2006 Lexington and Guadalupe Reservoirs Fish Sampling

San Francisco Bay Regional Water Quality Control Board

Summary

The purpose of the 2006 sampling was to better characterize the mercury risk to humans and wildlife of consuming fish from Lexington Reservoir (the reference reservoir for the Guadalupe River watershed mercury TMDL), and from Guadalupe Reservoir to characterize inter-annual variability.

The average mercury concentration in adult largemouth bass, a top predator, from Lexington Reservoir was 0.6 mg/kg, the same concentration as found in 2004. The average mercury concentration in a mix of trophic level 3 and 4 fish the size which humans consume from Lexington Reservoir is 0.3 mg/kg. The average mercury concentration in trophic level 3 prey fish is 0.08 mg/kg.

Fish mercury concentrations in Guadalupe Reservoir increased from 2004 to 2006 by 16% and 33% respectively in adult and age-1 largemouth bass.

Sampling Plan and Objectives

1) Human Health—sampling of TL3 and TL4 fish species other than largemouth bass, from Lexington Reservoir. Approximately 15 samples for each of the following 5 fish:
   - channel catfish (TL4) 500-600 mm
   - black crappie (TL3) 225-300 mm
   - rainbow trout (stocked, TL3) 10-12 in. (1/2 to 3/4 lb. fish) or close to most recently stocked size (TBD)
   - sunfish (TL3) > 100 mm

2) Wildlife—sampling of TL3 fish consumed by piscivorous wildlife to address Hg bioaccumulation that may be affecting wildlife
   - small (50 mm-150 mm) TL3 fish –species will be determined in the field by R9 Lab staff after seining—most prevalent species will be determined and sampled—this process was recommended by USFWS.

3) Inter-annual variability—sampling of adult and age-1 largemouth bass from Guadalupe Reservoir. Approximately 15 samples each of the following sizes:
   - Adult largemouth bass (TL4) 350-450 mm
   - Age-1 largemouth bass (TL4) 80-120 mm

4) Data from 1), 2) and 3) will be used in the TMDL to re-evaluate the impoundment methylmercury allocation (maximum seasonal methylmercury in hypolimnion)

5) Budget allowing, additional analyses will be performed on an archive sample(s) of fish or bird origin, should it be found, to help inform the discussion on background mercury conditions in its historic setting.

Table 1. Expected Fish Species and Trophic Levels in Lexington Reservoir		
TL2	**TL3**	**TL4**
Not Identified	Small brown bullheads, small channel catfishes, black crappie, Sacramento sucker, sunfishes (bluegill & pumpkinseed), pacu (an aquarium fish), and rainbow trout; California roach and stickleback near where Los Gatos Creek comes in	Largemouth bass, large brown bullheads, and large channel catfishes
Note: Trophic levels are approximate and simplified to primary trophic level.		

The design of sampling for Objective 1), protection of human health, was reviewed and approved by staff of the California Office of Environmental Health Hazard Assessment (OEHHA). This sampling plan is consistent with OEHHA's *General Protocol for Sport Fish Sampling and Analysis* (OEHHA 2005). Specifically, this design met the following guidelines in the OEHHA protocol:

- Number and Type of Samples
  15 fish for individual analysis collected from throughout the water body; however, fewer species were collected than are believed to be resident and consumed by humans (Table 1)
- Fish Size
  The plan and collection was consistent with OEHHA fish size guidelines
- Timing
  Both the 2004 and 2006 sampling occurred in the fall, meeting the OEHHA guideline for consistent timing between years
- Fish Collection
  Electroshocking is an approved method
- Preparation of Samples
  Sample handling and analysis of skinless filets are consistent with OEHHA guidelines
- Chemical Analyses
  The U.S. EPA lab used Method 7473, mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry.

Methods

U.S. EPA and Santa Clara Valley Water District staff collected fish from Lexington Reservoir on November 14, 2006. Additionally, Water Board staff participated in the fishing at Guadalupe Reservoir on November 16, 2006. Fish were collected from reservoirs by electroshocking and netting. Reservoir fish were wrapped in trace-metals cleaned aluminum foil, labeled, then placed in zip-lock plastic bags and put on ice for transport. Hatchery trout were netted from a tank on December 6, 2006. Hatchery trout were placed in zip-lock plastic bags, then labeled and put on ice for transport. Field water parameters were measured in both reservoirs on November 16 with a Horiba Water Checker U-10. The reservoirs were well-mixed by the sampling date, consequently mid-reservoir shallow water samples were collected using trace metals protocols off the front of the boat while motoring forward.

