HEALTH CONSULTATION

HOUSTON SHIP CHANNEL and TABBS BAY

Harris County, Texas

August 1, 2001

Prepared by

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

BACKGROUND AND STATEMENT OF ISSUES

A 1990 TDH consumption advisory for the Houston Ship Channel, the San Jacinto River, and Tabbs Bay was issued due to contamination of catfish and blue crabs with dioxins[1] [1]. TDH reevaluated the 1990 consumption advisory in 1997 and recommended continuation of the advisory due to the continuing presence of dioxins in the seafood. Subsequently, the Texas Natural Resource Conservation Commission (TNRCC) requested that the Texas Department of Health (TDH) reevaluate fish and crabs from the advisory area for any adverse health effects that could result from consumption of contaminated fish and crabs. TDH undertook that study, which was funded by TNRCC through a grant to the Seafood Safety Division (SSD). That investigation, reported in the present health consultation, addressed contaminants other than dioxins in seafood from the Houston Ship Channel and contiguous waters.

Along its length, the Houston Ship Channel receives permitted discharges from many industrial sites as well as nonpoint-source runoff from parts of metropolitan Houston. Approximately fifteen miles downstream of the turning basin, the ship channel traverses the San Jacinto State Park, where the San Jacinto River joins it near the San Jacinto State Monument. Channel waters then course east-southeast through the San Jacinto State Park, emptying into Tabbs Bay, a part of the Galveston Bay estuary system. Tabbs Bay and the San Jacinto State Park have many points of public access and support both recreational and subsistence fishing activities.

In January and July 1999, the Seafood Safety Division (SSD) at TDH collected, from four sites within the confines of the Houston Ship Channel, the San Jacinto River, and Tabbs Bay, twenty-four finfish: seven hybrid bass, five smallmouth buffalo, three sheepshead, three red drum, one freshwater drum, two southern flounder, two common carp, and one blue catfish. Eight composite (5 crabs/sample) crab samples were also collected. Samples were collected from the turning basin, the Lynchburg Ferry/San Jacinto State Park area (San Jacinto Monument), the San Jacinto River near Interstate 10, and Tabbs Bay near Houston Point. The San Jacinto River and the Houston Ship Channel yielded primarily freshwater fish; samples collected from Tabbs Bay were predominantly saltwater species. The TDH laboratory analyzed edible fillets (skin off) for seven metals: arsenic, cadmium, copper, lead, mercury, selenium and zinc. The laboratory also analyzed for polychlorinated biphenyls (PCBs), pesticides, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs).

Tables 1 through 4 summarize the sampling data. Results from blue crab composites were examined separately from those of finfish. All blue crab samples contained low levels of mercury, lead, cadmium, copper, selenium, zinc, chlordane, and DDE. The two composite crab samples from the San Jacinto River also contained low levels of DDD, dieldrin, heptachlor epoxide, and hexachlorobenzene. Additionally, one crab sample collected from the ship channel near the San Jacinto Monument contained low levels of dieldrin and heptachlor epoxide; both samples from the sampling site near the monument contained small quantities of hexachlorobenzene, as well, and pyridine, a naturally occurring component of crab tissue that the TDH has concluded is not the result of environmental contamination [2]. Blue crab samples

1 In this document, "dioxins" refers to combinations of polychlorinated di-benzo-p-dioxins and polychlorinated dibenzofurans.

generally contained lower levels and fewer contaminants than finfish, although zinc and copper concentrations were higher in crabs than in finfish regardless of collection site.

