

Health Implications of Mercury (Hg) in East Texas Lakes

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Background

- # There is increasing concern about Hg contamination in East Texas lakes.
 - # Hg has potential health impacts on susceptible populations (children, pregnant women, subsistence fisherman, fishing communities, and public health agencies).
 - # Some lakes have been posted or have had health advisories issued by State agencies.
-

The press releases

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Texas releases most mercury to air State also No. 1 in emissions of chemicals from manufacturing

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EPA: Texas plants are major mercury polluters

Government data show coal-fired power plants in
state lead the nation in emissions of toxic metal

Friday, May 24, 2002

By Kevin Carmody
AMERICAN-STATESMAN STAFF

Power plants are
Texas

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Mercury Threat to Kids Rising, Unreleased EPA Report Warns

February 20, 2003


By JOHN J. FIALKA
Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON -- A report warning that emissions of mercury by coal-fired power plants and other industrial sources poses an increasing health danger to young children has been delayed for nine months, while the Bush administration struggles with how to handle an increasingly contentious environmental problem.



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Fish - Water Pollution Reduction Site



HEALTHY FISH
Resources, Connections, and
Promoting Healthy Fish

Mercury In The News

For Media Release
April 21, 2003
Karen Hadden
512-797-8481

Fish from Austin Grocery Stores Exceed EPA Mercury Levels
After Fish Testing, Improved Public Notice and Mercury Emissions Reductions Needed

levels in many fish from Austin supermarkets exceed EPA safety thresholds
tent fish testing by the Sustainable Energy and Economic Development
ing results were announced today at a press conference held by
In limited, and Clean Water Action. The groups also
was lakes collected by the Texas Department of

"They don't realize that many fish
in," said Karen Hadden,
order to make sure
ns reductions."

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Fish advisories for Hg in Texas waters

Mercury Advisories

- ***B.A. Steinbagen Reservoir*** - largemouth bass, freshwater drum, white bass, hybrid white/striped bass
- ***Big Cypress Creek*** - largemouth bass, freshwater drum
- ***Caddo Lake*** - largemouth bass, freshwater drum
- ***Lake Daingerfield*** - largemouth bass
- ***Lake Kimball*** - all fish
- ***Lake Meredith*** - walleye
- ***Lake Pruitt (Black Cypress Bayou)*** - all fish
- ***Lake Ratcliff*** - largemouth bass
- ***Sam Rayburn Reservoir*** - largemouth bass, freshwater drum
- ***The Gulf of Mexico*** - king mackerel
- ***Toledo Bend Reservoir*** - largemouth bass, freshwater drum
- ***Upper Lavaca Bay*** - illegal to possess any species of fish or crabs from this area

NW TX



Gulf area





Caddo Lake



The newspapers, Caddo Lake

MONDAY, MAY 12, 2003 **Tyler Morning Telegraph** 5B

Heath Fair To Test Residents Years After Mercury Found

UNCERTAIN (AP) — It's been more than eight years since residents in this cloistered East Texas fishing community got wind of a secret their precious Caddo Lake was harboring in her murky, mysterious waters — she was contaminated with mercury.

Since 1995, the state health department has released advisories warning people not to eat largemouth bass and freshwater drum from Caddo — the only naturally formed lake in

point, we have not had the resources to do mercury assessments of people but that doesn't mean we couldn't do that in the future."

The state has said it hasn't been able to trace the source of the mercury in the lake, which straddles the Texas-Louisiana border, but environmentalists believe it comes from coal-fired power plants in the area. Texas power plants lead the nation in toxic mercury pollution with 9,302 pounds each year, accord-

among its 150 residents. It's a place where, if you don't show up with a boat and motor, folks wonder why you came.

The mayor is a skilled bass fisherman, as she will tell anyone who wanders into the grocery store where she has held court behind the counter for 14 years.

"Our lake has a lot of problems. At this point, it's a very unhealthy lake," says Betty Holder, a well-tanned wisp of a woman with a puff of brown hair. "I have eaten as healthy as anyone, but I don't know if I'm just about as healthy as anyone."

"I have eaten as healthy as anyone, but I don't know if I'm just about as healthy as anyone."

mere presence of a toxic element in the lake.

"I think they're just talking. There's no mercury in the fish," said 64-year-old fishing guide Henry Lewis. "They've got to prove it to me."

That's exactly what Shellman said he's trying to do with the health fair.

"Let's say everything comes out fine. Wouldn't it be nice to know?" he says.

No, says John Villanacci, director of the health department's Environmental Epidemi-

News-Journal.com
A product of the Longview News-Journal, Longview, Texas

Editorial ... 5-14-03

Caddo Lake: Do more extensive testing

After more than eight years, retesting of Caddo Lake fish for mercury contamination is overdue. The failure of the Texas Legislature and the state Department of Health to plan and fund an appropriate public health safety program is reprehensible.

