

**LCRA Fish Tissue Study
in the Colorado River Basin**

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Executive Summary

In 2005, LCRA conducted a study to determine concentrations of metals, pesticides and PCBs in fish tissue at two sites in the Colorado River basin: Lake Travis Pedernales River arm and the Colorado River at Webberville, downstream of Austin. The purpose of the study was to determine if any of the fish tissue contained concentrations of harmful constituents that were high enough to be a human health concern, and to compare results between sites upstream and downstream of Austin. LCRA reported the study results to the Texas Commission on Environmental Quality (TCEQ) so that the data can be used in future assessments of water quality.

LCRA staff collected 24 edible-size game fish from the two sites and the samples were analyzed for 31 constituents by LCRA's Environmental Laboratory Services. Lab results found four constituents in measurable concentrations: mercury, the pesticide DDT, DDE and DDD (both degradation products of DDT).

Mercury was detected in 18 of the 24 fish analyzed. All of the mercury concentrations were below the 0.7 milligrams per kilogram (mg/kg) Health Assessment Comparison screening value set by Texas Department of State Health Services (TDSHS). DDT, DDE or DDD were detected in 12 of the 24 fish analyzed, all from the Colorado River at Webberville site. None of the values exceeded the corresponding TDSHS Health Assessment Comparison screening values. Neither DDT, DDE nor DDD were found in measurable concentrations in any of the fish collected at the Lake Travis site. The remaining 27 constituents (2 metals and 25 organic compounds) were not found in measurable concentrations.

Since none of the constituents were at a high enough concentration to cause public health or fish consumption concerns, LCRA has no plans to monitor fish tissue in the immediate future.

