

HEALTH CONSULTATION

Lake Daingerfield

Daingerfield, Morris County, TEXAS 75638

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Prepared by

Texas Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

The Texas Parks and Wildlife Department (TPWD) recently surveyed Lake Daingerfield in Morris County for the presence and extent of mercury contamination in fish tissue. That survey revealed elevated mercury levels in largemouth bass [1]. Mercury occurs naturally in the earth's crust but human activity, namely burning fossil fuels, is a major source of mercury deposited into the environment. Bacteria in soil and water then transform inorganic mercury into methylmercury, an organic form of the element that is highly toxic to humans. Other investigators have reported that most of the mercury in marine life is methylmercury [2]. Seafood absorbs and concentrates methylmercury from ambient waters and from other forms of marine life, storing the contaminant primarily in muscle tissues. Methylmercury concentrations in seafood may thus be many times higher in the tissues of marine vertebrates than in water. Methylmercury is exceptionally toxic to the immature nervous system, producing adverse effects on the developing brain that vary from subtle to severe depending upon the circumstances of exposure [2]. Consumption of mercury-contaminated seafood is typically the main source of exposure to this developmental toxicant [2]. Therefore, regular consumption of fish containing high concentrations of methylmercury, especially by infants, young children, or pregnant or lactating women, may result in developmental effects on fetuses, infants and children. Other adverse health effects are also possible in both adults and children. Consequently, the Texas Natural Resource Conservation Commission (TNRCC) requested that the Texas Department of Health (TDH) evaluate Lake Daingerfield for potential public health hazards from consumption of contaminated fish.

Lake Daingerfield is a picturesque 80-acre lake located in Daingerfield State Park just outside the city limits of Daingerfield in northeast Texas. Daingerfield (population 2,517 in 2000) is a small town in Morris County (13,000 population) near Texarkana, Texas (population 34,000) [3]. Public access facilities at Lake Daingerfield include a fishing pier, launching ramp, boat dock, and fish-cleaning facilities. Fish species commonly found in the lake are crappie, perch, catfish, bass, and chain pickerel [4]. Recreational fishing is a popular pastime at Lake Daingerfield. Subsistence fishing also may occur there.

DISCUSSION

Sample Collection and Data Analysis

To evaluate potential health risks to recreational and subsistence fishers who consume environmentally contaminated seafood, the Texas Department of Health (TDH) collects and analyzes seafood samples from the state's public waters. These samples are representative of available species, trophic levels, lipid content, and legal sizes. When it is appropriate and practical, TDH collects samples from several locations within a water body to characterize the distribution of contaminants in seafood from that water body. It is important to note that people eating contaminated seafood are most likely exposed over the long term through consumption of one or more species contaminated with low concentrations of environmental pollutants. Consequently, people exposed to

environmental contaminants through consumption of seafood are unlikely to display acute or overt toxicity. Instead, subtle, delayed, or chronic adverse health effects may be more commonly expected. Thus, the main purpose of TDH contaminant studies is to examine human exposure to species commonly consumed over time. TDH typically uses average concentrations of chemical contaminants across species and/or sites to assess the probability of adverse health outcomes from low-level, long-term exposure. Despite the possibility that using average concentrations to estimate risk may lead to over- or underestimates of individual point-in-time exposures, use of average concentrations of contaminants is a reasonable approach to predicting long-term exposure to low levels of toxicants. Although TDH usually utilizes average concentrations to determine likely exposure doses, the agency does use other statistical procedures to assess the likelihood of adverse health effects from consumption of contaminated seafood when these procedures are appropriate.

The Seafood Safety Division collected seventeen fish samples from Lake Daingerfield in late 2000 (one blue catfish, five channel catfish, and eleven largemouth bass). All samples met the minimum legal size [4]. TDH analyzed edible fillets (skin off) of the blue catfish and one largemouth bass for seven metals (arsenic, cadmium, copper, lead, mercury, selenium, and zinc); volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); pesticides; and polychlorinated biphenyls (PCBs). The laboratory assayed the fifteen other fish for mercury only.

Fourteen of seventeen fish collected from Lake Daingerfield in 2000 contained mercury (Table 1). The blue catfish also contained very low levels of copper, selenium, zinc, chlordane, and p,p'-DDE, while the largemouth bass contained very low levels of cadmium, selenium, and zinc. Other than DDE in the blue catfish, the laboratory reported no pesticides at concentrations above the reporting limits. No VOCs, SVOCs or PCBs were detected in the fish collected for this study.