In 1995, the state health department issued advisories warning people not to eat largemouth bass and freshwater drum from Caddo. Fish that contain high levels of mercury can cause a variety of ailments, including damage to the nervous system, birth defects and, in high doses, death. The advisories specifically caution women who are pregnant to limit their intake of fish from the lake.

That's the last we've seen of state health officials in regard to this problem. We don't know if the levels of mercury have gone up or down. We don't know if any people have experienced health problems as a result of this contamination.

Dwight Shellman, the executive director of the Caddo Lake Institute, wants to hold a health fair this fall that would test residents' blood for cancer, diabetes and, for the first time, take hair samples to test for mercury. He says he has been asking the state for years to do the screening.

That seems like a reasonable request, given the health dangers of mercury poisoning.

News-Journal.com
A product of the Longview News-Journal, Longview, Texas

5-31, State: Despite mercury alerts, Caddo Lake residents still relish their catches

AP

UNCERTAIN — Mayor Betty Holder just loves fishing for bass and will tell you, from across the counter of her grocery store, that nothing — not even the mercury in Uncertain's Caddo Lake — keeps her from throwing in her line.

"I have eaten many bass and I think I'm just about as healthy as anyone," said Holder, a well-tanned wisp of a woman. "And if I wanted, I'd have bass tonight and I wouldn't be afraid to."

In fact, many folks in Uncertain — a resort town where, if you show up without a rod and reel, people will wonder why you are here at all — are fearless about eating what they pull from the lake's murky, cypress-covered coves and meandering bayous.

Dwight Shellman wants to do something about that.

Shellman, a part-time resident who heads the nonprofit Caddo Lake Institute dedicated to studying the lake, wants to have people living around Caddo Lake tested for mercury. At the very least, the testing would make them more aware of the dangers, he said.

What to believe?



© Tammy Croner Campbell

Mercury: A toxic heavy metal that causes learning disabilities, tremors, birth defects, attention deficits, mental retardation and even death.

