS PER MONTH EQUIVALENT TO REFERENCE DOSE*
Largemouth Bass (all legal)	3.1
Largemouth Bass <14"	5.1
Largemouth Bass >18"	2.3
Crappie	5.5
Freshwater Drum	2.0
White Bass	5.9
Channel Catfish	12.3
Spotted Sucker	5.0
Chain Pickerel	2.7
Redear Sunfish	6.6
Yellow Bullhead	6.0
All Fish	3.6

Assumes a body weight of 65 kg for women of childbearing age and a meal size of approximately 8 ounces.
Reference dose equals 0.0003 mg/kg/day.

SUMMARY

A total of 48 legal size fish, representing nine commonly consumed species were collected from Caddo Lake in order to determine whether contaminant levels would indicate a public health concern. Methylmercury was detected in all samples at levels ranging between 0.099 and 1.63 ppm, depending on the species and size of fish analyzed.

Risk calculations indicate the level of fish consumption that would be required to meet the EPA reference dose of 0.0003 mg/kg/day, or level of daily exposure that is likely to be without appreciable risk of deleterious effects over a lifetime. Based on the EPA reference dose, consumption limits are recommended for largemouth bass >18", freshwater drum, and chain pickerel from Caddo Lake.

The estimate of average consumption of fish by the 50th percentile of recreational fishermen is 30 grams per day or one 8 oz meal per week. This value has a reasonable application for local consumption of fish by adults in East Texas Lakes and was used to derive a level of concern of 0.65 ppm methylmercury in fish for women of childbearing age.

The majority of the literature documenting the neurotoxic effects of methylmercury is based on the massive poisoning incident in Iraq where the primary toxicological effects were seen in children exposed prenatally to heavily contaminated and consumed grain. It was assumed that infants would not consistently consume fish at levels high enough to increase body burden. Because the majority of an infant's body burden of mercury comes from prenatal exposure or breastfeeding, consumption limits for this group are not recommended as the basis of fish consumption advisories. Adequate protection of the infant from prenatal exposure to mercury will be provided by basing advisories on consumption limits for women of childbearing age.

Adverse health effects would not be expected to occur in children born to mothers who ingest 0.0003 mg/kg/day mercury while pregnant. Chronic ingestion of mercury at a dose equivalent to the RfD would be associated with a less than 2% risk of lowest adverse effects (late walking) in infants exposed prenatally (TDH,1995). The consumption limits allow a ten fold margin of safety between lowest adverse effects (parasthesia) for adults consuming Caddo Lake fish.

Recommendations for Consumption Limits:

Species	# meals per month (8 oz)
Largemouth Bass >18"	2
Freshwater Drum	2
Chain Pickerel	3
All Combined	3.6

REFERENCES

ATSDR, 1994. Toxicological Profile for Mercury. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, GA. TP-93/10.

Clarkson, 1987. Environmental Health Perspectives. Vol. 75, 59-65.

EPA, 1993. Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories, Vol. I, Fish Sampling and Analysis.

EPA, 1994. Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories, Vol. II, Risk Assessment and Fish Consumption Limits.

IRIS (Integrated Risk Information System).

Texas Department of Health, 1995. J. Villanacci, PhD. Comments on Caddo Lake Risk Assessment.