Deriving Health-Based Assessment Comparison Values (HACs)

TDH evaluated chemical contaminants in fish from Lake Daingerfield by comparing average concentrations of chemical contaminants with health-based assessment comparison (HAC) values for non-cancer and cancer endpoints. TDH used the U.S. Environmental Protection Agency's (USEPA) reference doses (RfDs) or the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk levels (MRLs) to derive the noncancer HAC values. RfDs [5] and MRLs are estimates of daily exposures to contaminants that are unlikely to cause adverse noncancer health effects, even if exposure occurs over a lifetime. The cancer risk comparison values in this health consultation are based on the USEPA's chemical-specific cancer slope factors (SF), an estimated lifetime risk of 1 excess cancer in 10,000 (1×10^{-4}) people exposed, and an exposure period of 30 years. TDH utilized standard assumptions for body weight (70 kilograms, adult; 35 kilograms, child) and fish consumption (30 grams per day, adult; 15 grams per day, child) to calculate the HAC values [6]. Many of the constants employed in calculating HAC values have margins of safety built into them. Thus, adverse health effects will not necessarily occur simply because concentrations of toxicants in seafood exceed HAC

values. Moreover, health-based assessment comparison values do not represent a sharp dividing line between safe and unsafe exposures. The strict demarcation between acceptable and unacceptable levels of exposure or risk is primarily a tool used by risk managers to ensure protection of public health. TDH views it as unacceptable when consumption of one or fewer meals per week would result in an exposure that exceeds a HAC value or other measure of risk

Addressing the Potential for Cumulative Effects

When multiple chemicals affect the same target organ, or when several chemicals present in seafood could be carcinogens, TDH assumes that adverse health effects are cumulative (i.e., additive) [7]. To evaluate the potential public health impact of additive noncancerous health effects, TDH calculates a hazard index (HI), which is the sum of the ratios of the estimated exposure doses for each contaminant divided by its respective RfD or MRL. A HI of less than 1 suggests that exposure to combined contaminants at specified concentrations is unlikely to cause adverse noncancerous health effects, even if that exposure continues for many years. On the other hand, while a HI greater than 1 does not necessarily mean exposure to the contaminants will result in adverse health effects, it does suggest that the agency might consider some public health intervention. To estimate the potential excess lifetime cancer risk from simultaneous exposure to multiple carcinogens, TDH calculates the cumulative risk by summing the estimated risk for each contaminant. TDH recommends limiting consumption of seafood contaminated with multiple carcinogenic chemicals to amounts resulting in an estimated theoretical lifetime cancer risk of not more than 1 excess cancer in 10,000 persons exposed through seafood.

Addressing the Unique Vulnerabilities of Children

TDH recognizes that fetuses, infants, and children may be uniquely vulnerable to the effects of toxic chemicals and that any such vulnerabilities demand special attention. Windows of vulnerability, i.e., critical periods, exist during development. These critical periods are particularly evident during early gestation, but also appear throughout pregnancy, infancy, childhood, and adolescence—indeed, at any time when toxicants can permanently impair or alter structure or function [8]. Unique childhood vulnerabilities result from the fact that at birth, many organs and body systems, including the lungs, immune, endocrine, reproductive, and nervous systems, have not achieved structural or functional maturity; these organ systems continue to develop throughout childhood and adolescence. Children can also differ from adults in absorption, metabolism, storage, and excretion of toxicants, any of which could result in higher biologically effective doses to target organs. Children's exposure to toxicants may be more extensive than that of adults because children consume more food and liquids in proportion to their body weight than do adults [8]. They can also ingest toxicants through breast milk—often unrecognized as an exposure pathway. Thus, children may experience toxic effects at a lower exposure than would affect adults. Stated differently, children could react more severely than would adults to an equivalent exposure dose [8]. Children may also be more prone than are adults to developing certain cancers from chemical exposures. Therefore, in

accordance with ATSDR's *Child Health Initiative* [9] and USEPA's *National Agenda to Protect Children's Health from Environmental Threats* [8], TDH evaluated the potential public health hazards to children who eat fish from Lake Daingerfield. Based on this health consultation, TDH has determined that consumption of largemouth bass from Lake Daingerfield **poses a public health hazard for children.**

Characterizing the Risk

Assessing the Risk of Noncancerous Health Effects

Mercury (Hg) was measurable in fourteen of seventeen samples collected from Lake Daingerfield. However, species differences were evident (Table 1). The average mercury concentration in all species was 0.563 mg/kg. The average mercury concentration in catfish was 0.289 mg/kg, while the average concentration of mercury in largemouth bass was 0.712 mg/kg (95% CI: 0.596-0.829 mg/kg). These data suggest that regular consumption of largemouth bass from Lake Daingerfield could pose an unacceptable risk to those who eat fish from the reservoir. On the other hand, consumption of channel catfish from Lake Daingerfield should not pose an unacceptable risk

Assessing the Risk of Cancer

Few published reports exist of cancer in humans after exposure to methylmercury [2]. Although methylmercury has been associated with neoplastic changes in the kidneys of experimental animals, those changes generally occurred only at doses that caused significant systemic toxicity and were associated with alterations in structure or function that were classified as threshold effects [2]. Thus, although the USEPA determined that methylmercury is a possible human carcinogen (Group C) [2], it is likely that systemic health effects would be observed at methylmercury exposures much lower than those required for tumor formation. Long-term administration of methylmercury to experimental animals produces overt symptoms of neurotoxicity at daily doses an order of magnitude lower than those required to induce tumors in mice. Therefore, USEPA has not derived a slope factor for methylmercury. For this reason, TDH did not assess potential carcinogenic risk from consuming fish from Lake Daingerfield that contain methylmercury.