The Awful Truth

Mercury Advisories

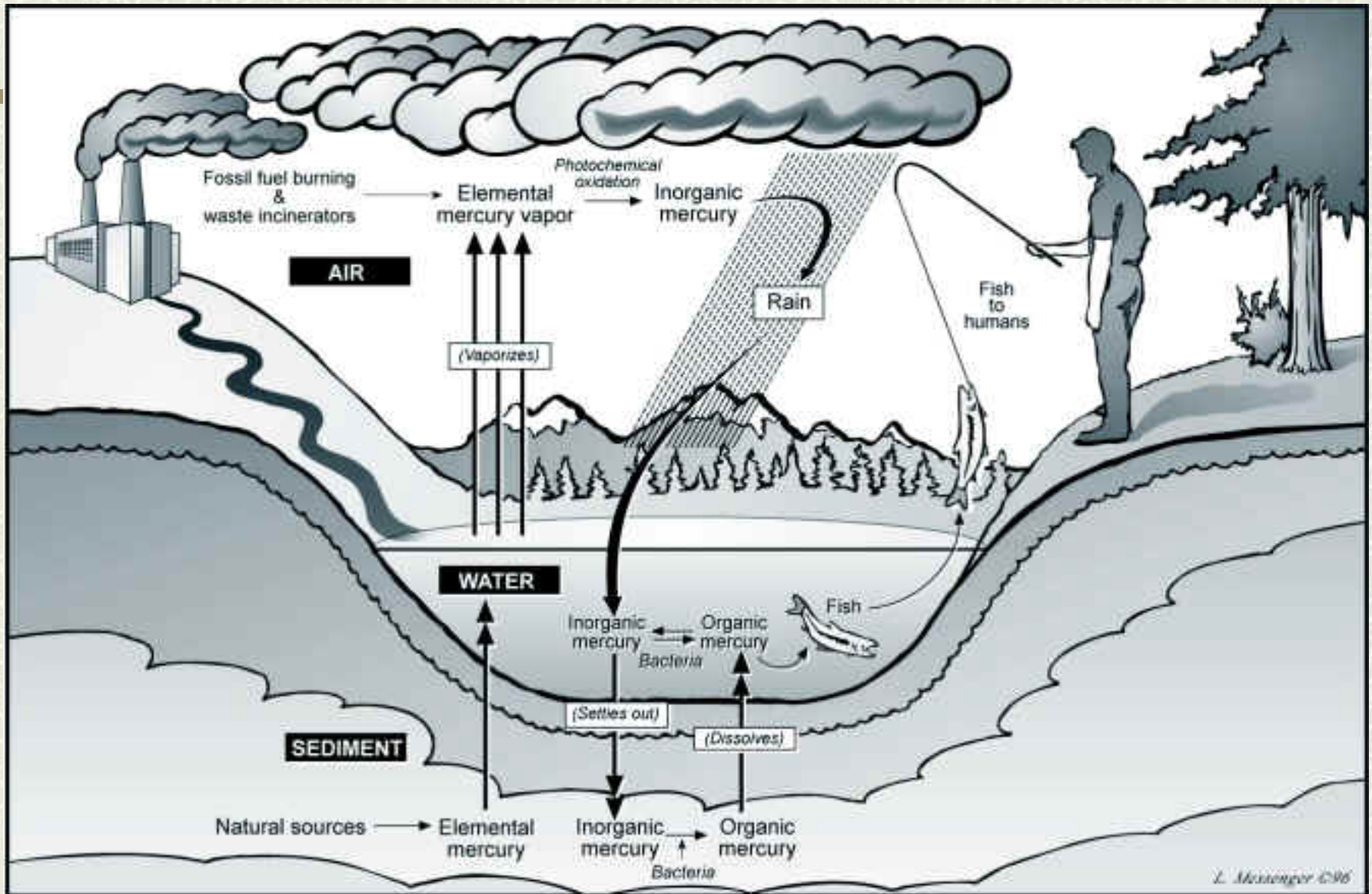
Outline of presentation

- # The Hg cycle - how Hg enters our food chain
 - # Sources of Hg in local lakes
 - # Methods for exposure assessment
 - # Mercury concentrations in lakes, fish
 - Reference values
-

Other topics

- # Factors affecting Hg accumulation in fish
 - # TDH risk assessments-fish advisories
 - # Assessment of exposure in humans
 - # Risks to susceptible populations
-

The Hg cycle



Description, Hg cycle

- # Mercury enters the atmosphere as Hg vapor
 - Incineration, power plants, natural sources
 - Evaporation from soil, lakes
 - # Mercury is photo-oxidized to inorganic Hg
 - # Inorganic Hg deposited in lakes and soil from rain
 - Other agents such as oxides of Nitrogen and Sulfur lead to acid rain
-

The cycling of Hg in lakes

- # Inorganic Hg cycles in lake and sediment
 - # Microflora convert inorganic Hg to methyl Hg (organic Hg)
 - # Methyl Hg accumulates up the food chain concentrating in the biggest game fish
 - # Fisherman catches fish, eats fish
-

Sources of mercury in local lakes

- # Widespread mercury contamination in most East Texas lakes
 - # Not tied to any point source or direct discharge
 - # Most likely:
 - Coal burning power plants
 - Incineration
 - # Seems to be associated with acidic lakes
 - Is this related to acid rain?
-

Exposure assessment methods

The dose makes the poison - Paracelsus

Assess exposure by

- Measurement of Hg in water

- Where in lake?

- How deep?