Three finfish from the ship channel at the San Jacinto River near the I-10 Bridge contained substantial quantities of PCBs consistent with Aroclor 1260. PCBs were not present in samples from any other site. Some finfish from sites within the ship channel contained very low levels of alpha-, beta-, and delta-hexachlorocyclohexane (BHC); chlordane; p,p'-DDT; p,p'-DDD; p,p'-DDE; dieldrin; heptachlor epoxide; hexachlorobenzene; lindane (gamma-hexachlorocyclohexane) and methoxychlor, while others contained acetone (a common laboratory contaminant) and very low levels tetrachloroethene, styrene, toluene, benzene, 4-isopropyl toluene, 2-butanone, naphthalene, 2-hexanone, diethylhexyl phthalate, and/or diethylhexyl adipate as well as inorganic constituents at low levels. A few samples from the channel also contained low concentrations of dacthal and the organophosphate pesticides, chlorpyrifos and diazinon. It is notable that the only organic contaminant detected in finfish from Tabbs Bay was the organochlorine pesticide chlordane (small quantities). Finfish from Tabbs Bay also contained very low levels of cadmium, copper, lead, mercury, selenium, and zinc. Samples collected from the turning basin generally contained higher concentrations and a larger variety of contaminants than did samples from other sites in the ship channel, with organochlorine pesticides predominating in finfish from the turning basin. It is important to note that, although several organic compounds were identified in finfish samples collected from the ship channel, most were present at extremely low levels and many were only sporadically observed.

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 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 may use 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 actual exposures or risks, use of averages is a reasonable approach to predicting long-term exposure to low levels of contaminants. Although TDH routinely uses average concentrations for determining external exposure doses, the agency has used and continues to use other statistical procedures to assess the likelihood of adverse health effects from consumption of contaminated seafood when these procedures are appropriate and necessary.

Deriving Health-based Assessment Comparison Values (HACs)

TDH evaluated chemical contaminants in fish and crabs from the Houston Ship Channel, San Jacinto River, and Tabbs Bay 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 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 for a lifetime, 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 [3]. Many of the constants used to calculate noncancer HAC values have safety margins built into them. Thus, adverse health effects will not necessarily occur simply because concentrations of toxicants in seafood exceed HAC values. Moreover, although health-based assessment comparison values (HAC values) do not represent a sharp dividing line between “safe” and “unsafe” exposures, in practice, TDH finds it unacceptable when consumption of less than one meal per week would result in exposures that exceed the RfD, the MRL, or, for multiple contaminants, a hazard index of 1. Thus, in the final analysis, the strict demarcation between acceptable and unacceptable exposures or risks is primarily a tool used by risk managers to ensure protection of public health.

Addressing the Potential for Cumulative Effects

When multiple chemicals affect the same target organ, or when several chemicals present in seafood tissue may be carcinogens, TDH assumes adverse health effects are cumulative (i.e., additive). To evaluate the potential public health impact of additive noncancerous health effects, TDH calculates a hazard index, which is the sum of the ratios of the estimated exposure dose for each contaminant divided by its respective RfD or MRL. A HI of less than 1.0 suggests that exposure to combined contaminants at specified exposure levels is unlikely to cause adverse noncancer health effects, even if that exposure continues for many years. On the other hand, while a HI greater than 1.0 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 adding the estimated risk for each contaminant. Based on such calculations, TDH recommends limiting consumption of seafood contaminated with carcinogenic chemicals to amounts resulting in an estimated theoretical lifetime cancer risk of not more than 1 excess cancer in 10,000 thousand persons exposed for a lifetime to the chemicals through seafood.

Addressing the Unique Vulnerabilities of Children

TDH recognizes that fetuses, infants, and children can 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 may permanently impair or alter structure or function [4]. Unique childhood vulnerabilities result, at least in part, 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. Childrens' exposures to toxicants may be more significant because children consume more food and liquids in proportion to their body weight than do adults [4]. Children can also ingest toxicants through breast milk -- often unrecognized as an exposure pathway. Thus, children can experience toxic effects at a lower exposure level than would affect adults. Stated differently, children could react more severely than would adults to an equivalent exposure dose [4]. Children can also be more prone to developing certain cancers from chemical exposures. Therefore, in accordance with ATSDR's *Child Health Initiative* [5] and EPA's *National Agenda to Protect Children's Health from Environmental Threats* [4], TDH evaluated the potential public health hazards to children who eat fish or crabs from the Houston Ship Channel, the San Jacinto River, or Tabbs Bay. TDH concludes that children consuming fish and crabs from the Houston Ship Channel, the San Jacinto River, or Tabbs Bay would have a greater risk of adverse health effects than children who do not consume seafood from these waters.