U.S. EPA Region IX laboratory analyzed the fish tissue samples for % solids and total mercury (method 7473) on a dry weight basis. The wet weight mercury concentration is obtained from Equation 1:

Total mercury (mg/kg, wet wt.) = (% solids / 100) x total mercury (mg/kg, dry wt.)

For the evaluation of human health, a sample of muscle tissue (a skinless plug of filet) was analyzed from individual large fish (adult largemouth bass, pumpkinseed and trout). For the evaluation of wildlife health, whole eviscerated individual prey fish (inland silverside and threadfin shad) were analyzed. City of San Jose analyzed the water samples for total methylmercury (method 1630).

No archive sample was acquired.

Field Conditions

A construction project in Lexington Reservoir resulted in considerable drawdown in summer 2006. Reportedly, comparable drawdown has occurred several times in Lexington Reservoir in the last decade. Drawdown has an adverse impact on the fishery and reduces the abundance and variety of species. No channel catfish, black crappie, or rainbow trout were collected. The California Department of Fish and Game (DFG) last stocked Lexington Reservoir with trout on May 11, 2006; DFG does not stock this reservoir with catfish, and neither the trout nor catfish fisheries are sustainable without stocking. Two species of fish were caught from Lexington Reservoir to evaluate the risk to human health, adult largemouth bass (LMB) which were abundant, but only 5 sunfish (pumpkinseed), not the planned 15 (Table 3). Two species of fish were caught from Lexington Reservoir to evaluate the risk to piscivorous wildlife, inland silverside and threadfin shad. No other fish species were identified in Lexington during sampling. Additionally, a sample of trout delivered to Stevens Creek Reservoir from Darrah Springs hatchery was provided by DFG on December 6, 2006. These hatchery fish are also used to stock Lexington.

Conditions appeared normal in Guadalupe Reservoir, but like in Lexington, only LMB were abundant (Table 4). Because sampling occurred in mid-November, the fall turnover had already occurred and the reservoirs were well-mixed.

The fish collected all met the size requirements specified in the sampling plan (above). Although fork length was measured in the field, in accordance with Tetra Tech's analysis of 2004 fish data, the fork length was converted to total length. The total length is obtained from Equation 2:

Total length (mm) = (conversion factor) x fork length (mm)

The conversion factors (obtained from www.fishbase.com) are: 1.024 for adult and age-1 LMB, 1.034 for pumpkinseed, 1.14 for threadfin shad, and 1.15 for trout; no conversion factor was available for inland silverside.

Water Quality Results

Total methylmercury in Lexington Reservoir was 0.084 and 0.088 ng/L (sample plus duplicate), and in Guadalupe Reservoir was 0.332 ng/L. Field water quality parameters are presented on Table 2, below.

Table 2. Field Water Quality Parameters

	Dissolved Oxygen (mg/L)	Temperature °C	Salinity ‰	pH	Conductivity mS/cm	Turbidity (NTU)
Lexington	4.89	16.2	0.01	8.26	0.374	6
Guadalupe	6.8	16.1	NM	8.4	0.58	7

Fish Mercury Results

2006 fish mercury and length summary data are presented on Tables 3-5 located after the references section, below. To facilitate comparison with previous data sets, 2004 & 2003 data are presented on Tables 6-8, and figures corresponding to Tables 3-8 are also included below.

A summary of the 2006 fish mercury and length results from Lexington Reservoir are presented on Table 3. Largemouth bass (LMB), a trophic level 4 (TL4) top predator, were the largest fish caught and had the highest mercury concentrations. The 2006 average adult largemouth bass (LMB) mercury concentration of 0.58 mg/kg is equal to the 2004 concentration (Table 6). The 2006 data provides the first indication of mercury concentrations in lower trophic level fish in Lexington, namely in sunfish (pumpkinseed), inland silverside, and threadfin shad, which had average mercury concentrations of 0.13, 0.092, and 0.074 mg/kg, respectively.

A summary of the adult and age-1 LMB data from Guadalupe Reservoir are presented on Table 4. Both the 2006 average adult and age-1 LMB mercury concentrations (7.1 and 1.1 mg/kg) are greater than the 2004 average concentrations (Table 6; 6.1 and 0.83 mg/kg), by 16% and 33% respectively.