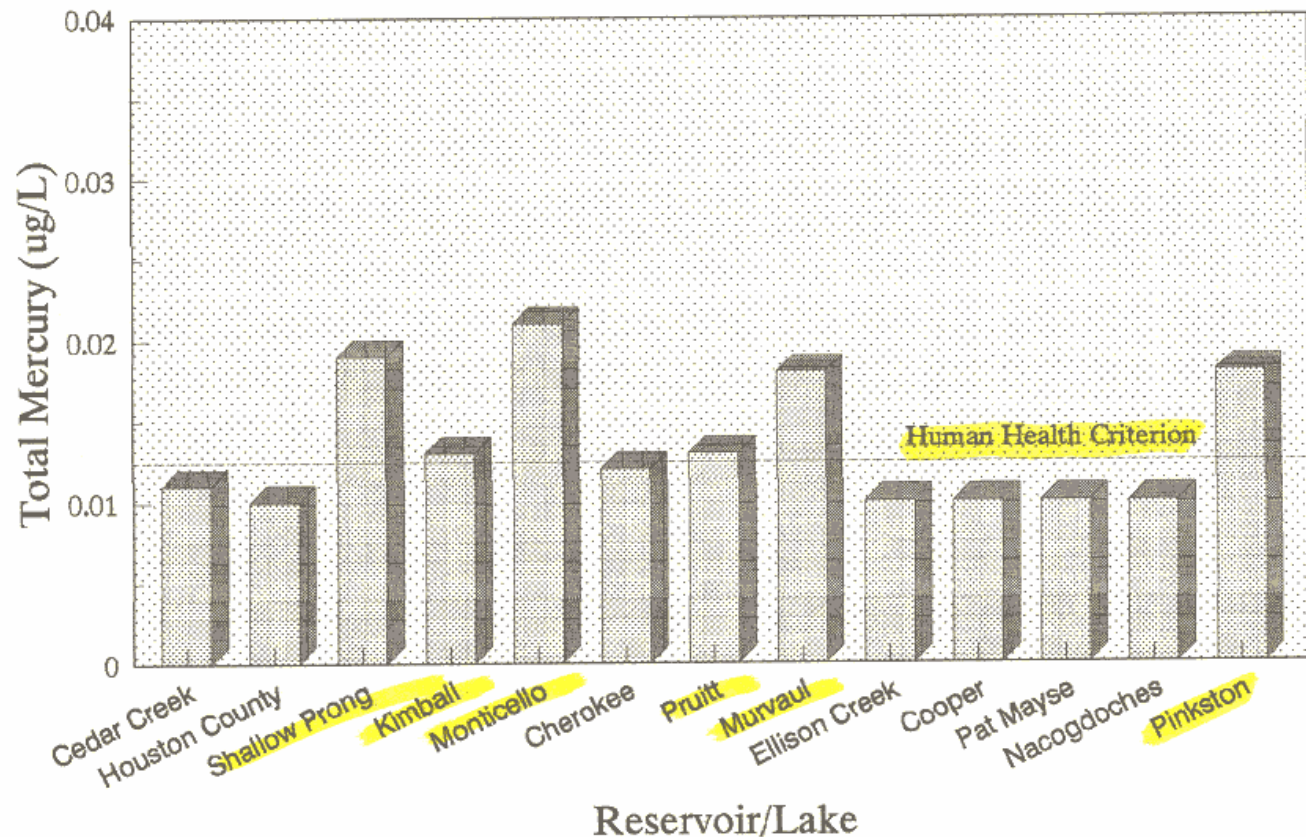
- Measurement of Hg in fish

- Whole fish: dilutes value

- Edible filet: represents human consumption

Total mercury data in East Texas lakes

Human health reference value: $0.0122 \mu\text{g/L}$ (Twidwell, TCEQ, 2000)



soFigure 11. Comparison of Total Mercury in Water Concentrations From 13 East Texas Reservoirs and Lakes Against the Human Health Criterion for Freshwater

Reference values, Hg in water

TCEQ

- 0.0122 $\mu\text{g/L}$

WHO

- 0.001 mg/L (1 $\mu\text{g/L}$)

EPA MCL for drinking water

- 0.002 mg/L (2 $\mu\text{g/L}$)
-

Mercury data in fish from lakes

- # Prior to 1993, total fish Hg – no problem found
 - # 1993 – elevated fish Hg in edible portions in LA, AR lakes
 - # Testing in TX using edible portions reveal widespread Hg in fish above advisory levels
-

Reference values for fish

TCEQ

- 0.65 mg/kg (ppm) total Hg in large predator fish (game fish) (0.7 sometimes listed)

FDA action level

- 1 ppm (mg/kg) methylmercury
 - Limit fish consumption to 7 oz per week
 - 0.5 ppm
 - Limit fish consumption to 14 oz per week
-

Fish data

(Twidwell, TCEQ, 2000)

- # Only eatable fish tissue analyzed
 - # Hg detected in 13 East Texas lake, mostly in large mouth bass.
 - # Levels exceeded reference levels in Pruitt lake and Kimball reservoir.
 - # Hg levels higher in larger predator fish
-

Fish data by size

(Reference value: 0.65 mg/kg, Twidwell, TCEQ 2000)

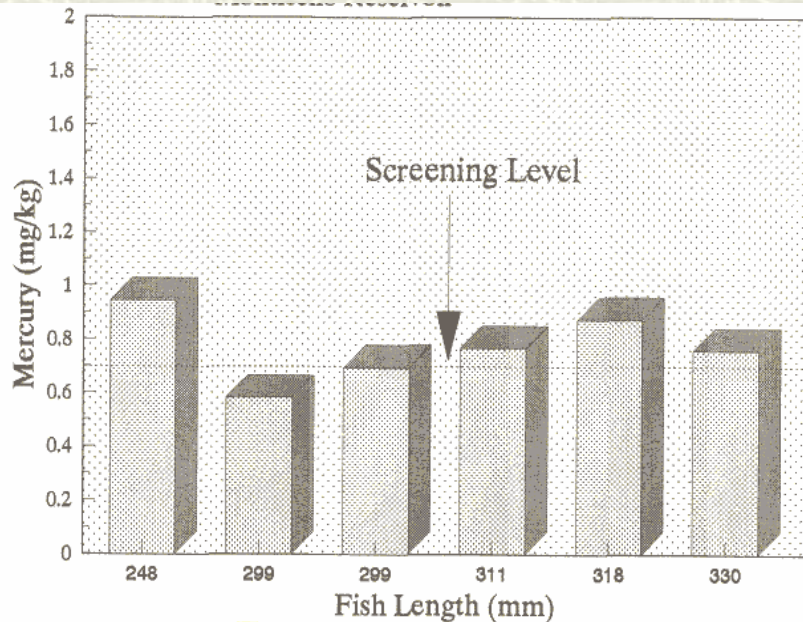


Figure 21. Mercury in Muscle Tissue of Largemouth Bass From Pruitt Lake (Black Cypress Bayou)

