4.7 Public Health

Seafood Safety

The Health Consultations performed by the Texas Department of Health on samples of fish and crabs from different segments of Galveston Bay were transformed into a database suitable for statistical analysis. Most of the variables in the database had too little data for analysis because nearly all of the samples analyzed had concentrations of the contaminants recorded as being below detection limits. The only set of variables that offered a robust data set for correlation analysis was the concentration of metals. Analytical techniques for metals were able to detect concentrations of cadmium, copper, lead, mercury, selenium and zinc in nearly all of the tissue samples examined.

The method of preparation of finfish and crab tissue differed and required separate analysis. Only muscle tissue was removed from finfish and analyzed for metal concentration. In crabs composite samples of multiple individuals were prepared that contained all of the tissues, including hepatopancreas. Liver and hepatopancreas tissues concentrate metals that bind to metallothionein and related proteins. Thus the concentrations of metals measured in crab tissue in these studies were higher. In the cases of cadmium, copper and zinc, crab tissue concentrations were an order of magnitude higher or more than those concentrations found in finfish.

Table 4.7.1. Concentrations of metal species found in samples of fish and crab collected from Galveston Bay by the TDH. Fish samples are based on muscle only, while crab samples are whole body. Concentrations are reported as mg/kg.

Metal	**Fish (N=243)**	**Crab (N=65)**
Cadmium	0.005	0.076
Copper	0.165	8.047
Lead	0.010	0.020
Mercury	0.050	0.012
Selenium	0.587	0.706
Zinc	3.911	37.645

Cadmium, copper and zinc exhibited correlated concentrations in both groups of organisms. Mercury and selenium showed no significant correlations with any of the other metals. Lead exhibited a significant correlation with zinc in fish muscle tissue ($r=0.29$; $p<0.0001$). The table below shows the relationships among cadmium, copper and zinc. It is not clear why the metabolism of these metals should be correlated when mercury, another divalent cation, shows no similar relationship. There is also no existing analysis of Galveston Bay water quality data to show that these metals are commonly discharged together to the Bay and would be ingested or absorbed together.

Table 4.7.2. Significant correlations of metal concentrations found in tissue of fish and crab collected from Galveston Bay by TDH. Fish samples are based on muscle only while crab samples are whole body.

Correlation	Fish	Crab
Cadmium to copper	Ns	0.50***
Cadmium to zinc	0.17*	0.64***
Copper to zinc	0.92***	0.42**

*= $p<0.01$
** = $p<0.001$
*** = $p<0.0001$

One additional correlation found in the analysis of this data was of interest. A correlation between mercury and weight of fish confirmed the reported tendency of mercury to bioaccumulate over the life of a fish. The correlation was 0.29 ($p<0.0001$).

Table 4.7.3 shows a summary of the average concentrations of metals in samples of different types of organisms collected from different sub-bays. The samples were divided into freshwater fish species, saltwater fish species and blue crabs to examine the association of habitat and life history with metal contamination. It appears from the table that fish associated with freshwater habitats and those associated with saltwater habitats have similar concentrations of copper, lead and zinc. The concentrations of cadmium and mercury appear to have different patterns in the freshwater and saltwater species, but t-tests on the sets of concentrations in freshwater and saltwater fish from the Houston Ship Channel and Trinity Bay are not significant.

Table 4.7.3. Concentrations of five metal species in tissue samples of freshwater fish species, saltwater fish species, and blue crab composite samples collected from the Houston Ship Channel, Trinity Bay and Upper Galveston Bay. Concentrations are reported as mg/kg.

		N	Cadmium	Copper	Lead	Mercury	Zinc
Houston Ship Channel	Freshwater Fish	16	0.0003	0.3044	0.0050	0.1137	3.8263
	Saltwater Fish	8	0.0039	0.1968	0.0055	0.0814	3.3575
	Blue Crab Composite	8	0.1187	11.8575	0.0286	0.0406	40.6625
Trinity Bay	Freshwater Fish	20	0.0032	0.0820	0.0024	0.0447	3.6640
	Saltwater Fish	11	0.0129	0.0660	0.0018	0.0169	3.2509
	Blue Crab Composite	8	0.0416	5.8000	0.0000	0.0163	32.5000
Upper Galveston Bay	Freshwater Fish	2	0.0028*	0.4155	0.0000	0.2615	3.7550
	Saltwater Fish	30	0.0008	0.2246	0.0000	0.0510	3.3733
	Blue Crab Composite	8	0.0795	7.5950	0.0087	0.0292	37.6625

Note: The freshwater fish consist of two species: 1) striped bass is found in freshwater and saltwater and exhibits a high cadmium concentration; 2) hybrid striped bass is only stocked in freshwater, and has no detectable cadmium. The two species have similar concentrations of copper, mercury and zinc.

