

HEALTH CONSULTATION

ARROYO COLORADO

Cameron and Hidalgo Counties, 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) Seafood Safety Division (SSD) evaluate the potential health risks associated with consumption of fish and crabs from two stream segments of the Arroyo Colorado. In 1980, the United States Fish and Wildlife Service (USFWS) reported that fish tissue collected since the mid 1960s contained significantly elevated concentrations of DDT, DDE, and toxaphene. At that time, the USFWS requested that the United States Environmental Protection Agency (EPA) investigate sources of contamination in the Arroyo and address any associated public health concerns. The EPA referred this request to the TDH regional office in Harlingen, Texas. In September 1980, the regional office recommended that people not consume fish from the Arroyo Colorado upstream of the Port of Harlingen because of contamination with p,p'- DDT (Fig. 1). In 1984, the Texas Department of Health reiterated this advisory. Sampling during the intervening years has repeatedly revealed the continuing presence of DDE, chlordane, toxaphene, and other pesticides in fish tissue from the Arroyo Colorado.

The Arroyo Colorado is a major drainage channel for Willacy, Cameron, and Hidalgo Counties, an area that encompasses almost 500,000 acres of irrigated crop land and several cities. Approximately 850,000 people live in the region. The Arroyo Colorado runs parallel to, and north of, the Rio Grande through Hidalgo and Cameron Counties in the Rio Grande Valley. Major agricultural products include cotton, citrus fruits, vegetables, grain, corn, and sugar cane. Upstream of the Port of Harlingen, the Arroyo Colorado is a narrow, shallow fresh-water ditch. The lower portion of the Arroyo Colorado (from the Port of Harlingen to the Laguna Madre) has been channelized to facilitate boat traffic (Fig. 1). This segment of the river is tidally-influenced and supports saltwater and freshwater marine life. Extensive recreational fishing and some commercial fishing occur in the Arroyo Colorado. Water quality is influenced by urban and agricultural nonpoint-source runoff, municipal and industrial effluents.

In October 1998, the SSD collected thirty-two finfish from upstream of the Port of Harlingen and eight fish and four composite blue crab samples downstream of the port. The TDH laboratory analyzed edible tissues from these samples for volatile organic compounds (VOCs), semivolatile organic compounds, polychlorinated biphenyls (PCBs), metals, and pesticides. The TNRCC provided funding for this project.

Low concentrations of the pesticides chlordane, chlorpyrifos, p,p'-DDE, dieldrin, and dacthal were detected in fish and crabs from the segment downstream of the Port of Harlingen (Downstream area, Table 1a). Higher concentrations of these pesticides as well as low concentrations of p,p'-DDD, p,p'-DDT, endrin, hexachlorobenzene, heptachlor, heptachlor epoxide, lindane, and methoxychlor were found in finfish from upstream of the port (Upstream area, Table 1a). Samples from both stream segments contained acetone or methylene chloride, both of which are common laboratory contaminants. Cadmium, copper, lead, mercury, selenium and zinc were detected at low levels in samples from both upstream and downstream of the Port of Harlingen (Table 1b).

DISCUSSION

Deriving Health-based Assessment Comparison Values (HACs)

TDH evaluated the chemical contaminants in fish and crab samples from the Arroyo Colorado for potential adverse health effects by comparing average contaminant concentrations with health-based assessment comparison (HAC) values for noncancer and cancer endpoints. We used the U.S. Environmental Protection Agency's (EPA) 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 that we used in this health 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}) people exposed to the chemicals, and an exposure period of 30 years. We 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]. Many of the constants we use to calculate HAC values have "safety" margins built in; thus, adverse health effects will not necessarily occur simply because concentrations of toxicants in seafood exceed HAC values.