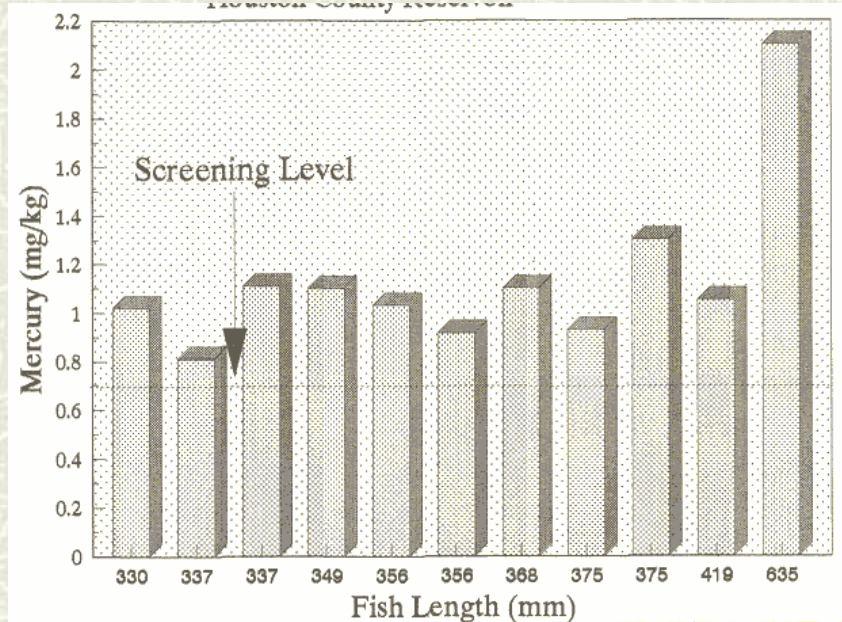


Figure 18. Mercury in Muscle Tissue of Largemouth Bass From Kimball Reservoir

Caddo Lake fish data

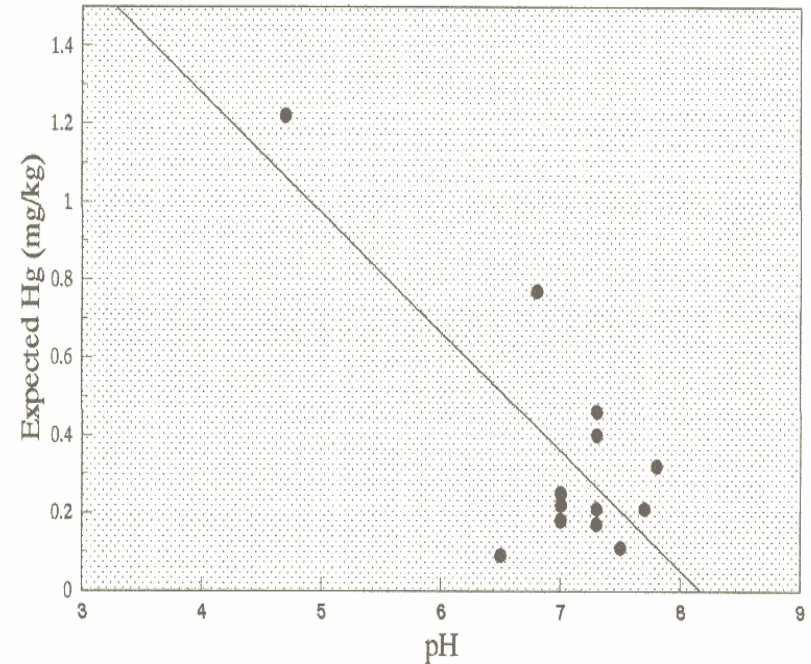
(Ref value: 0.65 mg/kg, TDH Risk Assessment, 1995)

Fish species	Size, in	Total Hg, mg/kg (range)
Largemouth bass	14-18 (illegal)	0.67 (0.526-0.883)
Largemouth bass	> 18 (legal)	1.11 (0.61 – 1.63)
Freshwater drum	17-27	1.27 (0.92 – 1.53)
Chain pickerel	19-21	0.96 (0.75-1.16)
Channel catfish	14-21	0.21 (0.10 – 0.36)

Effect of pH on Hg accumulation in fish

(Twidwell, TCEQ, 2000)

- ✚ When expected Hg concentration in fish is modeled, major factor is lake with acid pH
 - Based on expected Hg concentration in fish, pH explains 51% of fish Hg levels
 - Correlation of pH with fish Hg shown at right



Other contributing factors

(Twidwell, TCEQ, 2000)

- # Total organic carbon (organic matter)
- # Other water chemistry factors
- # Combination of pH and TOC explains 61% of fish Hg levels

Pearson Correlation (r) of Expected Largemouth Bass Mercury Concentration (EHg), and Level of Significance (P) with Water and Sediment Variables From East Texas Study Reservoirs/Lakes

Variable	r	P
Field Measurements		
pH	-0.743	0.004
Water Chemistry		
Hardness	-0.690	0.009
Total Organic Carbon	0.674	0.012
Calcium	-0.620	0.024
Total Dissolved Solids	-0.609	0.027
Sulfate	-0.598	0.031
Magnesium	-0.599	0.031
Sediment Chemistry		
Manganese	-0.593	0.033

