TEXAS DEPARTMENT OF HEALTH
DIVISION OF SEAFOOD SAFETY

ANALYSIS OF RISK

FROM CONSUMPTION OF FISH TAKEN FROM

TOLEDO BEND

AUGUST 1995

BACKGROUND

Toledo Bend is approximately 65 miles in length and is located on the middle Texas-Louisiana border on the eastern borders of Shelby, Sabine, Newton, and Panola Counties. It is surrounded by pine forests and is noted for its immense stands of dead timber and seasonal abundant 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 atmosperic contamination was suspected, since no major point sources of mercury were found.

The conditions necessary for the uptake of methylmercury 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 Lousiana 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.

A total of 54 legal size fish samples were taken from Toledo Bend, including largemouth bass, freshwater drum, blue catfish, channel catfish, flathead catfish, white crappie, white bass, and hybrid striped bass. Analyses included metals, pesticides, PCB's, and semi-volatile organic chemicals. Mercury was found in all fish analyzed, at levels ranging from 0.044 to 1.44 parts per million. There was no significant difference in mercury concentrations in largemouth bass from either upper or lower Toledo Bend Reservoir. All other chemicals were found to be near or below detection limits.

MERCURY CONCENTRATIONS IN FISH TAKEN FROM TOLEDO BEND RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (cm)	TOTAL Hg (ppm)
SAMPLES COLLECTED JULY 1994-MAY 1995			
Illegal Size			
TOLEDO BEND RESERVOIR	LARGEMOUTH BASS	9.0	0.209
		9.1	0.160
		9.7	0.174
		9.8	0.590
		9.9	0.098
		9.9	0.270
		10.2	0.359
		10.3	0.288
		10.3	0.177
		10.3	0.135
		10.7	0.274
		11.6	0.521
		12.1	0.195
		12.1	0.214
		12.2	0.605
		12.3	0.110
		12.6	0.443
		12.6	0.589
		12.6	0.584
		12.7	0.613
		12.8	0.465
		12.8	0.390
		13.7	0.114
		13.9	0.548

		13.9	0.832

MERCURY CONCENTRATIONS IN FISH TAKEN FROM TOLEDO BEND RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (cm)	TOTAL Hg (ppm)
SAMPLES COLLECTED JULY 1994-MAY 1995			
Legal Size			
TOLEDO BEND RESERVOIR	LARGEMOUTH BASS	14.1	0.787
		14.2	0.557
		14.3	0.653
		16.9	0.804
		17.3	1.17
		17.3	0.62
		17.3	0.8
		17.7	0.42
		17.7	0.699
		17.8	0.611
		17.9	0.75
		18.1	0.68
		18.1	0.85
		18.3	0.86
		18.9	1.16
		18.9	1.16
		18.9	1.44
		18.9	1.65
		19.3	0.89
		20.1	1.13
		20.9	1.1
		21.6	1.09

		23.6	0.753

MERCURY CONCENTRATIONS IN FISH TAKEN FROM TOLEDO BEND RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (cm)	TOTAL Hg (ppm)
SAMPLES COLLECTED JULY 1994-MAY 1995			
Legal Size			
TOLEDO BEND RESERVOIR	FRESHWATER DRUM	14.9	0.32
		15.3	0.19
		17.7	0.18
		21.2	0.23
		21.2	0.17
		24	0.60
	BLUE CATFISH	16.1	0.10
		18.9	0.044
		18.9	0.061
		19.3	0.093
		20.1	0.056
		22.8	0.097
		25.6	0.13
	CHANNEL CATFISH	24.8	0.39
	FLATHEAD CATFISH	24	0.28
	WHITE CRAPPIE	10.8	0.652
		13	0.24
		13	0.40
		13	0.542
		13	0.508
		13.2	0.358
		13.8	0.20
		14.2	0.389
		15.3	0.33

MERCURY CONCENTRATIONS IN FISH TAKEN FROM TOLEDO BEND RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (cm)	TOTAL Hg (ppm)
TOLEDO BEND RESERVOIR	WHITE BASS	15.7	0.33
		16.1	0.28
		16.1	0.14
		16.9	0.29
		16.9	0.38
		18.1	0.93
	HYBRID STRIPED/ WHITE BASS	23.6	0.66

SUMMARY OF RESULTS - TOLEDO BEND

FISH SPECIES(n)		AVG. SIZE		RANGE		MERCURY (PPM) AVERAGE		RANGE
LARGEMOUTH BASS(25)(ILLEGAL)		11.5"		(<14")		0.36		0.098-0.832
LARGEMOUTH BASS(ALL LEGAL)		18.2"		(14-24")	0.9		0.42-1.65	
LARGEMOUTH BASS(11)		16.6"		(14-18")	0.71		0.42-0.1.17	
LARGEMOUTH BASS(12)		19.6"		(>18")		1.06		0.68-1.65
FRESHWATER DRUM(6)	19"		14-24"		0.28		0.17-0.6	
BLUE CATFISH(7)		20.2"		16-26"		0.083		0.044-0.13
CHANNEL CATFISH(1)		24.8"				0.39		
FLATHEAD CATFISH(1)	24"				0.28			
WHITE CRAPPIE(9)		13.2"		10-16"		0.402		0.20-0.652
WHITE BASS(6)	16.6"		15-18"		0.39		0.14-0.93	
HYBRID STRIPED\WHITE BASS(1)		23.6"				0.66		

UPPER TOLEDO BEND
LARGEMOUTH BASS (n=11) 17.4" 0.828 ppm mercury

LOWER TOLEDO BEND
LARGEMOUTH BASS (n=12) 18.9" 0.96 ppm mercury

ALL FISH
n=54 0.56 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), dysanthria (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, irritabiltiy) 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 between both the ATSDR MRL and the 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 Toledo Bend 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 TOLEDO BEND FISH

SPECIES	NUMBER OF MEALS PER MONTH EQUIVALENT TO REFERENCE DOSE*
Largemouth Bass (all)	2.9
Largemouth Bass 14-18"	3.6
Largemouth Bass >18"	2.4
Freshwater Drum	9.2
Blue Catfish	31
Channel Catfish	6.6
Flathead Catfish	9.2
White Crappie	6.4
White Bass	6.6
Hybrid Striped\White Bass	4
All Fish	4.6

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 54 fish, representing eight commonly consumed species were collected from Toledo Bend Reservoir in order to determine whether contaminant levels would indicate a public health concern. Methylmercury was detected in all samples at levels ranging between 0.039 and 1.55 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. Consumption of all largemouth bass should be limited to less than one meal per week.

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.

Recommendations:

- Limit consumption of largemouth bass to less than one meal per week.

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 Toledo Bend fish.

REFERENCES

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