TEXAS DEPARTMENT OF HEALTH
SEAFOOD SAFETY DIVISION

ASSESSMENT OF RISK

FOR CONSUMPTION OF FISH TAKEN FROM

STEINHAGEN RESERVOIR

AUGUST 1995

BACKGROUND

B.A. Steinhagen (Dam B) Reservoir is located on the Neches River eight miles west of Jasper, Texas. The lake is located within the Piney Woods Vegetational Area. Steinhagen is a shallow, open reservoir (average depth 7 feet) with high turbidity due to wind action on the shallow mud flats which dominate most of the lake area. It is subject to extreme water fluctuations. The major fisheries are for channel, blue and flathead catfish and crappie. White bass also provide good fishing at times. Largemouth bass fishing is good in the old sloughs and lakes where the water is usually clear. Due to extremely shallow water, most of the good fishing is in or near the old river and creek channels. The tailrace area provides good fishing year around since water releases are continuous.

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 35 fish samples were taken from Steinhagen Reservoir, including largemouth bass, white bass, spotted bass, freshwater drum, white crappie, blue catfish, channel catfish, and smallmouth buffalo. Analyses included metals, pesticides, PCB's, and semi-volatile organic chemicals. Mercury was found in all 35 fish analyzed, at levels ranging from 0.136 parts per million to 1.52 parts per million. All other chemicals were found to be near or below detection limits.

MERCURY CONCENTRATIONS IN FISH TAKEN FROM STEINHAGEN RESERVOIR

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED July 1994-May 1995			
STEINHAGEN RESERVOIR	ILLEGAL SIZE		
	LARGEMOUTH BASS	9.5	0.294
		10.2	0.426
		10.2	0.296
		10.6	0.368
		10.8	0.341
		11.0	0.399
		11.2	0.296
		11.4	0.493
		11.5	0.368
		11.5	0.543
		11.7	0.335
		12.0	0.454
		12.3	0.410
		12.4	0.587
		12.5	0.453
		12.5	0.476
		12.6	0.514
		12.6	0.479
		12.9	0.522
		12.9	0.513
		13.0	0.344
		13.0	0.418
		13.1	0.431
		13.1	0.617
		13.3	0.490
		13.7	0.620
		13.8	0.424

MERCURY CONCENTRATIONS IN FISH TAKEN FROM STEINHAGEN RESERVOIR (cont.)

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED July 1994-May 1995			
STEINHAGEN RESERVOIR	LEGAL SIZE		
	LARGEMOUTH BASS	14.6	0.555
		14.7	0.831
		15.2	0.997
		16.1	0.584
		16.9	0.714
		17.3	0.976
		17.3	0.978
		17.3	0.853
		18.1	1.16
		18.9	1.22
	FRESHWATER DRUM	13.8	0.716
		18.5	0.935
		18.9	1.229
		20.9	0.705
		21.1	1.21
		21.2	1.19
		21.2	0.634
	WHITE BASS	15	1.21
		16.1	1.52
		16.3	1.33
		16.5	0.974
		17.7	0.94
	SPOTTED BASS	11.6	0.634

MERCURY CONCENTRATIONS IN FISH TAKEN FROM STEINHAGEN RESERVOIR (cont.)

LOCATION	SPECIES	SAMPLE LENGTH (inches)	TOTAL Hg (ppm)
SAMPLES COLLECTED July 1994-May 1995			
STEINHAGEN RESERVOIR	LEGAL SIZE		
	WHITE CRAPPIE	12.2	0.257
		13	0.529
		13.2	0.581
		14.2	0.673
		14.4	0.718
	SMALLMOUTH BUFFALO	16	0.206
	CHANNEL CATFISH	13.4	0.136
		19.3	0.385
	BLUE CATFISH	19.7	0.247
		24.2	0.288
		25.6	0.327
		25.8	0.418

SUMMARY OF RESULTS - STEINHEGAN RESERVOIR

FISH SPECIES(n)	AVG. SIZE	RANGE	MERCURY (ppm) AVERAGE	MERCURY (ppm) RANGE
LARGEMOUTH BASS(27)(ILLEGAL)	12"	(<14")	0.44	0.294-0.62
LARGEMOUTH BASS(10)(LEGAL)	19.4"	(14-22")	0.88	0.555-1.22
LARGEMOUTH BASS(8)	16.2"	(14-18")	0.811	0.555-0.997
LARGEMOUTH BASS(2)	18.5"	(>18")	1.19	1.16-1.22
WHITE BASS(5)	16.3"	15-18"	1.19	0.94-1.52
SPOTTED BASS(1)	11.6"		0.634	
FRESHWATER DRUM(7)	19.4"	13-22"	0.94	0.634-1.229
WHITE CRAPPIE(5)	13.4"	12-15"	0.55	0.257-0.718
BLUE CATFISH(4)	23.8"	19-26"	0.32	0.247-0.418
CHANNEL CATFISH(2)	16.3"	13-20"	0.26	0.136-0.385
SMALLMOUTH BUFFALO(1)	16"		0.206	

ALL FISH n=35 0.76 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 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 Steinhagen Reservoir 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 STEINHAGEN RESERVOIR FISH

SPECIES	NUMBER OF MEALS PER MONTH EQUIVALENT TO REFERENCE DOSE*
Largemouth Bass (all)	2.9
Largemouth Bass 14-18"	3.2
Largemouth Bass >18"	2.2
White Bass	2.2
Spotted Bass	4.1
Freshwater Drum	2.7
White Crappie	4.7
Blue Catfish	8.0
Channel Catfish	9.9
Smallmouth Buffalo	12.5
All fish	3.4

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 35 legal fish, representing eight commonly consumed species were collected from Steinhagen Reservoir in order to determine whether contaminant levels would indicate a public health concern. Methylmercury was detected in all samples at levels ranging between 0.136 and 1.52 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, white bass and freshwater drum from Steinghagen 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 Cypress Creek fish.

Recommendations for Consumption Limits:

Species	**# meals per month (8 oz)**
Largemouth Bass	3
White Bass	2
Freshwater Drum	3
All Combined	3.4

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.

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