In the *Data Collection Report,* Tetra Tech noted that the 2004 "coefficients of variation (CV) for the mercury measurements [*in adult largemouth bass from five impoundments*] at each impoundment (0.16 – 0.40) are relatively low for environmental measurements…. The coefficients of variation for the age-1 largemouth bass mercury concentrations were, with the exception of the CV value at Calero Reservoir, lower (between 0.17 and 0.29, Table 8-4)" (Tetra Tech 2005). The 2006 CV for adult LMB in Lexington Reservoir (0.29) was similar to the 2004 CV (0.27, Tables 3 & 6). The 2006 CV for adult LMB in Guadalupe Reservoir was 0.56, greater than the highest 2004 CV (0.40 in Guadalupe, Tables 4 & 7), although the age-1 CV in Guadalupe were similar (0.24 and 0.17, 2004 & 2006, respectively) and within the 2004 range from all 5 impoundments.

Hatchery trout, as expected, have relatively low mercury concentrations (Table 5) compared to reservoir fish; 0.031 mg/kg on average.

Adult LMB are the only TL4 fish of the size which humans eat from Lexington for which mercury data is available; the average TL4 concentration is 0.6 mg/kg. The average mercury concentration in pumpkinseed and trout, the only TL3 fish of the size which humans eat for which mercury data is available, is 0.08 mg/kg. The overall average (50% TL3 and 50% TL4) mercury concentration is 0.3 mg/kg.

The U.S. Fish and Wildlife Service calculated fish mercury concentration thresholds safe for wildlife consumption (USFWS 2005). The threshold for TL3 fish 50 – 150 mm is 0.05 mg/kg. The average 2006 inland silverside and threadfin shad mercury concentration from Lexington Reservoir is 0.08 mg/kg.

References

Froese, R. and D. Pauly (Eds.), 2004. FishBase. World Wide Web electronic publication. http://www.fishbase.org, version (01/2007).

Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, *General Protocol for Sport Fish Sampling and Analysis*. December 2005. http://www.oehha.ca.gov/fish/pdf/fishsampling121406.pdf

Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, *Development of Guidance Tissue Levels and Screening Values for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene*. Draft February 2006. http://www.oehha.ca.gov/fish/gtlsv/gtlsv1.html#gvsl

State Water Resources Control Board, California Environmental Protection Agency, *Water Quality Control Policy For Developing California's Clean Water Act Section 303(D) List*. Adopted September 30, 2004. http://www.waterboards.ca.gov/tmdl/docs/ffed_303d_listingpolicy093004.pdf

Tetra Tech, Inc. 2005. *Technical Memorandum 5.3.2, Data Collection Report, Volume 1*, Prepared for Santa Clara Valley Water District. February 8. http://www.valleywater.org/Water/Watersheds_-_streams_and_floods/Watershed_info_&_projects/Guadalupe/_Guadalupe_River_TMDL_project/index.shtm

U.S. Environmental Protection Agency (USEPA) 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury*, EPA-823-R-01-001, Office of Water, January, pp. ix to xvi, 7-1 to 7-2.

U.S. Environmental Protection Agency (USEPA) 2007. Listing Waters Impaired by Atmospheric Mercury Under Clean Water Act Section 303(d). http://www.epa.gov/owow/tmdl/mercury5m/

U.S. Fish and Wildlife Service (USFWS) 2005. *Derivation of Numeric Wildlife Targets for Methylmercury in the Development of a Total Maximum Daily Load for the Guadalupe River Watershed*. April. http://www.waterboards.ca.gov/sanfranciscobay/TMDL/guadalupe_river_mercury/usfws_targets.pdf

Table 3. 2006 Lexington Reservoir Fish

		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (total mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Adult Largemouth Bass	15	0.37	0.58	0.92	0.17	0.29	369	405	512	42	0.10	Muscle
Pumpkinseed	5	0.055	0.13	0.24	0.085	0.64	124	134	147	11	0.080	Muscle
Inland Silverside	15	0.053	0.092	0.21	0.046	0.50	103	105	111	3	0.026	Whole
Threadfin Shad	15	0.039	0.074	0.10	0.018	0.24	56	88	120	16	0.18	Whole

Note Table 3: Inland silverside length is fork length.