Characterizing the Risk

Assessing Noncancer Health Effects

Contaminant levels in fish and crabs taken from the survey area generally were below their respective noncancer HAC values (Tables 1- 4). In only one instance- Aroclor 1260 in finfish from the San Jacinto River- did the average concentration of a contaminant exceed a noncancer HAC value. We compared Aroclor 1260 with the HAC value for Aroclor 1254 (a mixture of PCBs that are structurally-similar to those of Aroclor 1260) because Aroclor 1260 has no reference dose from which to calculate a comparison value. High concentrations of Aroclor 1260 in three of the finfish from the San Jacinto River site caused this compound to exceed the noncancer HAC value for Aroclor 1254. The USEPA based the RfD for Aroclor 1254 on immune system dysfunctions in rhesus monkeys dosed with the toxicant for many months [6]. The EPA divided the LOAEL from the definitive study by a composite uncertainty factor of 300 (10 for use of a LOAEL, 10 for human variability, and 3 for extrapolation from animals to humans). Because of the concentrations of Aroclor 1260 detected in three finfish collected from the San Jacinto River site, average concentrations of PCBs in fish tissue from the area encompassed by the San Jacinto River and the San Jacinto State Park sites are approximately 1.4 times the HAC value. Finfish from the San Jacinto River near the I-10 Bridge contain Aroclor 1260 at concentrations approximately 2.7 times the HAC value. Based on the RfD for Aroclor 1254, TDH calculated that regular consumption of more than one-half meal per week (4 ounces per week for adults; 2 ounces for children) of finfish from the lower reaches of the Houston Ship

Channel or the San Jacinto River could cause consumers to exceed the RfD for immunological effects. Those who eat finfish exclusively from the San Jacinto River near the I-10 Bridge could exceed the RfD if they eat only one-third of a standard meal (2.6 ounces, adult or 1.3 ounces, child). Nevertheless, the doses of PCBs that produce adverse effects in rhesus monkeys (the lowest observed adverse effect level or LOAEL) are much higher than the doses to which people would likely be exposed by eating one meal per week of finfish from the Houston Ship Channel or contiguous waters.

Assessing the Potential for Cumulative Noncancerous Effects

Several chlorinated pesticides, including chlordane, DDD, DDE, DDT, dieldrin, heptachlor epoxide, and hexachlorobenzene identified at low levels in seafood from the survey area have had adverse noncancerous effects on the livers of experimental animals [7]. Assuming these effects to be additive, TDH calculated hazard indices for consumption of blue crabs (Table 5) or finfish (Table 5) from each site in which these compounds were identified. Hazard indices for the eight blue crab samples were less than 1.0, irrespective of collection site. Thus, consumption of blue crabs containing low levels of the contaminants of concern is unlikely to result in adverse, noncancerous health effects. The hazard index (HI) for chlorinated hydrocarbon pesticides in finfish from the turning basin was 1.4 (Table 5). Chlordane, (HR = 0.654), heptachlor epoxide (HR = 0.536), and dieldrin (HR = 0.217) contributed most heavily to the turning basin HI. Finfish from Tabbs Bay, on the other hand, had a HI of 0.015, reflecting the low concentrations of contaminants in samples from Tabbs Bay.

The ship channel at the San Jacinto Monument and the San Jacinto River upstream of the monument have no easily distinguished hydrological or geographical characteristics. Because fishers are unlikely to differentiate between the two areas, we analyzed finfish from these two sampling sites as one group. The hazard index for finfish from the San Jacinto Monument- San Jacinto River site was 1.8, the majority of which is due to high concentrations of Aroclor 1260 in three samples.