Addressing the Potential for Cumulative Effects

When multiple chemicals affect the same target organ or when several potential carcinogens are found together in seafood, we assume that adverse effects are cumulative. To evaluate the potential public health impact of additive noncancer 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 dose 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. On the other hand, 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 may be considered. To estimate the potential excess lifetime cancer risk associated with simultaneous exposure to multiple carcinogens, we calculate a cumulative risk by adding the estimated risks for individual contaminants. The Texas Department of Health recommends that consumption of seafood contaminated with potentially carcinogenic chemicals be limited to amounts that result in an estimated theoretical excess lifetime cancer risk of not more than 1 excess cancer in 10,000 persons exposed to contaminants in seafood.

Addressing the Unique Vulnerabilities of Children

We recognize that the unique vulnerabilities of infants and children demand special attention. Windows of vulnerability (critical periods) exist during development, particularly during early gestation, but also throughout pregnancy, infancy, childhood and adolescence-periods when toxicants may permanently impair or alter structure or function [2]. Unique childhood

vulnerabilities may be present because, at birth, many organs and body systems-including the lungs, immune, endocrine, reproductive, and nervous system-have not achieved structural or functional maturity; these organ-systems continue to develop throughout childhood and adolescence. Children may exhibit differences in absorption, metabolism, storage, and excretion of toxicants, resulting in higher biologically-effective doses to target tissues. They may also be more highly exposed than adults because they consume proportionately more food and liquids than adults [2]. Thus, children may suffer adverse effects not experienced by adults; they may experience toxic effects at lower exposure levels or they may react more severely to an equivalent exposure dose [2]. Children may also be more prone to developing certain cancers from chemical exposures than adults. Therefore, in accordance with ATSDR's *Child Health Initiative* [3] and EPA's *National Agenda to Protect Children's Health from Environmental Threats* [4], we evaluated the potential public health hazards to children who eat fish or crabs from the Arroyo Colorado.

Characterizing the Risk

Assessing Noncancer Health Effects

Average concentrations of individual contaminants in fish and crabs from the Arroyo Colorado both upstream and downstream of the Port of Harlingen were lower than their respective noncancer HAC values (Tables 1a & 1b). Thus, long-term consumption of seafood from the Arroyo Colorado that contains any one contaminant is unlikely to result in adverse noncancerous health effects. On the other hand, four chlorinated hydrocarbon pesticides (chlordane, DDE, dieldrin, and dacthal) detected in fish and crabs from downstream of the Port of Harlingen and eleven chlorinated hydrocarbon pesticides (chlordane, DDD, DDT, DDE, dacthal, dieldrin, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, and lindane) detected in fish upstream of the port are known to have adverse noncancerous effects on the livers of experimental animals [5]. We assessed the cumulative effect of simultaneous exposure to the observed contaminants by calculating the number of meals per week a person could eat without exceeding a hazard index of one (Table 2). As shown in Table 2, eating finfish and crabs from downstream of the port is unlikely to result in adverse noncancerous health effects. Conversely, eating more than one meal per week of mixed finfish from upstream of the Port of Harlingen could result in a hazard index greater than one (1.0). It is also evident that smallmouth buffalo, caught exclusively upstream of the Port of Harlingen, contained higher concentrations of contaminants than other species. Smallmouth buffalo are large, easy to catch, and are commonly consumed. Persons who eat more than one-half meal per week of smallmouth buffalo would exceed a HI of one (Table 2). However, excluding smallmouth buffalo from the diet would allow unlimited consumption of other species of finfish from upstream of the Port of Harlingen (Table 2).

Although a RfD or a HI does not represent a sharp dividing line between "safe" and "unsafe" exposures, in practice, we view it as "unacceptable" when consumption of less than one meal per week results in exposures that exceed health-based assessment guidelines. The strict demarcation between "acceptable" and "unacceptable" levels of exposure or risk is a tool used by risk managers to ensure protection of public health. Therefore, consuming more of a contaminant or

contaminants than that recommended for management of risk does not necessarily mean that adverse health effects will occur.