Table 4. 2006 Guadalupe Reservoir Fish

		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (total mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Adult Largemouth Bass	15	2.9	7.1	13	4.0	0.56	312	423	543	80	0.19	Muscle
Age-1 Largemouth Bass	15	0.43	1.1	1.5	0.26	0.24	72	82	94	5.4	0.07	Whole

Table 5. 2006 Hatchery Trout

		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (total mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Trout	15	0.024	0.031	0.049	0.0066	0.21	242	337	416	48	0.14	Muscle

Notes Tables 3 - 8:
n = sample size
Coefficient of Variation = (Standard Deviation) / (Mean)
Muscle = Muscle Tissue Skin Off
Whole = Whole Body (Eviscerated)

Table 6. 2004 Lexington Reservoir Fish

		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (total mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Adult Largemouth Bass	11	0.4	0.6	1.0		0.27	358	408	502		0.12	Muscle
Age-1 Largemouth Bass	20	0.06	0.09	0.14		0.22	71	89	102		0.10	Whole

Table 7. 2004 Guadalupe Reservoir Fish

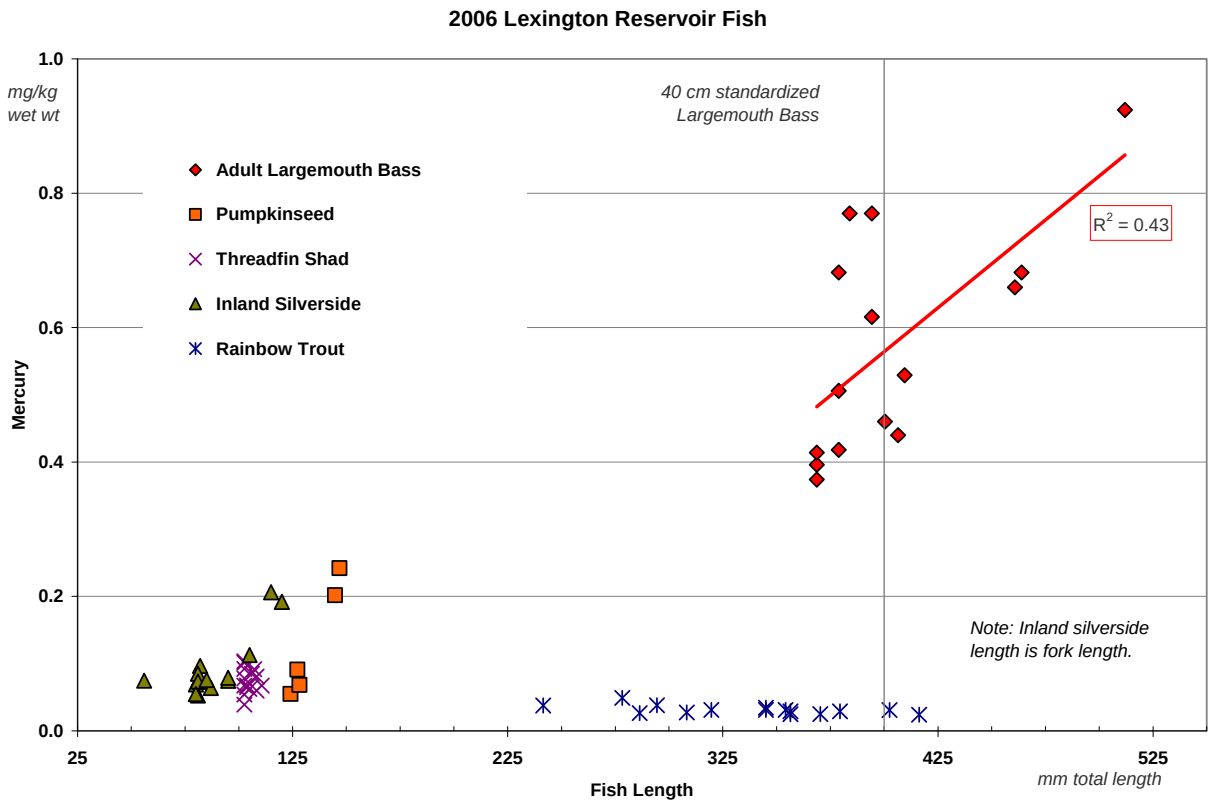
		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (total mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Adult Largemouth Bass	18	3.1	6.1	13		0.40	307	418	532		0.18	Muscle
Age-1 Largemouth Bass	20	0.64	0.83	1.1		0.17	77	90	97		0.07	Whole