Assessing Individual and Cumulative Cancerous Health Effects

Average concentrations of contaminants in fish and crabs from the turning basin, the ship channel at the San Jacinto Monument, the San Jacinto River, and Tabbs Bay were below their respective cancer HAC values (Tables 1a - 4). This suggests that an increase in the risk of cancer from exposure to individual contaminants is unlikely. The USEPA, however, has used increases in tumor incidence in experimental animals to classify many of the contaminants found in fish and crabs from these sites (chlordane, DDD, DDE, DDT, dieldrin, heptachlor epoxide, hexachlorobenzene, and Aroclor 1260) as probable human carcinogens (Group B2) [7]. Those who eat fish from the ship channel or the San Jacinto River could be simultaneously exposed to several of these chemicals. As a result, carcinogenic effects could be cumulative. TDH estimated cumulative cancer risk for persons exposed through seafood from the survey areas by adding the individual risk for each carcinogenic contaminant. Based on this calculation, the cumulative risk of cancer from exposure to contaminants in finfish (excluding catfish) from this area could have a theoretical lifetime cancer risk of 1.6×10^{-4} (1 in 6250 persons exposed; Table 6), which exceeds TDH's health-based guidelines. Qualitatively, this is interpreted as a low increase in the lifetime risk of cancer. People who regularly consume finfish (excluding catfish) from the San Jacinto River/San Jacinto State Park area have no apparent increase in the lifetime risk of cancer, while those who consume finfish (excluding catfish) from Tabbs Bay have an insignificant (approximately 1 in 900,000) increase in their theoretical lifetime risk for cancer. Consumption of blue crabs from any site in the survey area that contain average concentrations of all the compounds identified in the present survey would result in an insignificant or unapparent increase in the lifetime risk of cancer development (Table 6). However, TDH advises people to limit consumption of blue crabs and catfish from the Houston Ship Channel and Upper Galveston Bay due to the presence of dioxin congeners in this seafood species. Women who are pregnant or who may become pregnant, infants, and young children should not consume blue crabs or catfish from this area.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

1. TDH concludes that eating finfish taken from the turning basin of the Houston Ship Channel **poses a public health hazard**. Besides the presence of dioxins referenced in the existing consumption advisory [6], finfish from the turning basin contain other organochlorine contaminants that, when consumed, may increase the risk of noncancerous or cancerous adverse human health effects (Tables 5 and 6).

2. Consumption of finfish from the ship channel near the San Jacinto Monument or from the San Jacinto River **poses a public health hazard** because concentrations of Aroclor 1260 in these fish exceed the health-based assessment comparison values for PCBs. Exposure to Aroclor 1260 could increase the risk of noncancerous adverse health effects (Table 5) in those people who eat fish from these areas.

3. This health consultation should not serve as the basis for revisions to the existing dioxin-related consumption advisory because fish and crabs collected most recently from these areas were not tested for these substances.

4. Consumption of finfish other than catfish from Tabbs Bay **poses no apparent public health hazard**.

RECOMMENDATIONS

The Texas Department of Health has established criteria for issuing fish consumption advisories. When the data indicate that eating less than one meal per week (8 ounces, adult; 4 ounces, child) results in exposures exceeding a health-based guideline, risk assessors may recommend that the Commissioner of Health issue a consumption advisory. Based on the findings of this health consultation, the Seafood Safety Division and the Environmental Epidemiology and Toxicology Division of the Texas Department of Health recommend the following actions:

1. that TDH continues the existing advisory on consumption of blue crabs and catfish from the Houston Ship Channel and contiguous waters, including Tabbs Bay. The existing advisory limits adults' consumption of catfish and blue crabs to one eight-ounce meal per month and advises women of childbearing age and children not to consume catfish or blue crabs from the advisory area.

2. that TDH issues a second advisory for the Houston Ship Channel and the San Jacinto River to include all species of finfish due to the presence of pesticides and PCBs in concentrations exceeding health-based assessment comparison values (HAC values).

3. that TDH advises people that, excluding all species of catfish, they may consume finfish from Tabbs Bay without restriction.

4. that TDH reexamines catfish, other finfish, and blue crabs from Tabbs Bay for dioxins to decide whether it is necessary to continue to include this area of the estuary in the existing consumption advisory.

5. that, if resources are available, TDH continues to monitor finfish and blue crabs from the Houston Ship Channel and contiguous waters for dioxins and other contaminants.

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 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 (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 TWPD informs the fishing and hunting public of closure areas in an official hunting and fishing regulations booklet [3] that is available at some state parks and at establishments that sell fishing licenses.