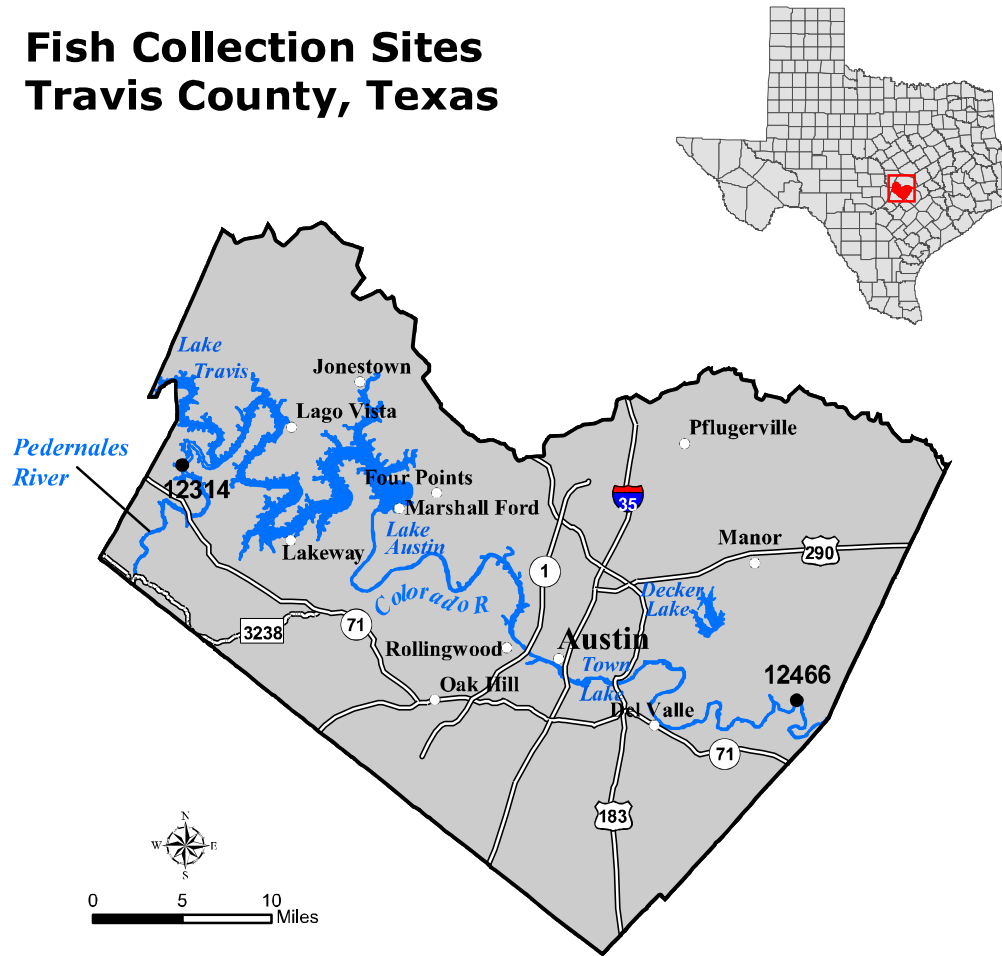
BACKGROUND

LCRA collected fish tissue samples for two purposes: so that LCRA would know the concentration of some metals and organic compounds in fish from the Colorado River, and so that TCEQ might evaluate fish tissue in their assessment of state water bodies. TCEQ has combined the CWA 305(b) and 303(d) assessments into the Water Quality Inventory and 303(d) list. The next assessment period for the TCEQ assessment includes data collected December 1, 1999, through November 30, 2004. For TCEQ's 2006 report, TCEQ will likely decide to not include the data summarized in this report even though it was collected and reported to TCEQ in 2005. Factored into the decision not to include LCRA's data was the fact that no fish were found to exceed known levels of concern. The fish tissue data presented in this report will be evaluated in TCEQ's next report, the 2008 assessment.

LCRA evaluated fish tissue concentrations from a human health perspective. For several years after the historic Christmas flood of 1991, LCRA staff received questions about chlordane in fish caught downstream of Town Lake and the safety of fish consumption. The basis for this concern is the fact that Town Lake had a consumption advisory based on chlordane. It is likely that the 1991 flood displaced some Town Lake fish downstream into the Colorado River. Chlordane was an issue in Town Lake due to the persistency of the pesticide in sediment and fish tissue and its use in the Austin area as an insecticide. The predecessor to TDSHS removed the Town Lake consumption advisory in 1999 after performing internal studies and fish collections. TDSHS is the state's authority in declaring or rescinding fish consumption advisories.

The fish tissue results collected from this study were reported to TCEQ through the Clean Rivers Program. TCEQ, Texas Parks and Wildlife and TDSHS staff meet periodically to discuss fish tissue results throughout the state and to plan future monitoring efforts. TCEQ, with data from this LCRA fish study in hand, can discuss and consider with these other agencies appropriate action.

Fish Collection Sites Travis County, Texas



METHODS

In 2005 LCRA collected edible size game fish from two sites: Lake Travis Pedernales River arm (12314) and Colorado River at Webberville (12466). Both sites are shown in the map above. Both sites receive considerable fishing pressure. The site at Webberville is downstream of Austin and receives urban runoff from the Austin metropolitan area. Lake Travis is the site of several fishing tournaments throughout the year. The selection of sample sites also allowed for an upstream-to-downstream of Austin comparison.

The fish were electroshocked and netted. For this study, a total of 56 minutes of electroshocking was performed. The two sites were sampled twice. The fish were identified, measured and weighed. No physical anomalies were seen in the fish that were collected. Each individual fish was treated as one sample. The fish were not combined into composite samples. The fish, wrapped in aluminum foil, were bagged in water-proof plastic bags, placed on ice and delivered to the LCRA Environmental Laboratory

Services (ELS) for filleting and analysis. The fish were filleted in the laboratory and only the muscle tissue was analyzed. The skin and internal organs were not analyzed.

The fish were analyzed by the ELS for the following analyte groups using the corresponding methods shown in Table 1.

Table 1. List of fish tissue analytes and methods used.