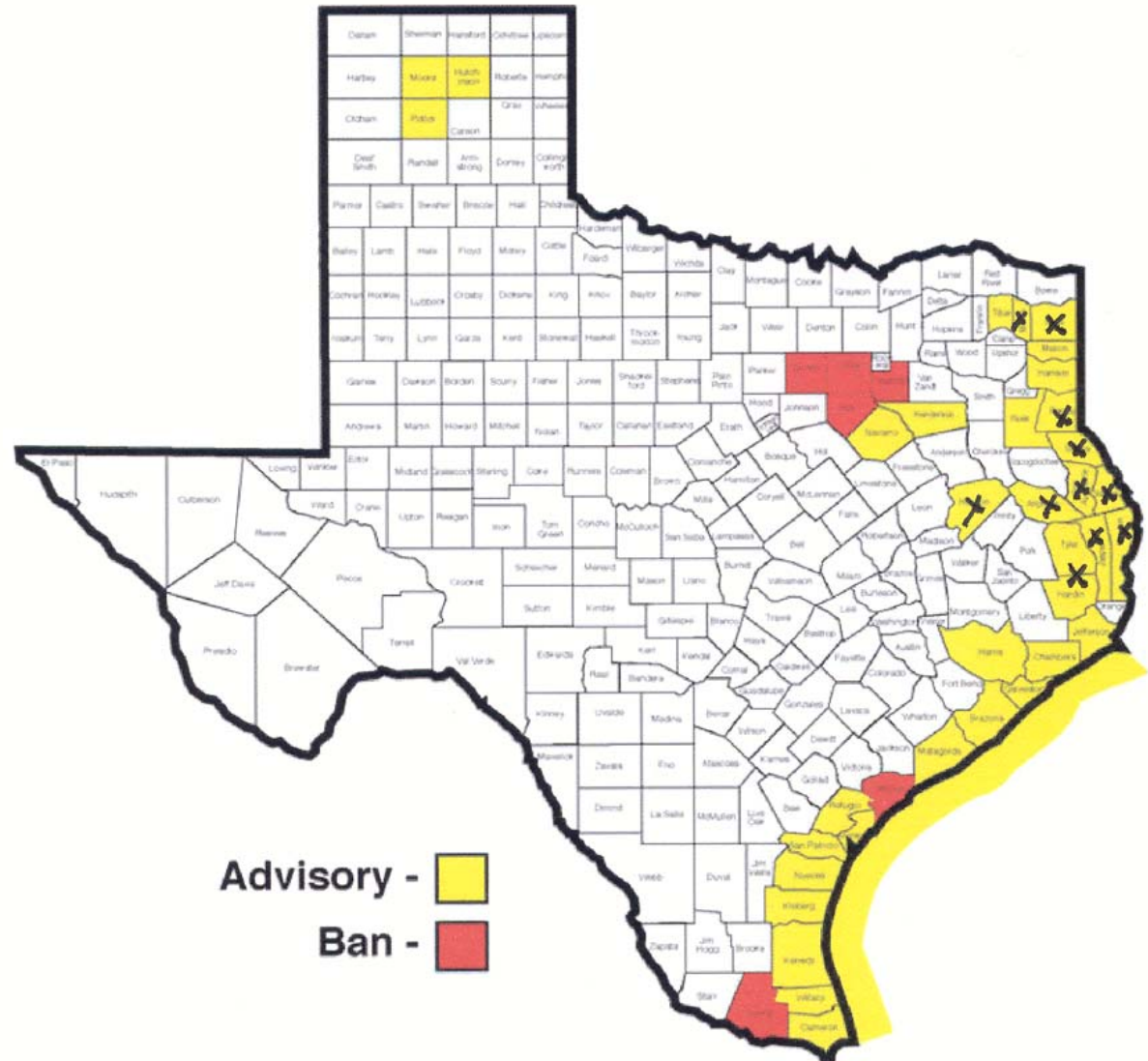
No correlation of Hg in lake with Hg in fish

(Twidwell, TCEQ, 2000)

Examples

- Pruitt and Kimball lakes
 - Moderate Hg in water
 - Highest pH, TOC, highest levels of Hg in fish
 - Other lakes
 - Moderate Hg in water
 - Normal pH, lower TOC, lower levels of Hg in fish
-

Mercury
shown by (x)



TDH fish advisories

Based on
risk
assessments
prepared by
TDH

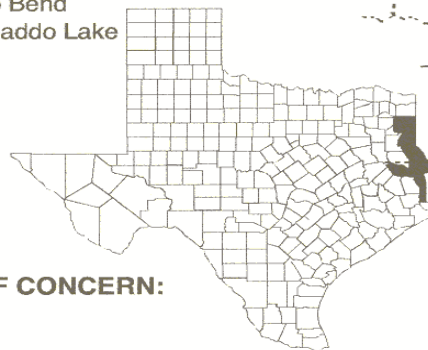
B.A. STEINHAGEN RESERVOIR, SAM RAYBURN RESERVOIR, BIG CYPRESS CREEK, TOLEDO BEND RESERVOIR AND CADDO LAKE