Assessing Cancer Health Effects

The individual contaminants in fish and crabs from either upstream or downstream of the Port of Harlingen area were found at average concentrations below their respective cancer HAC values (Table 1a). However, seven chemicals (chlordane, DDE, DDD, DDT, dieldrin, hexachlorobenzene, heptachlor, and heptachlor epoxide) in fish from the Arroyo Colorado are classified by the EPA as probable human carcinogens (group B2), based on an increase in the incidence of hepatic tumors in laboratory animals [5]. People who eat fish from the Arroyo Colorado may be exposed to several of these chemicals at the same time. Based on previously stated assumptions, we calculated that people eating one meal per week of mixed finfish from upstream of the port for 30 years could theoretically increase their excess lifetime cancer risk by approximately 8.7 per 100,000 persons exposed (Table 3). Qualitatively this is interpreted as no apparent increased lifetime risk for the development of cancer. On the other hand, people eating more than one meal per week of smallmouth buffalo could theoretically increase their excess lifetime cancer risk to 1.8 per 10,000 persons exposed (Table 3), interpreted as a low to moderate increase in the risk for development of cancer. Excluding smallmouth buffalo lowers the estimated excess lifetime cancer risk to 5.1 per 100,000 people exposed to the chemicals. Qualitatively, we interpret this as no apparent increase in the risk for development of cancer. For carcinogenic chemicals, the Texas Department of Health recommends that people limit consumption of contaminated fish to amounts that result in an estimated excess theoretical lifetime cancer risk of not more than 1.0 per 10,000 persons exposed to contaminants in seafood.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

1. Ingestion of fish and crabs from the Arroyo Colorado downstream of the Port of Harlingen does not pose a public health hazard.
2. Long-term consumption of smallmouth buffalo from the Arroyo Colorado upstream of the Port of Harlingen poses a public health hazard because persons regularly consuming more than one-half meal per week of this species would exceed a hazard index of one and would also exceed TDH's health-based guideline for excess cancers. While exposures to the estimated doses of the combined chemicals in smallmouth buffalo are not likely to result in overt signs and symptoms of disease or toxicity, the possibility of subtle adverse health effects from long-term, low-level simultaneous exposure to multiple chlorinated hydrocarbon contaminants cannot be easily dismissed. Because of this concern and because the estimated doses exceed TDH risk-management guidelines, ingestion of large quantities of smallmouth buffalo from the Arroyo Colorado may be cause for concern.

RECOMMENDATIONS AND PUBLIC HEALTH ACTION PLAN

Portions of the Arroyo Colorado in Cameron and Hidalgo Counties have long been under a consumption advisory due to contamination of fish tissue with DDE and other organic

compounds. The original advisory recommended that people not eat any species of fish from the Arroyo Colorado upstream of the Port of Harlingen due to the presence of elevated concentrations of chlorinated pesticides. TDH has established criteria for issuing fish consumption advisories based on consumption guidelines from the EPA [2]. EPA estimates that the 50th percentile of recreational fishers consume 30 grams of fish per day (approximately one eight-ounce meal per week). When the data show that eating less than one eight-ounce meal per week results in exposures that exceed health-based assessment guidelines, the Seafood Safety Division and the Environmental Epidemiology and Toxicology Division generally recommend that the Commissioner of Health issue a consumption advisory.

Based on the findings of this health consultation, the Seafood Safety and Environmental Epidemiology and Toxicology Divisions of the Texas Department of Health recommend the following:

3. People eating fish from the Arroyo Colorado upstream of the Port of Harlingen should limit consumption of smallmouth buffalo to two meals per month (eight ounces for adults, four ounces for children) because long-term consumption of large quantities of this species of fish could result in adverse noncancerous health effects or increase the risk of excess cancers in those who regularly consume this species of finfish.
4. People may consume other species of fish from the Arroyo Colorado upstream of the Port of Harlingen without restriction.
5. Finfish and crabs taken from downstream of the Port of Harlingen pose no apparent risk and may be consumed by the public without restriction.
6. TDH may continue to monitor contaminants in fish from the Arroyo Colorado as these data become available.

