HEALTH CONSULTATION

EAST GALVESTON BAY

GALVESTON COUNTY, TEXAS

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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 Natural Resource Conservation Commission (TNRCC) requested that the Texas Department of Health (TDH) evaluate potential health risks associated with consumption of fish and crabs taken from East Galveston Bay. This request resulted from the detection of mercury in water samples taken as part of TNRCC's routine monitoring of water bodies near industrial areas (303(d) list).

Galveston Bay is Texas' largest and most important estuarine source of seafood, generating nearly one billion dollars per year in commercial and recreational harvests. The bay accounts for approximately one third of the state's commercial fishing income and over one-half of the state's expenditures for recreational fishing. Nearly 300,000 licensed recreational anglers spend some two million hours sport-fishing on the bay annually. More than three million people live in the five coastal counties bordering the Galveston Bay system with twenty percent of the population living within two miles of the bay or its tidal tributaries. The Upper Galveston Bay system is home to one of the nation's largest petrochemical and industrial complexes. As a result, the bay receives treated wastewater from more than 1,400 industrial and municipal point source discharges that amount to more than 60% of the wastewater (by volume) discharged in Texas. It also receives non-point source pollutants in storm water runoff generated by agricultural, urban, suburban and rural land users within the bay.

East Galveston Bay is bordered on the north by the Anahuac Wildlife Refuge, a sparsely inhabited natural wetland, and on the south by Bolivar Peninsula. The population of Bolivar Peninsula is seasonal and is estimated to double in the summer months. Full time residency is approximately 3,000.

In May 1999, TDH collected and analyzed fish and crab samples from four sites in East Galveston Bay: Elmgrove Point, Long Point, Robinson's Bayou, and Stephenson Point. These areas encompass the area of Galveston Bay located east of Hanna's Reef known as East Galveston Bay. Forty-three samples, consisting of 14 black drum, ten spotted trout, five southern flounder, three sheepshead, one catfish, two red drum, and eight composite blue crabs, were analyzed for metals, polychlorinated biphenyls (PCBs), pesticides, and semivolatile and volatile organic compounds (VOCs). Funding for this project was provided by a grant from the TNRCC.

The organic compounds detected in fish and crab samples from East Galveston Bay are summarized in Table 1. Semi-volatile and volatile compounds, including pyridine, 2-butanone, 2-hexanone and acetone were detected at very low levels in a few samples. Pyridine was found only in crab samples. Acetone is commonly added to samples for laboratory procedures; therefore, this contaminant is considered a laboratory artifact and not an environmental contaminant. Low levels of the pesticides chlordane, p,p'DDE, and hexaclorobenzene were found in a few samples. Metals detected in these samples include cadmium, copper, lead, mercury, selenium, and zinc (Table 2).

DISCUSSION

Introduction

Deriving Health-based Assessment Comparison Values (HACs)

TDH screened the chemical contaminants found in the fish and crabs from East Galveston Bay for further consideration by comparing the average contaminant concentrations to health-based assessment comparison (HAC) values for non-cancer and cancer endpoints. We used the U.S. Environmental Protection Agency's (EPA's) 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 and MRLs are estimates of daily exposure to a contaminant that are unlikely to cause adverse noncancer health effects if exposure should occur over a lifetime. The cancer risk comparison values that we used in this consultation are based on EPA's chemical-specific cancer slope factors, an estimated excess lifetime risk of one cancer in ten thousand people (1×10^{-4}) exposed, and an exposure period of 30 years. TDH used 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 [1].

Addressing the Potential for Cumulative Effects

When multiple chemicals affect the same target organ or when several chemicals present in seafood tissues are carcinogens, we assume that adverse effects are additive. To evaluate the potential public health impact of additive noncancerous health effects, we calculate the number of meals per week needed to exceed a hazard index (HI) of one (1.0). The HI is the sum of the ratios of the estimated exposure doses for each contaminant divided by its respective RfD (or MRL). A hazard index of less than one suggests that exposure to the combined contaminants, at the specified exposure levels, is unlikely to cause adverse noncancer health effects, even if exposure continues for many years. While a hazard index that is greater than one does not necessarily mean that exposure to the contaminants will result in adverse health effects, it does suggest that some public health intervention should be considered. To estimate the potential excess lifetime cancer risk associated with multiple carcinogens, we calculate a cumulative risk by adding the estimated risk associated with each of the contaminants. For carcinogenic chemicals, the Texas Department of Health recommends that consumption of fish contaminated with carcinogenic chemicals be limited to amounts that result in an estimated excess theoretical lifetime cancer risk of less than 1 in 10,000 persons exposed to those contaminants in seafood.

Addressing the Unique Vulnerabilities of Children

TDH, EPA, and ATSDR recognize that the unique vulnerabilities of infants and children demand special attention. For several reasons, children have a special vulnerability to some toxic substances. Children are smaller than adults, for instance, resulting in higher doses of chemical exposure per unit of body weight. Their body systems are still developing, making them less able than adults to metabolize, detoxify, and excrete some toxic substances. Children's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Consequently, children who consume seafood contaminated with toxic chemicals may be at greater risk for toxic effects than adults. Therefore, in accordance with ATSDR's *Child Health Initiative* [2] and the EPA's *National Agenda to Protect Children's Health from Environmental Threats* [3], we evaluated the potential public health hazards to children who eat fish from East Galveston Bay.

