HEALTH CONSULTATION

UPPER 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 Upper Galveston Bay. This request resulted from the detection of mercury in water samples taken as part of TNRCC's routine monitoring, placing this portion of the Galveston Bay estuary system onto the EPA's 303(d) list. Currently, the upper portion of Galveston Bay and the Houston Ship Channel are under a fish consumption advisory issued in 1990 due to contamination of catfish and crabs with dioxins. Seafood samples analyzed from the advisory area in 1994 and 1996 indicated that catfish and crabs from the advisory area were still contaminated with dioxins. Samples collected in 1999 for the present evaluation were collected within the advisory area but were not analyzed for dioxins.

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. Annually, nearly 300,000 licensed recreational anglers spend some two million hours sport fishing on the bay. More than three million people live in the five coastal counties bordering the Galveston Bay system; twenty percent of those people live 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 area.

In February 1999, TDH collected and analyzed fish and crab samples from four sites in Upper Galveston Bay: ten each from Morgan's Point, the Houston Yacht Club, Sylvan Beach, and the mouth of Little Cedar Bayou. These forty samples, consisting of seven black drum, three red drum, eight sheepshead, three southern flounder, eight spotted sea trout, one sand sea trout, two striped bass, and eight composite blue crabs, were analyzed for metals, polychlorinated biphenyls (PCBs), pesticides, and semivolatile (SVOCs) and volatile organic compounds (VOCs). Funding for this project was provided through a grant from the TNRCC.

The organic compounds detected in fish and crab samples from Upper Galveston Bay are summarized in Table 1. Semivolatile and volatile compounds, including pyridine, diethyl phthalate, bis(2-ethylhexyl)phthalate, benzene, toluene, and acetone were detected at very low levels and in only a few samples. Pyridine was found only in crab samples. Low levels of the pesticides chlordane, heptachlor epoxide, DDD, DDE, dieldrin, hexaclorobenzene, lindane, and dacthal were found in a few samples. Aroclor 1260 was detected in three samples. Metals detected in these samples include cadmium, copper, lead, mercury, selenium, and zinc (Table 2).

DISCUSSION

Deriving Health-based Assessment Comparison Values (HACs)

TDH screened the chemical contaminants found in the fish and crabs from Upper Galveston Bay for further consideration by comparing the average concentration of each contaminant 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 exposures to contaminants that are unlikely to cause adverse noncancer health effects even if exposure occurs for 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 (1×10^{-4}) persons exposed to the contaminants, 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. The Texas Department of Health recommends limiting consumption of fish contaminated with carcinogenic chemicals 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 susceptibility to some toxic substances. Children are smaller than adults, which results 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 or excrete some substances, and they may be more likely to absorb specific toxicants. Children's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Children may be more prone to developing certain cancers as a result of chemical exposures than adults. 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 Upper Galveston Bay.

Characterizing Risk

Assessing Noncancer Health Effects

Individually, average concentrations of the contaminants in the fish and crabs from Upper Galveston Bay were found at levels below their respective noncancer HAC values (Tables 1 and 2). TDH investigated the origin of pyridine found in crab tissues from this water body 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. Eight of the chlorinated hydrocarbon pesticides (chlordane, dacthal, DDD, DDE, dieldrin, heptachlor epoxide, hexachlorobenzene, and lindane) detected in fish from Upper Galveston Bay are known to have adverse non-cancerous effects on the livers of experimental animals [5]. The HI for the combinations of contaminants observed in samples from this water body was less than one (1.0).

Assessing Cancer Health Effects

The individual contaminants in fish and crabs from Upper Galveston Bay were found at average concentrations below their respective cancer HAC values (Table 1). Seven of the chemicals (chlordane, DDE, DDD, dieldrin, heptachlor expoxide, hexachlorobenzene, and bis(2-ethylhexyl)phthalate) found in fish from the bay are classified by the EPA as probable human carcinogens (Group B2) based on an increase in the incidence of tumors in laboratory animals [5]. Benzene is classified by the EPA as a known human (Group A) carcinogen, based on epidemiological evidence [5]. People who eat fish from the bay may be exposed to several of these contaminants at the same time. Using EPA's chemical-specific cancer slope factors and the average concentration for each of the compounds, we calculated that eating one eight-ounce meal per week of finfish other than catfish from the bay that contain average concentrations of all the observed contaminants (an unlikely scenario) for 30 years could theoretically increase excess lifetime cancer risk by approximately one excess cancer in 34,483 exposed persons. Qualitatively, we interpreted this as low increased risk of contracting cancer during a lifetime.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

1. Consuming finfish other than catfish from Upper Galveston Bay poses no apparent public health hazard. Long-term ingestion of more than one meal per week of finfish, excluding catfish, would be unlikely to have an adverse impact on human health.

2. Catfish and blue crabs from Upper Galveston Bay are currently under a fish consumption advisory issued in 1990 due to contamination with dioxins. Based on the data available for this report, we were not able to re-evaluate the existing catfish and blue crab advisory.