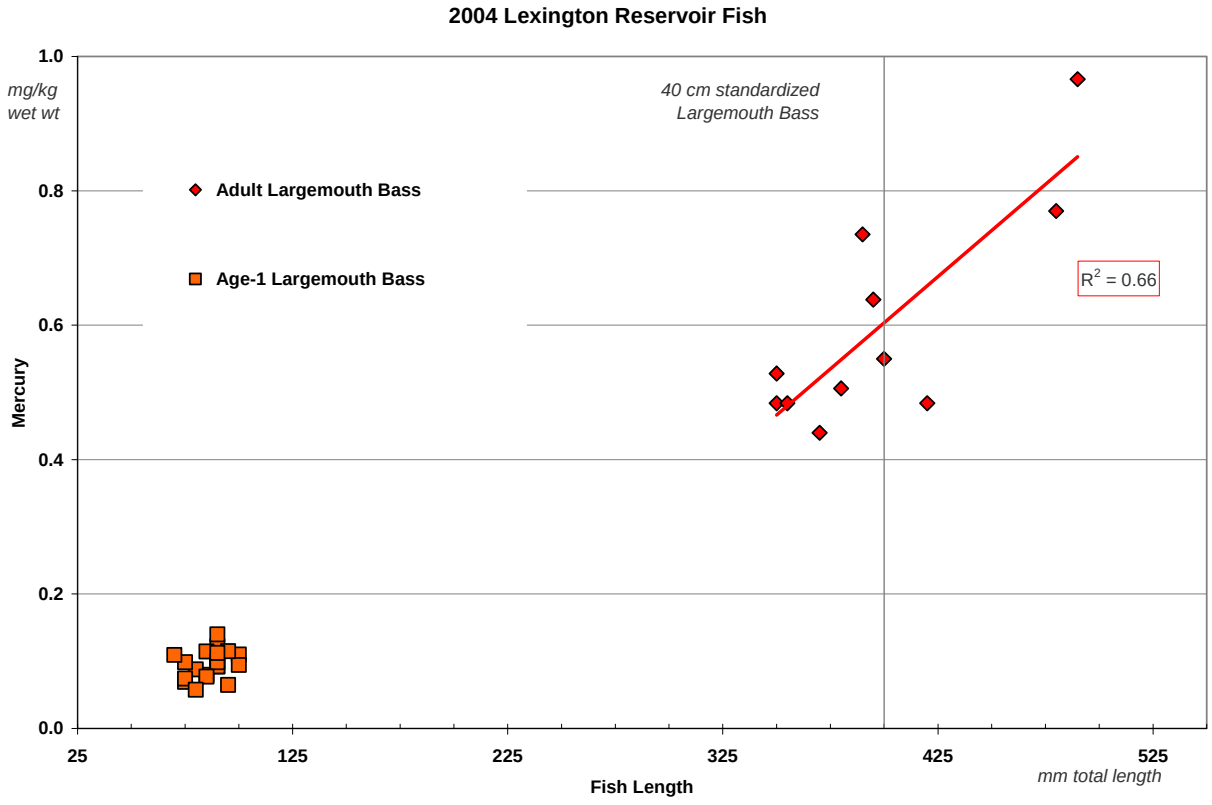
Table 8. 2003 Guadalupe Reservoir Fish

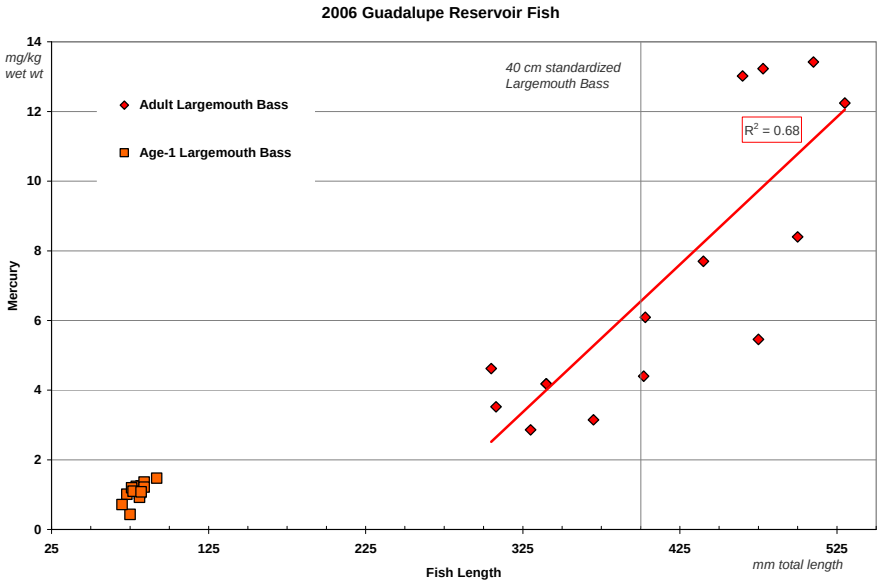
		Total Mercury Concentrations (mg/kg wet wt)					Fish Length (mm)					Tissue
Species	n	Min	Mean	Max	Std Dev	Coef Var	Min	Mean	Max	Std Dev	Coef Var	
Adult Largemouth bass	15	2.6	4.0	5.8	0.9	0.22	273	374	505	56	0.15	Muscle