Analyte Group	Analyte	Analytical Method
Metals	Mercury	EPA 245.6
	Chromium	SW 6010B
	Copper	SW 6010B
Organochlorine Pesticides	4,4' - DDT	SW 8081A
	4,4' - DDE	SW 8081A
	4,4' - DDD	SW 8081A
	Aldrin	SW 8081A
	Alpha-BHC	SW 8081A
	Beta-BHC	SW 8081A
	Chlordane	SW 8081A
	Delta- BHC	SW 8081A
	Dieldrin	SW 8081A
	Endosulfan I	SW 8081A
	Endosulfan sulfate	SW 8081A
	Endrin	SW 8081A
	Gamma-BHC	SW 8081A
	Heptachlor	SW 8081A
	Heptachlor epoxide	SW 8081A
Methoxychlor	SW 8081A	
Organochlorine Pesticides	Toxaphene	SW 8081A
PCBs	PCBs	SW 8082
	Arochlor 1016	SW 8082
	Arochlor 1221	SW 8082
	Arochlor 1232	SW 8082
	Arochlor 1242	SW 8082
	Arochlor 1248	SW 8082
	Arochlor 1254	SW 8082
	Arochlor 1260	SW 8082
Organophosphorus Pesticides	Diazinon	SW 8141A
	Ethyl parathion	SW 8141A
	Malathion	SW 8141A

RESULTS

Twenty-four individual fish were collected and analyzed. The nine fish species, collected from both sites, are shown in Table 2. The EPA species code is required in reporting the data to TCEQ. As shown in Table 2, *Ictalurus punctatus* and *Micropterus salmoides* were the most commonly collected fish species.

Table 2. List of fish species and number of individuals collected and analyzed.

Fish Species	Common Name	# of Individuals	EPA Species Code
<i>Pomoxis nigromaculatus</i>	Black crappie	1	005
<i>Ictalurus punctatus</i>	Channel catfish	5	016
<i>Micropterus salmoides</i>	Largemouth bass	5	031
<i>Moxostoma congestum</i>	Gray redhorse	4	041
<i>Carpiondes carpio</i>	River carpsucker	1	042
<i>Pomoxis annularis</i>	White crappie	1	059
<i>Micropterus treculi</i>	Guadalupe bass	3	095
<i>Morone saxatilis x M. chrysops</i>	Hybrid striped bass	1	198
<i>Pylodictus olivaris</i>	Flathead catfish	3	489

Most of the constituents, 27 of 31, analyzed by the laboratory were below a detectable concentration. These analytes for which were not detected by the laboratory are shown in Table 3 along with the corresponding laboratory detection limit and parameter code. The various aroclors shown in Table 3 are multi-component mixtures of polychlorinated biphenyl (PCB) compounds. Similarly, to the EPA species code shown in Table 2, the parameter code is required in reporting the fish tissue data to TCEQ. All results, even those with a concentration less than detectable, were reported to TCEQ.

Table 3. Analytes that were below the detection limit in all samples analyzed.

Analyte	Detection Limit (mg/kg)	Parameter Code
Chromium	5	71939
Copper	5	71937
Aldrin	0.005	34680
Alpha- BHC	0.005	39074
Beta-BHC	0.005	34258
Chlordane	0.05	34682
Delta- BHC	0.005	34263
Dieldrin	0.005	39406
Endosulfan I	0.005	34365
Endosulfan sulfate	0.005	34355
Endrin	0.005	34685
Gamma- BHC	0.005	39785
Heptachlor	0.005	34687
Heptachlor epoxide	0.005	34686
Methoxychlor	0.01	81644
Toxaphene	0.05	34691
PCB	0.05	39515
Aroclor 1016	0.05	34674
Aroclor 1221	0.05	34664
Aroclor 1232	0.05	34667
Aroclor 1242	0.05	34689
Aroclor 1248	0.05	34669
Aroclor 1254	0.05	34690
Aroclor 1260	0.05	34670
Diazinon	0.05	81806
Ethyl parathion	0.05	81810
Malathion	0.05	39534

Mercury, DDE, DDD and DDT concentrations exceeded the minimum reporting limit in the fish samples collected for this study. The results of these four constituents are the focus of this report. A brief description of human health effects is included with these analytes.

