

**TEXAS DEPARTMENT OF HEALTH  
SEAFOOD SAFETY DIVISION**

**ASSESSMENT OF RISK  
FOR CONSUMPTION OF FISH TAKEN FROM  
SAM RAYBURN RESERVOIR**

**AUGUST 1995**

## **BACKGROUND**

Sam Rayburn Reservoir is 114,500 acres in size and lies in five counties, including San Augustine, Angelina, Jasper, Nacogdoches, and Sabine Counties. The Reservoir is surrounded by pine forests and is noted for immense stands of dead timber and aquatic vegetation in the upper end of the lake. The habitat provides an excellent fishery for catfish, bass, and crappie.

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.

A total of 64 legal size fish were taken from Upper and Lower Sam Rayburn Reservoir. There was no significant difference in mercury concentrations in largemouth bass from the two areas. Analyses included metals, pesticides, PCB's, and semi-volatile organic chemicals. Results indicate significant levels of mercury in fish, depending on size and species. All other chemicals were found to be near or below detection limits.

**MERCURY IN FISH TAKEN FROM SAM RAYBURN RESERVOIR**

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAM RAYBURN RESERVOIR	LARGEMOUTH BASS (ILLEGAL SIZE)	8	0.484
		8.4	0.376
		8.5	0.136
		9	0.402
		9.2	0.214
		9.6	0.96
		10.2	0.211
		10.2	0.142
		10.4	0.375
		10.6	0.235
		10.7	0.353
		10.7	0.66
		10.7	0.482
		11.1	0.208
		11.3	0.203
		11.7	0.562
		11.8	0.176
		12.1	0.354
		12.6	0.491
		12.8	0.088
12.8	0.912		
13	0.525		

	13	0.051
	13	0.311
	13.1	0.573
	13.4	0.377
	13.7	0.483
	13.8	0.652
	13.9	0.547
	13.9	0.585

**MERCURY IN FISH TAKEN FROM SAM RAYBURN RESERVOIR**

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
<b>SAMPLES COLLECTED AUGUST 1994-MAY 1995</b>			
SAM RAYBURN RESERVOIR	LARGEMOUTH BASS (LEGAL SIZE)	14.6	0.201
		15	0.372
		16.2	0.889
		16.4	0.388
		16.6	0.628
		16.9	0.715
		17.3	0.592
		17.3	0.887
		17.5	0.635
		18.3	0.608
		18.7	1.01
		18.9	0.737
		18.9	0.741
		19.1	0.686
		19.3	0.656
19.7	0.602		

		19.9	0.765
		20.5	0.879
		20.5	1.26
		21.1	0.93
		21.2	0.663
		22.8	1.14
		23.6	0.852

## MERCURY IN FISH TAKEN FROM SAM RAYBURN RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
<b>SAMPLES COLLECTED AUGUST 1994-MAY 1995</b>			
SAM RAYBURN RESERVOIR	FRESHWATER DRUM (LEGAL SIZE)	10.7	0.199
		13.3	0.53
		14.2	0.797
		14.2	0.452
		15.3	0.903
		15.3	0.551
		15.7	0.68
		15.7	0.973
		16.5	0.247
		16.9	0.582
		17.3	0.211
		18.9	0.418
		18.9	0.473
		19.3	0.547
		19.9	0.909
	HYBRID STRIPED/WHITE BASS	20.9	0.454
		22.2	0.52
		22.8	0.957
		23.6	1.6
		24	1.0
		25.2	0.394

## MERCURY IN FISH TAKEN FROM SAM RAYBURN RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
<b>SAMPLES COLLECTED AUGUST 1994-MAY 1995</b>			
SAM RAYBURN RESERVOIR	CRAPPIE	10.2	0.200
		10.2	0.260
		10.2	0.299
		10.6	0.377
		10.6	0.298
		11	0.22
		11.2	0.36
		15	0.433
	CHANNEL CATFISH	16.3	0.098
		16.5	0.129
		16.7	0.088
		17.3	0.16
		18.9	0.204
	FLATHEAD CATFISH	22	0.447
		27.9	0.429
		31.9	0.629
	BLUE CATFISH	20.9	0.248
		22.2	0.737
		24	0.652
		24.8	0.363

**SUMMARY OF RESULTS - SAM RAYBURN RESERVOIR**

FISH SPECIES(n)	AVG. SIZE	RANGE	MERCURY (ppm)	
			AVERAGE	RANGE
LARGEMOUTH BASS(30)(ILLEGAL)	11.4"	(<14")	0.4	0.051-0.96
LARGEMOUTH BASS(23)(LEGAL)	18.7"	(14-24") 0.73		0.201-1.26
LARGEMOUTH BASS(9) 16.5"		(14-18") 0.59	0.201-0.889	
LARGEMOUTH BASS(14)	20.2"	(>18")	0.82	0.602-1.26
FRESHWATER DRUM(15)	16.1"	(10-20") 0.56		0.199-0.973
HYBRID STRIPED/WHITE BASS(6)	23"	(20-25") 0.82		0.394-1.6
CRAPPIE(8)	11.1"	(10-15") 0.3		0.2-0.433
CHANNEL CATFISH(5)	17.1"	(16-19") 0.136		0.088-0.204
FLATHEAD CATFISH(3) 27.3"		(22-32") 0.5	0.429-0.629	
BLUE CATFISH(4)	23"	(20-25") 0.5		0.248-0.737

**UPPER SAM RAYBURN RESERVOIR**  
 LARGEMOUTH BASS (n=9) 18" 0.67 ppm mercury

**LOWER SAM RAYBURN RESERVOIR**  
 LARGEMOUTH BASS (n=14) 19" 0.77 ppm mercury

ALL FISH n=64 0.576 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 Sam Rayburn 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 SAM RAYBURN FISH**

<b>SPECIES</b>	<b>NUMBER OF MEALS PER MONTH EQUIVALENT TO REFERENCE DOSE*</b>
Largemouth Bass (all)	3.5
Largemouth Bass 14-18"	4.4
Largemouth Bass >18"	3.1
Freshwater Drum	4.6
Hybrid Striped\White Bass	3.1
Crappie	8.6
Channel Catfish	18.9
Flathead Catfish	5.2
Blue Catfish	5.2
All Fish	4.5

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 64 legal size fish, representing seven commonly consumed species were collected from Sam Rayburn Reservoir in order to determine whether contaminant levels would indicate a public health concern. Methylmercury was detected in all samples at levels ranging between 0.088 and 1.26 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" and hybrid striped\white bass from Sam Rayburn Reservoir.

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 Sam Rayburn fish.

### Recommendations for Consumption Limits:

<b>Species</b>	<b># meals per month (8 oz)</b>
Largemouth Bass >18"	3
Hybrid Striped/White Bass	3

## REFERENCES

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