Black Crappie	11	1.7	2.0	2.9	0.34	0.17	130	166	275	38	0.23	Muscle

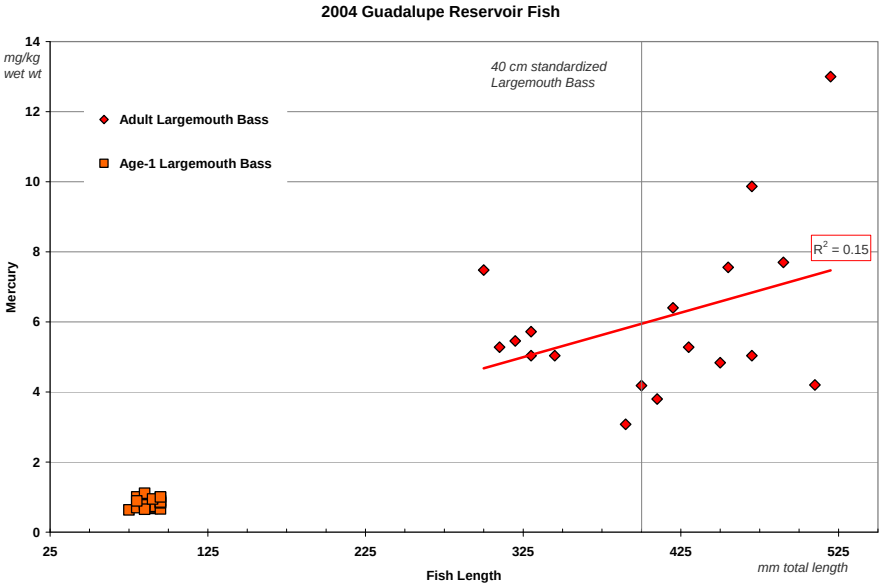
Note Table 8: fish length not specified fork or total

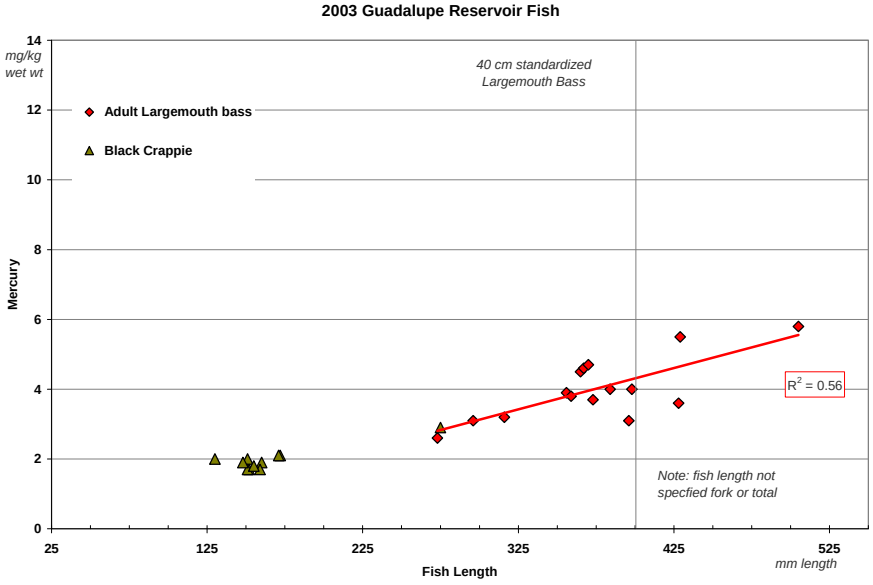
Notes Tables 3 - 8:
n = sample size
Coefficient of Variation = (Standard Deviation) / (Mean)
Muscle = Muscle Tissue Skin Off
Whole = Whole Body (Eviscerated)