Mercury

Seventy percent of total annual mercury releases to the environment are from human activities. Most mercury releases to the air occur when fossil fuels are burned and solid waste is incinerated. Microbes convert elemental mercury to the biologically available form, methyl mercury. Fetuses, infants and children are most susceptible to nervous system damages that can be caused by mercury. Mercury is important to human physiology in that it can cause developmental toxicity.

Eighteen of 24 fish analyzed had detectable mercury concentrations. These 18 individuals represent nine different species and were of various sizes and are shown in Table 4. A largemouth bass contained the highest concentration of mercury, 0.634 mg/kg. The mercury fish tissue results were reported to TCEQ using parameter code 71930. The detectable concentration for mercury was 0.1 mg/kg. The fish containing mercury were collected at both the Lake Travis (12314) and the Colorado River (12466) sites.

Table 4. Fish with detectable mercury concentrations.

Collection Date	Site	Result (mg/kg)	Species	Length (mm)	Weight (g)
6/21/2005	12314	0.634	<i>Micropterus salmoides</i>	350	425
2/24/2005	12314	0.602	<i>Micropterus salmoides</i>	455	1049
2/24/2005	12314	0.498	<i>Micropterus salmoides</i>	410	765
4/28/2005	12466	0.444	<i>Morone saxatilis x M. chrysops</i>	464	1814
2/24/2005	12314	0.289	<i>Pomoxis annularis</i>	290	283
8/23/2005	12466	0.262	<i>Carpiondes carpio</i>	435	503
6/21/2005	12314	0.245	<i>Micropterus salmoides</i>	340	425
8/23/2005	12466	0.197	<i>Micropterus salmoides</i>	305	485
2/24/2005	12314	0.195	<i>Pomoxis nigromaculatus</i>	300	340
4/28/2005	12466	0.175	<i>Micropterus treculi</i>	318	340
6/21/2005	12314	0.163	<i>Pylodictus olivaris</i>	420	567
6/21/2005	12314	0.136	<i>Pylodictus olivaris</i>	410	567
4/28/2005	12466	0.106	<i>Micropterus treculi</i>	241	227
8/23/2005	12466	0.105	<i>Pylodictus olivaris</i>	440	481
4/28/2005	12466	0.0681	<i>Ictalurus punctatus</i>	381	531
8/23/2005	12466	0.0618	<i>Ictalurus punctatus</i>	560	1860
2/24/2005	12314	0.0536	<i>Moxostoma congestum</i>	345	397
8/23/2005	12466	0.0471	<i>Ictalurus punctatus</i>	520	1374

To provide information about which species contained the higher mercury concentrations, LCRA performed an analysis by evaluating mercury concentrations measured in each of the nine fish species. Figure 1 is a graph of the sum of mercury concentrations found in each fish species. The graph represents only those individuals that had measurable concentrations of mercury. Largemouth bass (*Micropterus salmoides*) contained the highest combined concentrations of mercury, 51%. Hybrid striper (*Morone saxatilis x M. chrysops*) and channel catfish (*Ictalurus punctatus*) also had relatively high mercury concentrations. Of the fish that were analyzed and that had detectable concentrations of mercury, gray redhorse (*Moxostoma congestum*) had the lowest mercury concentration, 1%.