ADV-12 Issued November 2, 1995

SABINE, SHELBY, PANOLA, JASPER, ANGELINA, SAN AUGUSTINE, MARION, HARRISON, NEWTON, AND TYLER COUNTIES

ADVISORY AREA:

All waters of the B.A. Steinhagen Reservoir, Sam Rayburn Reservoir, and Big Cypress Creek. All Texas waters of Toledo Bend Reservoir and Caddo Lake



CHEMICAL OF CONCERN:

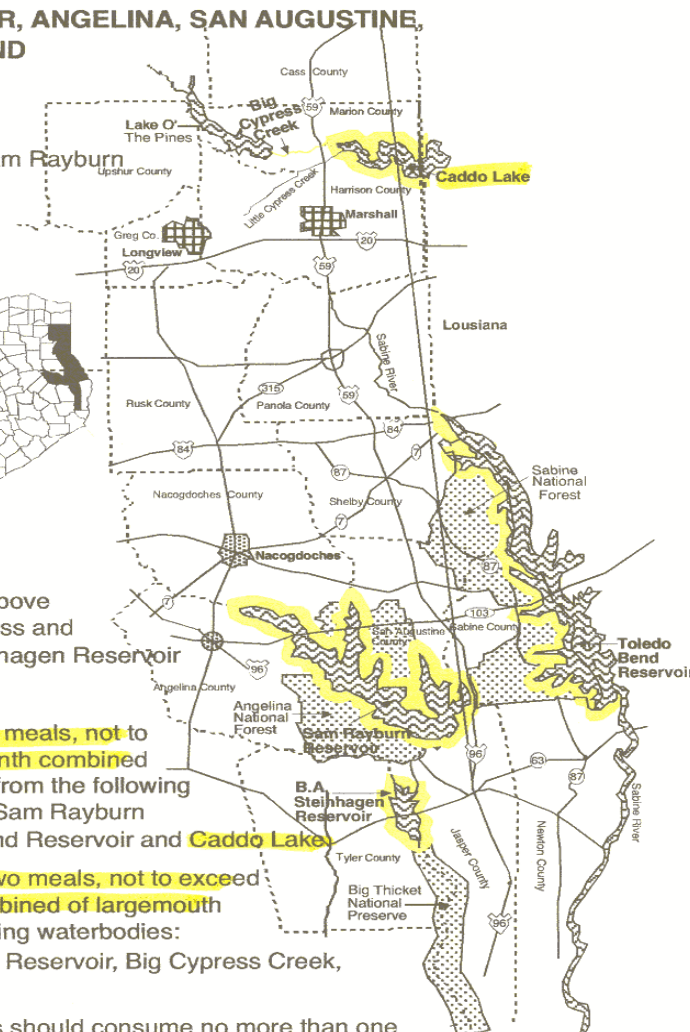
Mercury (Hg)

SPECIES AFFECTED:

Largemouth bass and freshwater drum in the above mentioned reservoirs, creek and lake. White bass and hybrid white/striped bass taken from B.A. Steinhagen Reservoir

CONSUMPTION ADVICE:

- 1) Adults should consume no more than two meals, not to exceed 8 ounces of fish per meal, per month combined of largemouth bass and freshwater drum from the following waterbodies: B.A. Steinhagen Reservoir, Sam Rayburn Reservoir, Big Cypress Creek, Toledo Bend Reservoir and Caddo Lake.
- 2) 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 the following waterbodies: B.A. Steinhagen Reservoir, Sam Rayburn Reservoir, Big Cypress Creek, Toledo Bend Reservoir and Caddo Lake.
- 3) Of the meals recommended above, adults should consume no more than one meal, not to exceed 8 ounces of fish per meal, per month of white bass or hybrid/striped bass from B.A. Steinhagen Reservoir.
- 4) Of the meals recommended above, children should consume no more than one meal, not to exceed 4 ounces of fish per meal, per month of white bass or hybrid white/striped bass from B.A. Steinhagen Reservoir.



What is the basis or reference value?

Older risk assessments (like Caddo Lake)

- Based on EPA reference dose of 0.0003 mg/kg/day with a 10 x margin of safety
- Screening value is 0.65 mg/kg (ppm) for women of childbearing age consuming 30 grams per day.