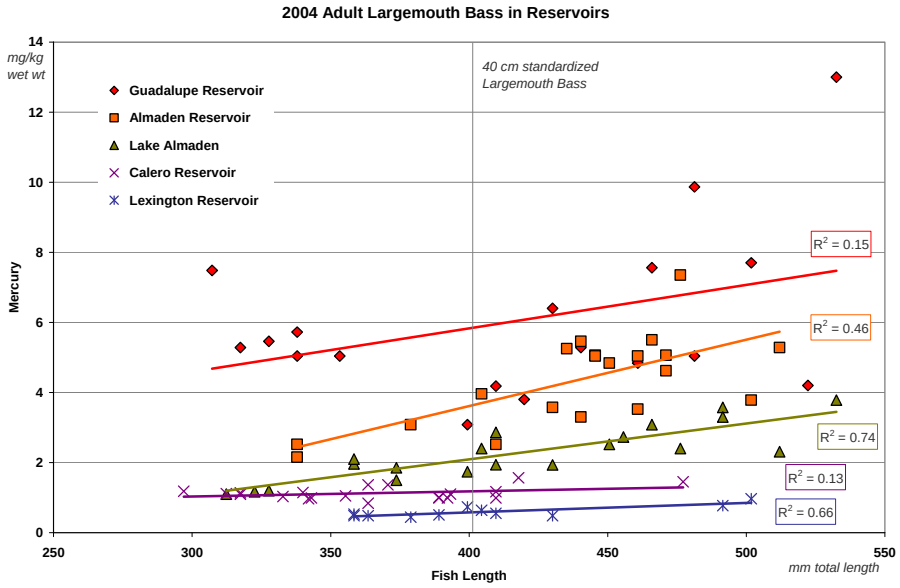

2006 Lexington Reservoir Fish
mg/kg
wet wt
40 cm standardized
Largemouth Bass
Adult Largemouth Bass
Pumpkinseed
Threadfin Shad
Inland Silverside
Rainbow Trout
R2 = 0.43
Note: Inland silverside
length is fork length.
Mercury
1.0
0.8
0.6
0.4
0.2
0.0
25
125
225
325
425
525
Fish Length
mm total length

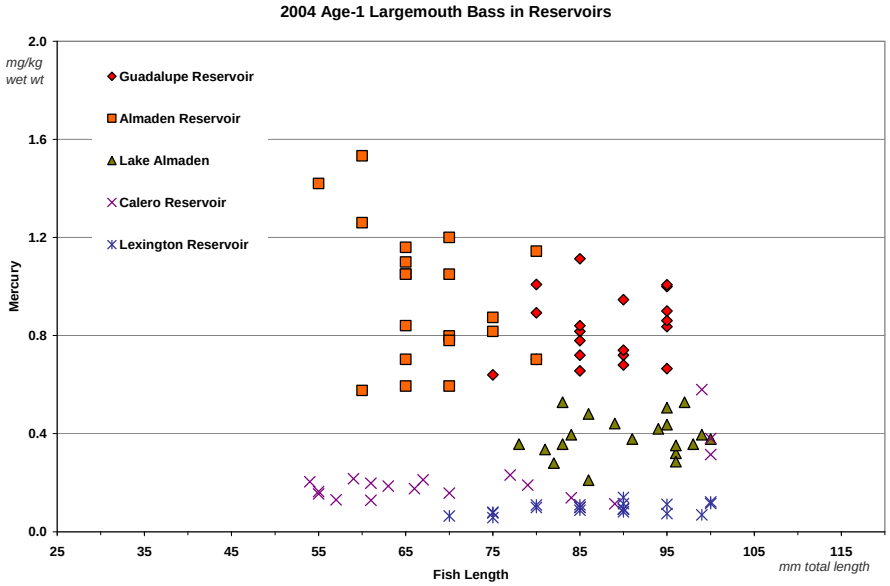

2004 Lexington Reservoir Fish
mg/kg
wet wt
40 cm standardized
Largemouth Bass
Adult Largemouth Bass
Age-1 Largemouth Bass
R2 = 0.66
Mercury
1.0
0.8
0.6
0.4
0.2
0.0
25
125
225
325
425
525
Fish Length
mm total length