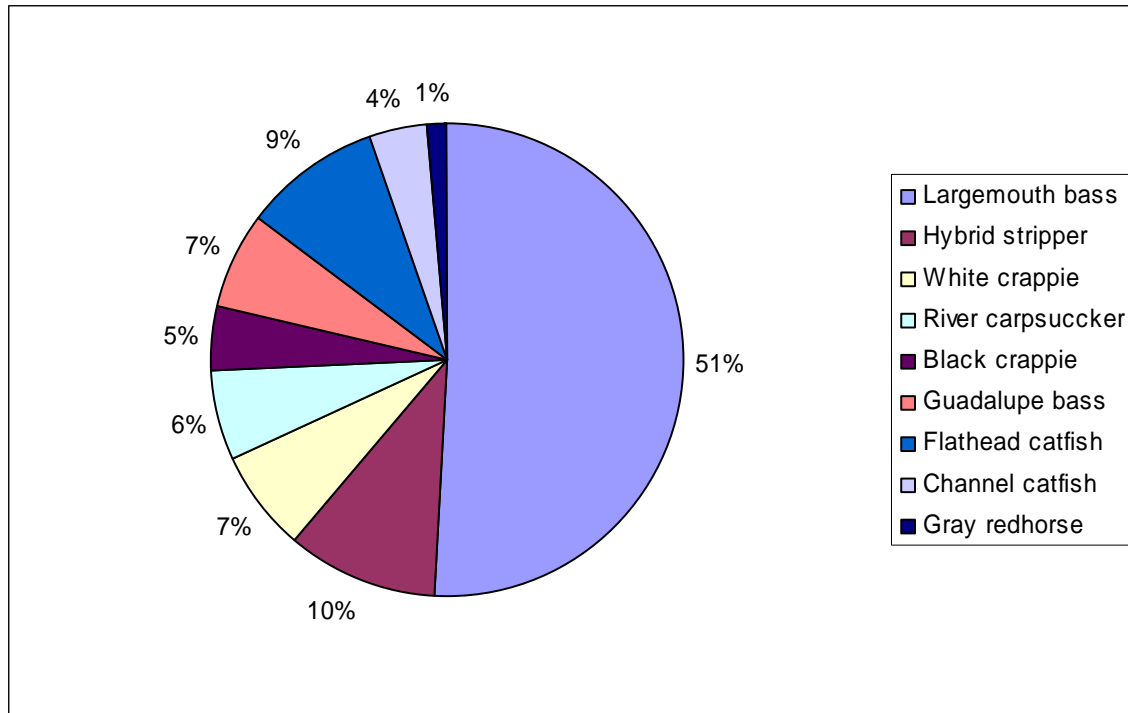


Figure 1. Sum of mercury concentrations in fish.

DDT, DDE and DDD

The fish tissue samples were analyzed for DDT, DDE and DDD. DDT is a pesticide that was once widely used to control insects in agricultural settings or that carry diseases such as malaria. DDT is a white, crystalline solid with no odor or taste. Its use in the United States was banned in 1972 because of damage to wildlife, but is still used in some other countries. In 1979 EPA banned the manufacture of PCB in the United States.

DDE and DDD are chemicals similar to DDT that contaminate commercial DDT preparations. DDE has no commercial use. DDD was also used to kill pests, but its use has also been banned. One form of DDD has been used medically to treat cancer of the adrenal gland. DDT, DDE and DDD may cause cancers in humans.

DDT, DDE and DDD were reported to TCEQ using the parameter codes 39376, 81896 and 81879, respectively. Table 5 shows DDT and its degradation products or contaminants and the fish in which these were detected. DDT, DDE and DDD were found in six of nine species collected. Because DDT, DDE and DDD were found only at the Colorado River at Webberville site Table 5 does not include the site number.

DDT, DDE and DDD were detected in 12 individuals representing six species. Some fish contained more than one contaminant. These fish and the analyte detected in each are also shown in Table 5. The highest DDE and DDD concentration measured, 0.135 mg/kg and 0.023 mg/kg, respectively, were measured in one channel catfish individual. The highest DDT concentration, 0.014 mg/kg, was measured in another channel catfish.

Table 5. Fish with detectable DDT, DDE and DDE concentrations.