If questions or concerns arise about the scientific information presented in this in this health consultation, readers 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 1a. Organic Contaminants (mg/kg) detected in Finfish from the Houston Ship Channel (HSC) and the San Jacinto River, 1999				
Contaminant	**# Detected/ # Sampled**	**Average Concentration (Min-Max)[1]**	**Health Assessment Comparison Value[2]**	**Basis for Comparison Value**
HSC at Turning Basin				
chlordane	6/6	0.763 (0.10-2.600)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.17	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	6/6	0.044 (0.013-0.087)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
p,p'-DDD	1/6	0.002 (nd[3]-0.013)	2.3	EPA slope factor: 0.24 $(mg/kg/day)^{-1}$
p,p'-DDT	1/6	0.0045 (nd-0.027)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
dieldrin	4/6	0.025 (nd-0.089)	0.034	EPA slope factor: 16 $(mg/kg/day)^{-1}$
			0.117	EPA chronic oral RfD: 0.00005 mg/kg/day
heptachlor epoxide	4/6	0.016 (nd-0.057)	0.06	EPA Slope Factor: 9.1 $(mg/kg/day)^{-1}$
			0.03	EPA chronic oral RfD: 0.000013 mg/kg/day
hexachlorobenzene	4/6	0.0048 (nd-0.014)	0.34	EPA Slope Factor: 1.6 $(mg/kg/day)^{-1}$
			1.87	EPA chronic oral RfD: 0.0008 mg/kg/day
HSC- San Jacinto Monument/San Jacinto River at I-10				
chlordane	7/12	0.161 (nd-1.00)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.17	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	7/12	0.028 (nd-0.080)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
p,p'-DDD	3/12	0.010 (nd-081)	2.3	EPA slope factor: 0.24 $(mg/kg/day)^{-1}$
p,p'-DDT	3/12	0.004 (nd-0.022)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
dieldrin	3/12	0.003 (nd-0.026)	0.034	EPA slope factor: 16 $(mg/kg/day)^{-1}$
			0.117	EPA chronic oral RfD: 0.00005 mg/kg/day
heptachlor epoxide	5/12	0.005 (nd-0.021)	0.06	EPA Slope Factor: 9.1 $(mg/kg/day)^{-1}$
			0.03	EPA chronic oral RfD: 0.000013 mg/kg/day
hexachlorobenzene	6/12	0.003 (nd-0.009)	0.34	EPA Slope Factor: 1.6 $(mg/kg/day)^{-1}$
			1.87	EPA chronic oral RfD: 0.0008 mg/kg/day
Aroclor 1260	3/12	**0.068 (nd-0.330)**	0.047	EPA chronic oral RfD for Aroclor 1254: 0.00002 mg/kg/day
			0.27	EPA slope factor: 2.0 $(mg/kg/day)^{-1}$

[1] *Minimum concentration to Maximum concentration (to calculate the range, subtract the minimum concentration from the maximum concentration).*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 1b. Inorganic Contaminants (mg/kg) in Finfish from the Houston Ship Channel (HSC) and the San Jacinto River, 1999.

Contaminant	# Detected/ # Sampled	Average Concentration (Min-Max) [1]	Health Assessment Comparison Value[2]	Basis for Comparison Value
HSC-Turning Basin				
cadmium	1/6	0.0008 (nd-0.0048)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	6/6	0.34 (0.23-0.5)	--------	Not Available
lead	2/6	0.0094 (nd[3]-0.037)	--------	Not Available
mercury	5/6	0.069 (nd-0.1590)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	6/6	0.43 (0.38-0.52)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
zinc	6/6	4.2 (2.97-5.8)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day
HSC-San Jacinto Monument/San Jacinto River at I-10				
cadmium	1/12	0.001 (nd-0.017)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	12/12	0.267 (0.097-0.398)	--------	Not Available
lead	2/12	0.0036 (nd-0.0227)	--------	Not Available
mercury	12/12	0.1262 (0.0186-0.366)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	12/12	0.539 (0.328-1.23)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
zinc	12/12	3.52 (2.84-6.17)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day

[1] *Minimum concentration to maximum concentration; (range = maximum conc - minimum conc)*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 2. Organic and Inorganic Contaminants (mg/kg) in Finfish from Tabbs Bay, 1999.