Assessing cumulative effects

Mercury was the only contaminant of concern identified in fish from Lake Daingerfield. Therefore, TDH did not evaluate samples from this reservoir for potential cumulative effects.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

1. Largemouth bass from Lake Daingerfield contain mercury at levels that, if regularly consumed, **poses a public health hazard.**

2. Catfish from Lake Daingerfield contain relatively low levels of mercury. Consumption of catfish from Lake Daingerfield currently **does not pose a public health hazard**.

RECOMMENDATIONS

TDH uses established criteria for issuing fish consumption advisories. When analysis confirms that consumption of one or fewer meals per week (adults: eight ounces; children: four ounces) would result in exposures that exceed health-based assessment guidelines established by the department, risk managers may recommend that the Commissioner of Health issue a consumption advisory or an order to close a water body to possession of seafood. Based on this health consultation, the Seafood Safety Division and the Environmental Epidemiology and Toxicology Division recommend that:

1. TDH advises people to consume **no more than two meals** (adults: 8 ounces; children 4 ounces) **per month of largemouth bass** from Lake Daingerfield.
2. TDH advises that people may consume catfish from Lake Daingerfield without restriction.
3. To the extent that agency resources allow, TDH continues to monitor mercury levels in fish from Lake Daingerfield.

PUBLIC HEALTH ACTION PLAN

Information about TDH fish consumption advisories and bans is available to the public through the TDH Seafood Safety Division (512-719-0215) or on the World Wide Web at URL: <http://www.tdh.state.tx.us/bfds/ssd>. Health consultations dealing with contaminants in seafood from Texas waters may also be available to the public from the Agency for Toxic Substances and Disease Registry at URL: http://www.atsdr.cdc.gov/HAC/PHA/region_6.html. The Texas Department of Health provides this information to the U.S. Environmental Protection Agency (<http://fish.rti.org>), the Texas Natural Resource Conservation Commission (TNRCC; <http://www.tnrcc.state.tx.us>) and to the Texas Parks and Wildlife Department (TPWD; <http://www.tpwd.state.tx.us>). Each year, the TPWD informs the fishing public of closure areas in an official hunting and fishing regulations booklet [4] that is available at some state parks and establishments that sell fishing licenses.

For questions or concerns about the scientific information in this health consultation, the reader may telephone the Seafood Safety Division (512-719-0215) or the Environmental Epidemiology and Toxicology Division (512- 458-7269) at the Texas Department of Health. Toxicological information is also available from the Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology, at the toll-free number (800-447-1544) in Atlanta, Ga.

Table 1. Mercury concentrations (mg/kg) in catfish and largemouth bass from Lake Daingerfield in 2000.				
Species	Number Affected/ Sampled	Average Concentration (Min-Max) [*]	Health Assessment Comparison Value [†]	Basis for Comparison Value
Catfish	3/6	0.289 (nd-0.803)	0.700 mg/kg	ATSDR MRL: 0.0003 mg/kg/day
Largemouth bass	11/11	0.712 (0.532-1.060)		
All Species	14/17	0.563 (nd-1.060)		

^{*}Minimum concentration to Maximum concentration (to calculate the range, subtract the minimum concentration from the maximum concentration).

[†]Derived from the Minimal Risk Level for noncarcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day.

REFERENCES

1. Mills, R. Texas Parks and Wildlife. Personal Communication, 2000.
2. [IRIS] Integrated risk information system. United States Environmental Protection Agency. Office of Research and Development, National Center for Environmental Assessment. 2001. Available at URL: <http://www.epa.gov/iris>
3. [USCB] United States Census Bureau. 2000 decennial census data. Washington, D.C.: 2001. Available at URL: <http://www.census.gov>.
4. [TPWD] Texas Parks and Wildlife 2000-2001 Outdoor Annual: Official Hunting and Fishing Regulations. Texas Monthly Custom Publishing. Dallas, TX: 2000.
5. [USEPA] US Environmental Protection Agency. Glossary of risk assessment-related terms. 1994.
6. [USEPA] US Environmental Protection Agency. Guidance for assessing chemical contaminant data for use in fish advisories, Volume 2. Risk assessment and fish consumption limits, 3rd ed. Washington D.C: 2000. Available at URL: <http://www.epa.gov>.
7. [USEPA] US Environmental Protection Agency. Guidelines for the health risk assessment of chemical mixtures. Office of Research and Development. Washington, D.C: 1986.
8. [USEPA] US Environmental Protection Agency. Strategy for research on environmental risks to children, section 1.2. Office of Research and Development, Washington D.C.: 2000.
9. [ATSDR] Agency for Toxic Substances and Disease Registry, Office of Children's Health. Child health initiative. Atlanta, GA: 1995.

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