Collection Date	DDE	DDD	DDT	Species	Length (mm)	Weight (g)
4/28/2005	0.045	0.007	<0.005	<i>Ictalurus punctatus</i>	483	975
4/28/2005	0.135	0.023	<0.005	<i>Ictalurus punctatus</i>	381	513
4/28/2005	0.019	<0.005	<0.005	<i>Ictalurus punctatus</i>	381	531
4/28/2005	0.017	<0.005	<0.005	<i>Micropterus treculi</i>	241	227
4/28/2005	0.06	<0.005	<0.005	<i>Micropterus treculi</i>	318	340
4/28/2005	0.089	0.008	<0.005	<i>Morone saxatilis x M. chrysops</i>	464	1814
8/23/2005	0.075	0.019	<0.005	<i>Ictalurus punctatus</i>	520	1374
8/23/2005	0.066	0.012	0.014	<i>Ictalurus punctatus</i>	560	1860
8/23/2005	0.005	<0.005	<0.005	<i>Micropterus salmoides</i>	305	485
8/23/2005	0.027	<0.005	0.009	<i>Micropterus treculi</i>	230	113
8/23/2005	0.005	<0.005	<0.005	<i>Carpoides carpio</i>	435	503
8/23/2005	0.018	<0.005	<0.005	<i>Pylodictus olivaris</i>	440	481

Figure 2 is a graph of the sum of the DDT organochlorine pesticide products found in each of six fish species. The figure represents only those individuals that had measurable concentrations of DDT, DDE and DDD. The species that contained the greatest sum of DDT, DDE and DDD concentrations were channel catfish. Largemouth bass and river carpsucker were the species containing the lowest of the organic constituents.

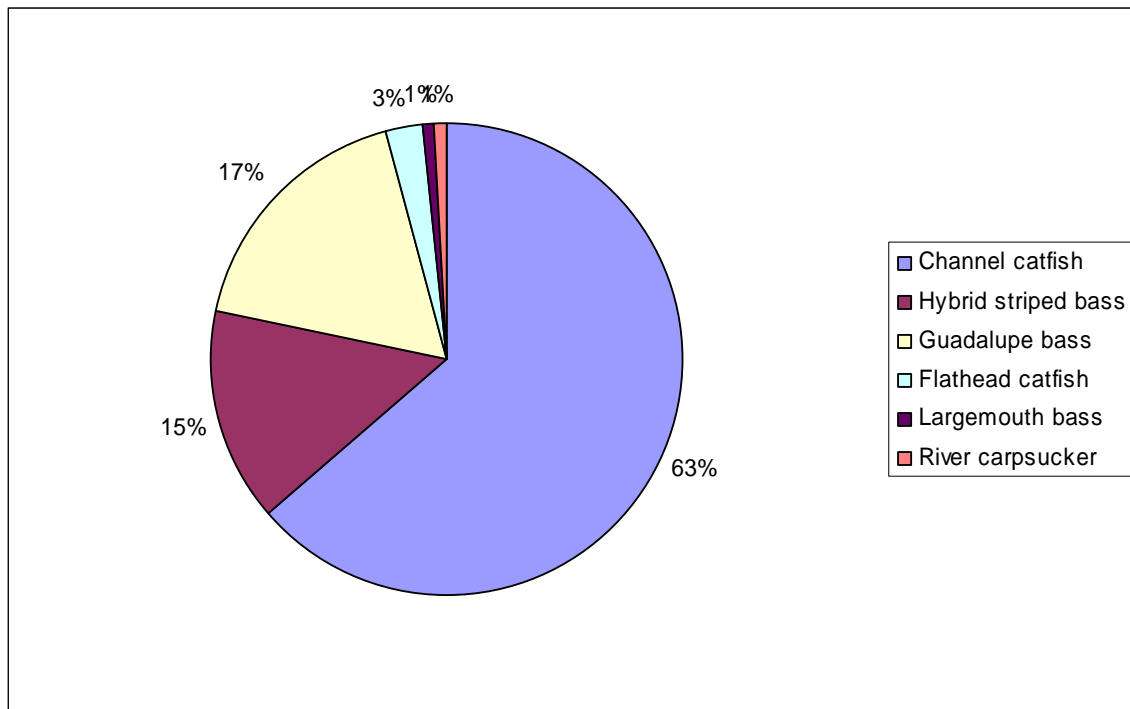


Figure 2. Sum of DDT, DDE and DDD concentrations in fish.