Contaminant	# Detected/ # Sampled	Average Concentration (Min-Max)[1]	Health Assessment Comparison Value[2]	Basis for Comparison Value
Organochlorine Pesticides				
chlordane	3/6	0.017 (nd [3]-0.029)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.2	EPA chronic oral RfD: 0.0005 mg/kg/day
Metals				
cadmium	2/6	0.002 (nd-0.008)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	4/6	0.25 (0.095-0.523)	--------	Not Available
lead	1/6	0.004 (nd-0.024)	--------	Not Available
mercury	6/6	0.09 (0.025-0.327)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	6/6	0.76 (0.32-1.03)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
zinc	6/6	3.42 (3.09-4.58)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day

[1] *Minimum concentration to maximum concentration; (range = maximum conc - minimum conc)*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of $1x10^{-4}$*
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 3a. Organic Contaminants (mg/kg) in Blue Crabs from the Houston Ship Channel (HSC) and the San Jacinto River, 1999.

Contaminant	# Detected/ # Sampled	Average Concentration (Min-Max)[1]	Health Assessment Comparison Value[2]	Basis for Comparison Value
HSC-Turning Basin				
chlordane	2/2	0.260 (0.22,0.30)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.17	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	2/2	0.010 (0.0082,0.012)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
HSC-San Jacinto Monument/San Jacinto River at I-10				
chlordane	4/4	0.085 (0.014,0.180)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.17	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	4/4	0.009 (0.0025-0.014)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
p,p'-DDD	2/4	0.0063 (nd [3]-0.025)	2.3	EPA slope factor: 0.24 $(mg/kg/day)^{-1}$
dieldrin	1/4	0.0020 (nd-0.0079)	0.034	EPA slope factor: 16 $(mg/kg/day)^{-1}$
			0.117	EPA chronic oral RfD: 0.00005 mg/kg/day
heptachlor epoxide	2/4	0.0035 (nd-0.009)	0.06	EPA Slope Factor: 9.1 $(mg/kg/day)^{-1}$
			0.03	EPA chronic oral RfD: 0.000013 mg/kg/day
hexachlorobenzene	2/4	0.0033 (nd-0.010)	0.34	EPA Slope Factor: 1.6 $(mg/kg/day)^{-1}$
			1.87	EPA chronic oral RfD: 0.0008 mg/kg/day

[1] *Minimum concentration to maximum concentration; (range = maximum conc - minimum conc)*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 3b. Inorganic Contaminants (mg/kg) in Blue Crabs from the Houston Ship Channel (HSC) and the San Jacinto River, 1999.				
Contaminant	**# Detected/ # Sampled**	**Average Concentration (Min-Max)** [1]	**Health Assessment Comparison Value**[2]	**Basis for Comparison Value**
HSC-Turning Basin				
Cadmium	2/2	0.069 (0.065, 0.073)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
Copper	2/2	8.6 (8.4, 8.7)	--------	Not Available
Lead	2/2	0.07 (0.059, 0.084)	--------	Not Available
Mercury	1/2	0.108 (nd [3], 0.165)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
Selenium	2/2	0.36 (0.34, 0.37)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
Zinc	2/2	31.2 (28.5, 33.9)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day
HSC-San Jacinto Monument/San Jacinto River at I-10				
Cadmium	4/4	0.132 (0.093-0.234)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
Copper	4/4	16.3 (10.3-22.2)	--------	None Available
Lead	3/4	0.015 (nd-0.022)	--------	None Available
Mercury	1/4	0.055 (nd- 0.096)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
Selenium	4/4	0.71 (0.43-1.12)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
Zinc	4/4	44.4 (32.3-55.5)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day

[1]*Minimum concentration to maximum concentration; (range = maximum conc - minimum conc)*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 4. Organic and Inorganic Contaminants (mg/kg) in Blue Crabs from Tabbs Bay, 1999.				
Contaminant	**# Detected/ # Sampled**	**Average Concentration (Min-Max)[1]**	**Health Assessment Comparison Value[2]**	**Basis for Comparison Value**
Organochlorine Pesticides				
chlordane	2/2	0.053 (0.050, 0.055)	1.6	EPA slope factor: 0.35 $(mg/kg/day)^{-1}$
			1.2	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	1/2	0.0038 (nd [3], 0.005)	1.6	EPA slope factor: 0.34 $(mg/kg/day)^{-1}$
Metals				
cadmium	2/2	0.142 (0.046, 0.238)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	2/2	6.2 (5.7, 6.8)	--------	Not Available
lead	1/2	0.0125 (nd, 0.0249)	--------	Not Available
Mercury	1/2	0.022 (nd, 0.04)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
Selenium	2/2	1.12 (0.95, 1.29)	12	ATSDR/EPA chronic oral MRL/RfD: 0 .005 mg/kg/day
Zinc	2/2	42.6 (38.5, 46.8)	700	ATSDR/EPA chronic oral MRL/RfD: 0.3 mg/kg/day