RECOMMENDATIONS AND PUBLIC HEALTH ACTION PLAN

The TDH Seafood Safety Division has established criteria for issuing fish consumption advisories based on recommendations from the EPA [1]. If long-term consumption of one meal per week could have an adverse impact on human health, the Seafood Safety Division recommends that the Commissioner of Health issue a consumption advisory. Based on the above conclusions, we recommend:

1. The existing advisory recommending that blue crabs and catfish from Upper Galveston Bay not be consumed should remain in effect.

2. The public may consume finfish other than catfish from Upper Galveston Bay without restriction.

3. TDH should monitor finfish and blue crab data from Upper Galveston Bay as this information becomes available. Analysis of dioxins should be included in any monitoring activities.

Table 1. Organic Contaminant Concentrations (mg/kg) in Fish and Crabs from Upper Galveston Bay				
Chemical	**# Affected/ # Sampled**	**Average Concentration (Range)**	**Comparison Value[1]**	**Basis for Comparison Value**
Pesticides (mg/kg)				
chlordane	20/40	0.37 (nd[2]-0.19)	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 $(mg/kg/day)^{-1}$
dacthal	1/40	0.0001 (nd-0.004)	23	EPA chronic oral RfD: 0.01 mg/kg/day
DDD	5/40	0.0017 (nd-0.023)	1.2	EPA chronic oral RfD for DDT: 0.0005 mg/kg/day
			1.6	EPA slope factor : 0.24 $(mg/kg/day)^{-1}$
DDE	15/40	0.0073 (nd-0.08)	1.2	EPA chronic oral RfD for DDT: 0.0005 mg/kg/day
			1.6	EPA chronic oral slope factor 0.34 $(mg/kg/day)^{-1}$
dieldrin	3/40	0.0006 (nd-0.01)	0.12	EPA/ATSDR chronic oral RfD/MRL 0.00005 mg/kg/day
			0.03	EPA slope factor 16 $(mg/kg/day)^{-1}$
heptachlor expoxide	10/40	0.0017 (nd-0.11)	0.03	EPA chronic oral RfD 0.000013 mg/kg/day
			0.06	EPA slope factor 9.1 $(mg/kg/day)^{-1}$
hexachlorobenzene	5/40	0.0005 (nd-0.006)	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 $(mg/kg/day)^{-1}$
lindane	2/40	0.0001 (nd-0.003)	0.7	EPA chronic oral RfD 0.0003 mg/kg/day
Semivolatile Organic Compounds (mg/kg)				
bis(2-ethylhexyl) phthalate	1/40	0.05 (nd-2.1)	46.7	EPA chronic oral RfD: 0.02 mg/kg/day
			38.8	EPA slope factor: 0.014 $(mg/kg/day)^{-1}$
diethyl phthalate	1/40	0.035 (nd-1.4)	1,866	EPA chronic oral RfD: 0.8 mg/kg/day
pyridine	6/8 (crabs only)	0.33 (nd-3.4)	2.3	EPA chronic oral RfD: 0.03 mg/kg/day
Volatile Organic Compounds (mg/kg)				
acetone	7/40	0.048 (nd-0.39)	233	EPA chronic oral RfD: 0.1 mg/kg/day
benzene	1/40	0.0003 (nd-0.011)	9.9	EPA slope factor: 0.055 $(mg/kg/day)^{-1}$
toluene	1/40	0.0003 (nd-0.011)	466	EPA chronic oral RfD: 0.2 mg/kg/day
Polychlorinated biphenyls (mg/kg)				
Aroclor 1260	3/40	0.006 (nd-0.13)	0.047	EPA/ATSDR chronic oral RfD/MRL-Aroclor 1254: 0.00002 mg/kg/day
			0.271	EPA slope factor 2 $(mg/kg/day)^{-1}$

[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 1×10^{-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 Upper Galveston Bay				
Chemical	**# Affected/# Sampled**	**Average Concentration (Range)**	**Comparison Value[1]**	**Basis for Comparison Value**
Metals				
cadmium	11/40	0.016 (nd[2]-0.14)	0.47	ATSDR chronic oral MR:L 0.0002 mg/kg/day
copper	34/40	1.7 (nd-9.8)	--------	none available
lead	2/40	0.0017 (nd-0.04)	--------	IEUBK[3]
mercury	18/40	0.057 (nd-0.32)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	40/40	0.92 (0.4-2.6)	12	ATSDR/EPA chronic oral MRL/RfD: 0.005 mg/kg/day
zinc	40/40	10.2 (2.9-47.6)	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*

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4. Fest G, Villanacci J, Ward J, Williams L et al. Assessment of the source of pyridine in crabs from water bodies in Texas. Austin: Texas Department of Health (in preparation).

3 IRIS. Integrated Risk Information System. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. September, 2000.

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CERTIFICATION

This Upper 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