DISCUSSION

PCBs and organophosphorus pesticides were not detected in any of the fish collected for this study. Mercury, DDE, DDD and DDT were detected at concentrations that are below concern for human health. To place LCRA fish tissue results in perspective, Table 6 contains analytes for which screening values exist and were analyzed as part of this study. For some analytes the ELS could not meet the detection limit requirements and thus were not analyzed because these could not be reported to TCEQ. Eleven of the parameters included in this study do not have screening criteria. These include primarily the PCB arochlors and organophosphorus pesticides. LCRA decided to evaluate these constituents because they could possibly be of concern at the sites that were sampled.

Table 6. Highest analyte concentration, reporting limits and screening values.

Parameter	High Concentration (mg/kg)	Reporting Limit (mg/kg)	TDSHS Screen Level (mg/kg)	HAC* (mg/kg)	TCEQ** (mg/kg)
Chromium	<5	0.05	5.25	7	100.0
Copper	<5	1.0	NA	NA	40.0
Mercury	0.634	0.005	0.525	0.7	0.7
DDD	0.023	NA	0.227	2.27	9.606
DDE	0.135	NA	0.16	1.6	5.450
DDT	0.014	NA	0.16	1.6	5.277
Aldrin	<0.005	0.005	0.003	0.03	0.136
cis-chlordane, trans-chlordane	<0.05	0.005	0.156	1.56	0.300
Dieldrin	<0.005	0.005	0.003	0.03	0.057
Endosulfan I	<0.005	0.005	10.5	14	NA
Endosulfan Sulfate	<0.005	0.005	10.5	14	NA
Endrin	<0.005	0.005	0.525	0.7	NA
Heptachlor	<0.005	0.005	0.012	0.12	0.202
Heptachlor Epoxide	<0.005	0.005	0.006	0.06	0.253
Methoxychlor	<0.01	0.005	8.75	11.7	NA
Toxaphene	<0.05	0.1	0.049	0.5	0.827
PCBs, 20 congeners	<0.05	0.005	0.027	0.27	0.134
alpha-Hexachlorohexane	<0.005	NA	0.525	NA	0.366
beta- Hexachlorohexane	<0.005	NA	NA	NA	1.281
gamma- Hexachlorohexane	<0.005	NA	NA	NA	5.852

* HAC= Health-based Assessment Comparison Value, in draft form. Statewide screening initiative TDSHS, 3-12-2003.

** TCEQ Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2004.

The reporting limit shown in Table 6 is the detection limit that TDSHS prefers in order to perform a meaningful evaluation of the data. The TDSHS screening value for a compound is based on the probability that the toxicant will induce one additional cancer

in 100,000 equally exposed humans. TDSHS uses the screening levels to evaluate fish for toxicants at levels that could be of significance to human health, advise the public on consumption limits or to recommend regulatory actions. HAC values for cancer are based on the probability of inducing one additional cancer in 10,000 equally exposed individuals. The TCEQ screening levels for most of the toxicants were developed from human health criteria, found in the Texas State Water Quality Standards. Screening levels for the three metals shown in Table 6, among others, were developed from TDSHS screening levels.

In this study, both mercury and DDT organochlorine pesticides were measured in piscivorous fish. Of samples with detectable mercury concentrations, largemouth bass (n=5) and hybrid stripers (n=1) had the highest average mercury concentrations, 0.44 mg/kg. Of samples with detectable mercury concentrations, Lake Travis fish had higher average mercury concentrations than fish collected at Colorado River at Webberville.

The DDT organochlorine pesticide group was measured primarily in channel catfish. DDE, DDD, and DDT products were detected only at the Colorado River at Webberville site. No DDT or contaminant products were measured from samples collected at Lake Travis. Because these organic constituents are fat-soluble, biological magnification may be the primary mechanism in the concentration of these contaminants up the food chain.