Table 1a. Organic contaminant concentrations in fish and crabs from the Arroyo Colorado (mg/kg)				
Chemical	Number Affected/ Sampled	Average Concentration (Range)	Comparison Value¹	Basis for Comparison Value
Downstream area (fish and crabs)				
chlordane	1/12	0.005 (nd ² -0.058)	1.2	EPA chronic oral RfD: 0.0005 mg/kg/day
			1.6	EPA slope factor: 0.35 (mg/kg/day) ⁻¹
chlorpyrifos	1/12	0.0013 (nd-0.015)	7.0	EPA chronic oral RfD: 0.003 mg/kg/day
			2.3	ATSDR chronic oral MRL: 0.001 mg/kg/day
p,p'-DDE	9/12	0.044 (nd-0.16)	1.6	EPA slope factor: 0.34 (mg/kg/day) ⁻¹
dieldrin	1/12	0.0007 (nd-0.008)	0.034	EPA chronic oral RfD: 0.00005 mg/kg/day
			0.117	EPA slope factor: 16 (mg/kg/day) ⁻¹
dacthal	1/12	0.007 (nd-0.086)	23.3	EPA chronic oral RfD: 0.01 mg/kg/day
Upstream area (fish, only)				
chlordane	29/32	0.13 (nd-0.61)	1.2	EPA chronic oral RfD: 0.0005 mg/kg/day
			1.6	EPA slope factor: 0.35 (mg/kg/day) ⁻¹
chlorpyrifos	12/32	0.011 (nd-0.075)	7.0	EPA chronic oral RfD: 0.003 mg/kg/day
p,p'-DDD	11/32	0.01 (nd-0.10)	2.27	EPA slope factor 0.24 (mg/kg/day) ⁻¹
			1.167	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDE	31/32	0.88(0.04-4.2)	1.6	EPA slope factor 0.34 (mg/kg/day) ⁻¹
			1.167	EPA chronic oral RfD: 0.0005 mg/kg/day
p,p'-DDT	4/32	0.008 (nd-0.21)	1.167	EPA chronic oral RfD: 0.0005 mg/kg/day
			1.6	EPA slope factor 0.34 (mg/kg/day) ⁻¹
dieldrin	14/32	0.007 (nd-0.045)	0.117	EPA chronic oral RfD: 0.00005 mg/kg/day
			0.034	EPA slope factor 16 (mg/kg/day) ⁻¹
dacthal	32/32	0.256 (nd-1.6)	23.3	EPA chronic oral RfD: 0.01 mg/kg/day
endrin	5/32	0.0025 (nd-0.028)	0.7	EPA chronic oral RfD: 0.0003 mg/kg/day
hexachlorobenzene	6/32	0.0008 (nd-0.012)	1.867	EPA chronic oral RfD: 0.0008 mg/kg/day
			0.34	EPA slope factor: 16 (mg/kg/day) ⁻¹
heptachlor	1/32	0.00008 (nd-0.0025)	1.167	EPA chronic oral RfD: 0.0005 mg/kg/day
			0.121	EPA slope factor 4.5 (mg/kg/day) ⁻¹
heptachlor epoxide	3/32	0.0009 (nd-0.014)	0.03	EPA chronic oral RfD: 0.000013 mg/kg/day
			0.06	EPA slope factor 9.1 (mg/kg/day) ⁻¹
lindane	3/32	0.0005 (nd-0.005)	0.7	EPA chronic oral RfD: 0.0003 mg/kg/day
methoxychlor	2/32	0.002 (nd-0.035)	11.67	EPA chronic oral RfD: 0.005 mg/kg/day

¹ derived from the MRL or RfD for non-carcinogens, and 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 1 in 10,000 persons exposed to the chemical.