Newer risk assessments

- Based on human exposure data and observed health effect. Same number
-

Exposure assessment in humans

- # Baseline data from NHANES study

- # Body burden measurements

 - Blood

 - Urine

 - Hair

Reference values, Hg in blood

Table 8. Mercury

Geometric mean and selected percentiles of blood concentrations (in $\mu\text{g/L}$) for males and females aged 1 to 5 years and females aged 16 to 49 years in the U.S. population, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Age group								
1-5 years (males and females)	.343 (.299-.393)	< LOD	< LOD	.300 (.200-.300)	.500 (.500-.600)	1.40 (1.10-2.00)	2.30 (1.40-3.20)	705
Males	.317 (.270-.372)	< LOD	< LOD	.200 (.200-.300)	.500 (.500-.600)	1.10 (.800-1.50)	2.10 (1.10-3.50)	387
Females	.377 (.311-.457)	< LOD	< LOD	.200 (.200-.300)	.800 (.500-1.00)	1.60 (1.20-2.30)	2.70 (1.80-4.80)	318
16-49 years (females)	1.02 (.860-1.22)	.200 (<LOD-.200)	.400 (.400-.600)	.900 (.800-1.20)	2.00 (1.60-2.70)	4.90 (4.00-6.10)	7.10 (5.60-9.90)	1709
Race/ethnicity (females, 16-49 years)								
Mexican Americans	.820 (.691-.974)	.200 (<LOD-.200)	.400 (.300-.500)	.900 (.700-1.00)	1.40 (1.20-1.90)	2.60 (2.10-3.40)	4.00 (2.70-5.50)	579
Non-Hispanic blacks	1.35 (1.11-1.64)	.300 (.200-.500)	.600 (.500-.900)	1.30 (1.10-1.60)	2.60 (1.90-3.30)	4.80 (3.30-6.60)	5.90 (4.40-10.9)	370
Non-Hispanic whites	.944 (.765-1.17)	< LOD	.400 (.300-.400)	.900 (.700-1.10)	1.90 (1.40-2.90)	5.00 (3.40-6.50)	6.90 (5.40-10.6)	588

< LOD means less than the limit of detection, which is 0.14 $\mu\text{g/L}$.

Reference values, Hg in urine

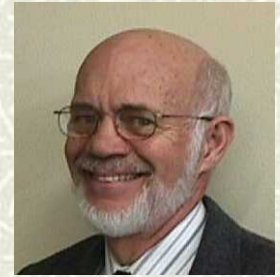
Table 9. Mercury

Geometric mean and selected percentiles of urine concentrations (in µg/L) for females aged 16 to 49 years in the U.S. population, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Age group (females) 16-49 years	.720 (.642-.808)	< LOD	.310 (.260-.370)	.770 (.650-.880)	1.62 (1.46-1.84)	3.15 (2.68-3.58)	5.00 (3.86-5.55)	1748
Race/ethnicity (females, 16-49 years)								
Mexican Americans	.724 (.607-.864)	< LOD	.280 (.240-.350)	.650 (.520-.890)	1.69 (1.33-2.35)	3.68 (3.10-4.45)	5.62 (4.68-7.51)	595
Non-Hispanic blacks	1.07 (.888-1.29)	< LOD	.450 (.360-.650)	1.03 (.870-1.34)	2.30 (1.85-2.89)	4.81 (3.41-6.08)	6.98 (5.13-9.64)	381
Non-Hispanic whites	.657 (.576-.748)	< LOD	.280 (.210-.340)	.710 (.560-.810)	1.50 (1.31-1.77)	2.84 (2.35-3.32)	4.05 (3.26-5.24)	594

< LOD means less than the limit of detection, which is 0.14 µg/L.

Reference values, Hg in hair



- # No established values from NHANES
- # Values from literature
 - Drasch, 1997 (Germany) median 0.25 $\mu\text{g/g}$
 - From 150 cadavers with no known exposure to Hg.
 - Grandjean, 1992 (Faroe Islands) median 0.8 $\mu\text{g/g}$
 - From 18 islanders with no fish consumption
 - Japanese studies – less than 2 $\mu\text{g/g}$
 - Known to be higher in metals than other populations

Health effects from consumption of Hg in the diet

Neurotoxic effects most common in adults.

- Tremor, paresthesia (numbness) , ataxia (unstable), malaise, visual disturbances

Prenatal exposures, infants

- Developmental delays
 - Neurobehavioral changes
-

Effects from fish consumption

Three studies with inconclusive results

Faroe Islands

- High Hg in fish and whale food
- Some developmental delays, failed to account for other chemical exposures

Seychelles

- No effects seen at hair Hg levels seen above

New Zealand

- Some effects on psychological and developmental tests, no effects if eliminate one outlier
-

Health effects in susceptible populations

Pregnant women

- Concerns are for developmental disorders in the fetus

Children, infant to teen

- Children are more susceptible to developmental disorders and behavioral changes as their systems are developing
-

Subsistence fishermen

- # Fish advisories are for casual fish eaters
 - Example: Caddo Lake, 2 fish meals a month at 2 week intervals for adults (8 oz), children (4oz)
 - # What about a subsistence fisherman that eats an 8 ounce serving every day?
 - Possibility of substantial dose of Hg and more chronic conditions associated with Hg poisoning
 - Fish studies above not conclusive
-

What about others?

- # What about the pregnant spouse of the subsistence fisherman?
 - # What about the risks to children of these families?
 - # What about risks to native Americans?
-

Conclusions

- # Hg in fish pose little risk to most casual eaters of fish, even in those lakes with fish advisories
 - # Hg in fish may pose a significant risk to children and to subsistence fisherman and their families
-



Southwest Center
Pediatric Environmental Health

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