Though possibly attributable to a small sampling of fish, correlations to size and weight of fish were not biologically significant. The r^2 values were less than ± 0.8 . All 24 fish met the TCEQ recommended minimum length requirement for determining long-term trends and ecosystem health. Six of the 18 fish (three largemouth bass and three flathead catfish) did not meet minimum length for human health risk assessment found in TCEQ's Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2004. These TCEQ-suggested minimum requirements and the fish that did not meet these are shown in Table 7.

Table 7. Fish not meeting the TCEQ suggested minimum size requirements.

Scientific Name	Captured Fish Size (mm)	Background Long-Term Trends Ecosystem Health Minimum Length (mm)	Human Health Risk Minimum Length (mm)
<i>Micropterus salmoides</i>	350	250	356
<i>Micropterus salmoides</i>	340	250	356
<i>Micropterus salmoides</i>	305	250	356
<i>Pylodictus olivaris</i>	420	350	457
<i>Pylodictus olivaris</i>	410	350	457
<i>Pylodictus olivaris</i>	440	350	457

Correlation coefficients, r^2 , are used to help determine the relationship between two properties. Table 8 depicts the correlation coefficient of the analyte to the corresponding

length or weight for all the fish with a detectable concentration of the analyte. DDT only had two specimens in which it was detected so the correlation coefficient between these two would be one, indicating a perfect correlation.

Table 8. Correlation coefficients between analytes and fish size.

Analyte	Weight (grams)	Length (mm)	Number of Observations
Mercury	0.094	-0.002	18
DDE	0.461	0.350	12
DDD	-0.541	-0.413	5
DDT	1	1	2

SUMMARY AND RECOMMENDATION

Results of this study indicate that the concentrations of all of the constituents analyzed are below that to be of a human health concern based upon TDSHS and TCEQ screening criteria. All data meeting quality objectives were reported to TCEQ.

In evaluating TCEQ's state-wide fish tissue monitoring program, it is easy to discern that mercury seems to be found state-wide. In 2003, 47 of 47 fish tissue samples had detectable concentrations of mercury. In 2003, 22 reservoirs and three rivers were sampled. In 2004, 21 reservoirs and six rivers were sampled and 48 of 49 fish samples had detectable mercury concentrations.

In 2003, the highest mercury concentration, 0.70 mg/kg, measured in the state-wide monitoring was in largemouth bass collected in nearby Canyon Lake. Mercury was also detected above a screening level from freshwater drum and smallmouth buffalo collected in the Neches River, 0.55 and 0.54 mg/kg, respectively. In this LCRA study the highest mercury concentration measured was detected in a largemouth bass, 0.634 mg/kg.

DDE was found in relatively high concentrations in 2003 state-wide fish tissue monitoring. DDE was found in common carp collected at O.H. Ivie Reservoir. The p,p DDE concentration measured in the common carp was 0.162 mg/kg. In 2004, p,p DDE was measured in common carp collected from Granger Reservoir. The p,p DDE concentration was 0.197 mg/kg. In this LCRA study the highest DDE concentration measured was detected in a largemouth bass, 0.135 mg/kg.

Based on available information the continuation of fish tissue monitoring is not anticipated. If, based upon extraneous information not considered in this report, fish tissue monitoring does continue it is recommended that results be reported to TCEQ. This reporting of the data ensures that the data are properly reviewed and acted upon, if needed, by state human health experts, i.e. TDSHS.

If monitoring is to continue, lower detection limits for the metals by using inductively coupled plasma/mass spectroscopy (ICP/MS) technology is recommended. The use of more sensitive methods, such as Method 6020, allows for lower detection limits and thus the analysis of more metals samples. In this study only mercury, chromium and copper were analyzed because these were the only metals that the laboratory could meet the detection limit required by TCEQ.

Should there be a need to reproduce this study, field and laboratory data from this study is transferred onto a compact disk and is stored in the office of the author of this report. Additionally, the laboratory data can be obtained from TCEQ.

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Texas Department of State Health Services communication with *Jerry Ann Ward, Ph.D.*