In the cases of PCB, pesticides and volatile compounds, most of the variables measured were undetectable in the tissue samples. Some of the contaminants were detected in a subset of the samples. The samples collected from the Houston Ship Channel had the highest frequency of detectable contaminants. Variables were selected that had detectable concentrations in more than 25% of the fish or crab samples from the Houston Ship Channel for calculation of averages. This resulted in the inclusion of one PCB, eight pesticides, and eight volatile compounds. Table 4.7.4 shows concentrations of the pesticides and PCB compounds in blue crab and fish tissues. Unlike the metals, crabs have lower pesticide and PCB concentrations than fish muscle tissue. The contamination has a geographic distribution of high levels in the Houston Ship Channel samples, reduced levels in the northern sub-bays and low to zero concentrations in the southern sub-bays. One exception to this pattern is the level of DDT found in crabs from Christmas and Bastrop Bays.

Table 4.7.4. Average concentration of eight pesticides and one PCB found in the tissue of fish and crabs from various locations around the Galveston Bay system. Concentrations are reported as ug/kg.

	p'p'-DDD		p'p'-DDE		p'p'-DDT		Dieldrin	
Location	**FISH**	**CRAB**	**FISH**	**CRAB**	**FISH**	**CRAB**	**FISH**	**CRAB**
Houston Ship Channel	5.63	3.13	24.49	7.41	3.17	0	7.94	0.99
Trinity Bay	6.75	0	11.41	0	0.89	0	0.69	0
Upper Galveston Bay	1.66	1.63	7.53	6.49	0	0	0.77	0
Lower Galveston Bay	0	0	0.76	0.83	0	0	0	0
Clear Lake	0.61	0	3.72	0	0	0	0	0
East Bay	0	0	1.21	0	0	0	0	0
West Bay	0	0	0	0	0	0	0	0
Christmas Bay	0	0	1.09	0	0	4	0	0

	Heptachlor epoxide		Hexachlorobenzene		Lindane		Chlordane	
Location	**FISH**	**CRAB**	**FISH**	**CRAB**	**FISH**	**CRAB**	**FISH**	**CRAB**
Houston Ship Channel	6.69	1.76	2.74	1.63	1.58	0	274.00	120.75
Trinity Bay	0.43	0	0.37	0	0	0	40.32	3.88
Upper Galveston Bay	0.96	4.8	0.58	0	0.17	0	32.72	54.25
Lower Galveston Bay	0	0	0	0	0	0	0	0
Clear Lake	0	0	0	0	0	0	54.97	43
East Bay	0	0	0.69	0	0	0	8.94	1.5
West Bay	0	0	0	0	0	0	3.75	3.13
Christmas Bay	0	0	0	0	0	0	1.82	0

	Arochlor 1260	
Location	**Fish**	**Crab**
Houston Ship Channel	34.2	0
Trinity Bay	19	0
Upper Galveston Bay	7.9	0
Lower Galveston Bay	5.2	0
Clear Lake	14.7	0
East Bay	0	0
West Bay	0	0
Christmas Bay	0	0

It is clear that crabs in most cases have lower pesticide and PCB concentrations than fish. This could be related to the inclusion of all tissues in the blue crab composite sample, while fish are sampled for muscle tissue only. Lindane and the PCB, Arochlor 1260, do not appear in detectable amounts in crab samples.

One of the problems encountered in the interpretation of data obtained on tissue contaminant concentration is lack of knowledge of the history of the organisms sampled. Presence of pollutants in fish found in Galveston Bay does not mean that the contaminants were obtained near the collection site. The Table 4.7.5 below shows the difference in concentration of volatile compounds in the tissue of fish species classified according to whether their habitat is commonly freshwater or salt water. Saltwater species show non-detectable concentrations of these contaminants. This suggests that fish encounter these compounds in areas that are distinct from Galveston Bay, a saltwater habitat.

Table 4.7.5. Concentrations of volatile compounds in muscle tissue from freshwater and saltwater fish collected in the Houston Ship Channel. Concentrations are reported as ug/kg.

Volatile Compound	**Freshwater Fish* (N = 16)**	**Saltwater Fish** (N = 8)**
1,3,5-Trimethylbenzene	3.69	0
1,4-Dichlorobenzene	7.38	0
Benzene	1.31	0
Chloroform	3.82	0
Naphthalene	1.5	0
Styrene	6.38	0
Tetrachloroethene	23.31	0
Toluene	2.94	0

* Species are bass, Buffalo, blue catfish, common carp and drum.
** Species are red drum, sheepshead, and Southern flounder.