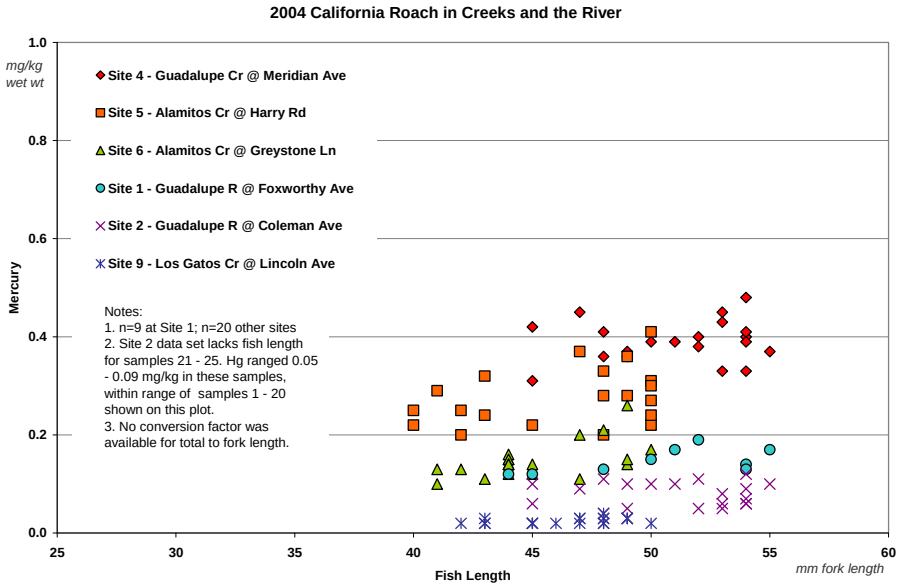

2006 Guadalupe Reservoir Fish
mg/kg wet wt
40 cm standardized Largemouth Bass
Adult Largemouth Bass
Age-1 Largemouth Bass
R2 = 0.68
Mercury
Fish Length
mm total length


2004 Guadalupe Reservoir Fish
mg/kg wet wt
40 cm standardized Largemouth Bass
Adult Largemouth Bass
Age-1 Largemouth Bass
R2 = 0.15
Mercury
Fish Length
mm total length


2003 Guadalupe Reservoir Fish
mg/kg wet wt
40 cm standardized Largemouth Bass
Adult Largemouth bass
Black Crappie
R2 = 0.56
Note: fish length not specfied fork or total
Mercury
Fish Length
mm length


2004 Adult Largemouth Bass in Reservoirs
mg/kg wet wt
40 cm standardized Largemouth Bass
Guadalupe Reservoir
Almaden Reservoir
Lake Almaden
Calero Reservoir
Lexington Reservoir
R2 = 0.15
R2 = 0.46
R2 = 0.74
R2 = 0.13
R2 = 0.66
Mercury
Fish Length
mm total length


2004 Age-1 Largemouth Bass in Reservoirs
mg/kg wet wt
Guadalupe Reservoir
Almaden Reservoir
Lake Almaden
Calero Reservoir
Lexington Reservoir
Mercury
Fish Length
mm total length


2004 California Roach in Creeks and the River
mg/kg wet wt
Site 4 - Guadalupe Cr @ Meridian Ave
Site 5 - Alamitos Cr @ Harry Rd
Site 6 - Alamitos Cr @ Greystone Ln
Site 1 - Guadalupe R @ Foxworthy Ave
Site 2 - Guadalupe R @ Coleman Ave
Site 9 - Los Gatos Cr @ Lincoln Ave
Notes:
1. n=9 at Site 1; n=20 other sites
2. Site 2 data set lacks fish length for samples 21 - 25. Hg ranged 0.05 - 0.09 mg/kg in these samples, within range of samples 1 - 20 shown on this plot.
3. No conversion factor was available for total to fork length.
Mercury
Fish Length
mm fork length