² nd-not detected at concentrations above laboratory reporting limit

Table 1b. Inorganic contaminant concentrations in fish and crabs from the Arroyo Colorado (mg/kg)				
Chemical	Number Affected/Sampled	Average Concentration (Range)	Comparison Value ¹	Basis For Comparison Value
Downstream area (fish and crabs)				
cadmium	12/12	0.03 (0.001-0.12)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	12/12	3.1 (0.09-10)	-----	none available
lead	3/12	0.006 (nd ² -0.03)	-----	IEUBK ³
mercury	12/12	0.14 (0.04-0.37)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg/day
selenium	12/12	0.6 (0.49-0.78)	12	ATSDR chronic oral MRL/EPA chronic oral RfD: 0.005 mg/kg/day
zinc	12/12	16 (2.7-47)	700	ATSDR chronic oral MRL/EPA chronic oral RfD: 0.3 mg/kg/day
Upstream area (fish, only)				
cadmium	14/32	0.005 (nd ² -0.27)	0.047	ATSDR chronic oral MRL: 0.0002 mg/kg/day
copper	15/32	0.12 (nd-0.54)	----	none available
lead	6/32	0.004 (nd-0.27)	----	IEUBK ³
mercury	24/32	0.17 (0.045-0.46)	0.7	chronic oral MRL: 0.0003 mg/kg/day
selenium	32/32	0.41 (0.15-0.79)	12	chronic oral MRL/RfD: 0.005 mg/kg/day
zinc	32/32	4.6 (2.1-8.3)	700	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

Table 2. Number of meals per week of fish from the Arroyo Colorado that can be eaten without exceeding a Hazard Index of 1.0 ¹		
	Upstream Area	Downstream Area
All species	1.0	20
All species excluding smallmouth buffalo	1.6	not applicable ²

Smallmouth buffalo, only	0.5	not applicable ²
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¹ Assumes a 70-kg adult and a meal size of eight-ounces or a 35-kg child and a meal size of four-ounces.

² Smallmouth buffalo are not found in this area.

Table 3. Theoretical lifetime excess cancer risk from consumption¹ of fish from the Arroyo Colorado			
COMPOUND	<i>Smallmouth Buffalo only</i>	<i>All species except Smallmouth Buffalo</i>	<i>All fish species</i>
Upstream area			
dieldrin	4.7x10 ⁻⁵	1.1x10 ⁻⁵	2.1x10 ⁻⁵
p,p'-DDD	1.5x10 ⁻⁶	1.3x10 ⁻⁷	5.3x10 ⁻⁷
p,p'-DDT	1.6x10 ⁻⁶	5.6x10 ⁻⁸	4.9x10 ⁻⁷
p,p'-DDE	1.1x10 ⁻⁴	3.3x10 ⁻⁵	5.5x10 ⁻⁵
chlordane	1.5x10 ⁻⁵	6x10 ⁻⁶	8.6x10 ⁻⁶
heptachlor	2.3x10 ⁻⁷	0	6.5x10 ⁻⁸
heptachlor epoxide	3.7x10 ⁻⁶	6.7x10 ⁻⁷	1.5x10 ⁻⁶
hexachlorobenzene	6.9x10 ⁻⁷	7.6x10 ⁻⁸	2.5x10 ⁻⁷
CUMULATIVE RISK	1.8x10⁻⁴	5.1x10⁻⁵	8.7 x10⁻⁵
Downstream area²			
chlordane	not applicable		3.1x10 ⁻⁷
p,p'-DDE	"		2.7x10 ⁻⁶
dieldrin	"		2.1x10 ⁻⁶
Cumulative Risk			5x10⁻⁶

¹ Assumes an average body weight of 70-kg and an average daily consumption of 30 grams (approximately one eight-ounce fish meal per week). Acceptable Risk Level (ARL) = 1 X 10⁻⁴ or one extra cancer in 10,000 exposed individuals.

² eight finfish and four crab samples collected downstream

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CERTIFICATION

This Arroyo Colorado 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.

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