[1] *Minimum concentration to maximum concentration; (range = maximum conc - minimum conc)*
[2] *derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
[3] *nd-not detected at concentrations above the laboratory reporting limit*

Table 5. Hazard Indices for Finfish and Crabs from the Houston Ship Channel (HSC), San Jacinto River, and Tabbs Bay, 1999.

Contaminant	Hazard Ratio		
	HSC-Turning Basin	HSC-San Jacinto Monument/San Jacinto River at I-10	Tabbs Bay
Finfish			
chlordane	0.65	0.14	0.02
p,p'-DDD	0.002	0.01	ND
p,p'-DDE	0.04	0.02	ND
p,p'-DDT	0.004	0.004	ND
dieldrin	0.22	0.03	ND
heptachlor epoxide	0.54	0.16	ND
hexachlorobenzene	0.003	0.002	ND
Aroclor 1260	ND[1]	1.46	ND
HAZARD INDEX, Finfish	**1.45**	**1.82**	**0.02**
Blue Crab			
chlordane	0.22	0.07	0.045
p,p'-DDD	ND	0.005	ND
p,p'-DDE	0.009	0.008	0.003
p,p"-DDT	ND	ND	ND
dieldrin	ND	0.02	ND
heptachlor epoxide	ND	0.12	ND
hexachlorobenzene	ND	0.002	ND
Aroclor 1260	ND	ND	ND
HAZARD INDEX, Blue Crab	**0.23**	**0.22**	**0.048**

[1] *ND-Contaminant not detected at concentrations above laboratory reporting limit*

Table 6. Cumulative Cancer Risks from Consumption of Finfish or Blue Crabs from the Houston Ship Channel, San Jacinto River, and Tabbs Bay, 1999.			
Contaminant	**HSC-Turning Basin**	**HSC-San Jacinto Monument/ San Jacinto River at I-10**	**Tabbs Bay**
Finfish			
chlordane	4.9 X 10^{-5}	1.0 X 10^{-5}	1.1 X 10^{-6}
p,p'-DDD	4.1 X 10^{-7}	4.5 X 10^{-7}	ND
p,p'-DDE	2.7 X 10^{-6}	1.7 X 10^{-6}	ND
p,p'-DDT	2.8X 10^{-7}	2.5 X 10^{-7}	ND
dieldrin	7.4 X 10^{-5}	9.5 X 10^{-6}	ND
heptachlor epoxide	2.7 X 10^{-5}	8.4 X 10^{-6}	ND
hexachlorobenzene	1.4 X 10^{-6}	8.8 X 10^{-7}	ND
Aroclor 1260	ND[1]	2.5 X 10^{-5}	ND
CUMULATIVE RISK	**1.6 X 10^{-4}**	**5.7 X 10^{-5}**	**1.1 X 10^{-6}**
Blue Crabs			
chlordane	1.7 X 10^{-5}	5.5 X 10^{-6}	3.4 X 10^{-6}
p,p'-DDD	ND	2.8 X 10^{-7}	ND
p,p'-DDE	6.3 X 10^{-7}	5.7 X 10^{-7}	2.4 X 10^{-7}
p,p'-DDT	ND	ND	ND
dieldrin	ND	5.8 X 10^{-6}	ND
heptachlor epoxide	ND	5.9 X 10^{-6}	ND
hexachlorobenzene	ND	9.6 X 10^{-7}	ND
Aroclor 1260	ND	ND	ND
CUMULATIVE RISK	**1.7 X 10^{-5}**	**1.9 X 10^{-5}**	**3.6 X 10^{-6}**

[1] *ND-not detected at concentrations above the laboratory reporting limit*

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CERTIFICATION

This Houston Ship Channel/Tabbs 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.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

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