Risk Characterization

Assessing noncancer health effects

Individually, the contaminants found in the fish and crabs were found at average concentrations below their respective noncancer HAC values (Tables 1 and 2). Pyridine was detected in crab tissue at concentrations ranging from nondetectable levels to 3.8 mg/kg. The Texas Department of Health laboratory investigated the origin of pyridine found in crab tissues and concluded that pyridine is a naturally-occurring component of crab tissue [4]. Pyridine in crabs does not appear to be the result of, or related to, environmental contamination. Three of the chlorinated hydrocarbon pesticides (chlordane, DDE, and hexachlorobenzene) detected in fish and crab samples from East Bay are known to have cumulative adverse non-cancerous effects on the livers of experimental animals [5]. The HI for this combination of chlorinated pesticide contaminants was less than one (1.0).

Assessing cancer health effects

All contaminants in fish and crabs from East Bay were observed at average concentrations well below their respective cancer HAC values (Table 1). Three of the chemicals (chlordane, DDE, and hexachlorobenzene) found in fish and crabs from the Bay are classified as probable human carcinogens (Group B2) based on an increase in the incidence of tumors in laboratory animals [5]. People who eat fish from East Bay may be exposed to several of these chemicals at the same time. Based on previously stated assumptions, we estimated that people eating one meal per week of fish from the bay for 30 years could theoretically increase their excess lifetime cancer risk by approximately 7 excess cancers in 10,000,000 persons exposed to the contaminants. Qualitatively, we interpret this as an insignificant increased lifetime risk for the development of cancer.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

1. The contaminants measured in samples of fish and crabs from East Galveston Bay pose no apparent public health hazard because regular consumption of this seafood would not be likely to have an adverse impact on human health.

2. Fish and crabs from this water body may be consumed by the general public without restriction.

RECOMMENDATIONS AND PUBLIC HEALTH ACTION PLAN

The TDH Seafood Safety Division has established criteria for issuing fish consumption advisories [1]. If long-term consumption of one meal each week could have an adverse impact on human health, the Seafood Safety Division recommends that the Commissioner of Health issue or retain a consumption advisory. In the present instance, we recommend only that TDH review fish and crab tissue data from East Galveston Bay as that information becomes available.

Table 1. Organic Contaminant Concentrations (mg/kg) in Fish From East Galveston Bay

Chemical	Number Affected/ Number Sampled	Average Concentration (Range)	Comparison Value[1]	Basis for Comparison Value
Pesticides				
chlordane	11/43	0.0076 (nd[2]-0.086)	1.2	EPA chronic oral RfD: 0.0005 mg/kg/day
			1.4	ATSDR chronic oral MRL: 0.0006 mg/kg/day
			1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
DDE	6/43	0.00098 (nd-0.011)	1.6	EPA chronic oral RfD for DDT: 0.0005 mg/kg/day
			1.6	EPA slope factor : 0.34 $(mg/kg/day)^{-1}$
hexachlorobenzene	1/43	0.0005 (nd-0.024)	1.9	EPA chronic oral RfD: 0.0008 mg/kg/day
			0.047	ATSDR chronic oral MRL: 0.00002 mg/kg/day
			0.34	EPA slope factor: 1.6 $(mg/kg/day)^{-1}$
Semivolatile Organic Compounds				
pyridine	5/8 (crabs only)	2.1 (nd-3.8)	2.3	EPA chronic oral RfD: 0.03 mg/kg/day
Volatile Organic Compounds				
acetone	25/43	0.24 (nd-1.0)	233	EPA chronic oral RfD: 0.1 mg/kg/day
2-hexanone	1/43	0.001 (nd-0.055)	466	EPA chronic oral RfD: 0.2 mg/kg/day
2-butanone	1/43	0.005 (nd-0.2)	1,400	EPA chronic oral RfD: 0.6 mg/kg/day

[1] assumes 70 kg adult ingesting 30 grams of fish and crabs per day (one eight-ounce meal per week) and, for carcinogenicity risk, an acceptable risk level of 1 x 10^{-4} for a lifetime of exposure

[2] not detected at concentrations above laboratory reporting limit

Table 2. Inorganic Contaminant Concentrations (mg/kg) in Fish and Crabs From East Galveston Bay

Chemical	Number Affected/Number Sampled	Average Concentration (Range)	Comparison Value[1]	Basis for Comparison Value
Metals				
cadmium	24/43	0.02 (nd[2]-0.17)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	22/43	1.06 (nd-8.5)	--------	none available
lead	18/43	0.023 (nd-0.3)	--------	IEUBK[3]
mercury	4/43	0.016 (nd-0.2)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	43/43	0.55 (0.16-0.96)	12	ATSDR/EPA chronic oral MRL/RfD: 0.005 mg/kg/day
zinc	43/43	9.4 (2.8-39.6)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day

[1] *assumes 70 kg adult ingesting 30 grams of fish and crabs per day (one eight-ounce meal per week)*
[2] *not detected at concentrations above laboratory reporting limit*
[3] *Integrated Exposure Uptake Biokinetic Model, EPA*

REFERENCES

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4. Texas Department of Health (TDH) 2000. Assessment of the toxicological significance of pyridine in crabs from various water bodies within the state of Texas. Texas Department of Health Laboratory, unpublished communications.

5. IRIS. Integrated Risk Information System.September 2000. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. www.epa.gov/ngispgm3/iris/.

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CERTIFICATION

This East Galveston Bay Health Consultation was prepared by the Texas Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Chief, State Programs Section, SSAB, DHAC, ATSDR