CACHE CREEK OFF-CHANNEL AGGREGATE MINING PONDS – 2015 MERCURY MONITORING

Final Report
May 2017

Monitoring and Report by

Darell G. Slotton, Ph.D.*
and
Shaun M. Ayers

* *(530) 574-3491*
dgslotton@ucdavis.edu

TABLE OF CONTENTS

SUMMARY OF THE 2015 MONITORING AND ITS FINDINGS

- Pursuant to Section 10-5.517 of the Yolo County Code, this Fall 2015 monitoring was the first year of fish mercury testing for off-channel wet pit aggregate mining adjacent to lower Cache Creek between Capay and Woodland (Figure A in the Introduction). A variety of techniques were used to obtain samples of the fish present in each of these ponds. Large, angling-sized fish were tested individually for fillet muscle mercury, relevant to human consumption. Small, young-of-year, 'biosentinel' fish were analyzed whole-body, relevant to wildlife consumption, in multiple-individual composite samples.

- Useful samples of both large and small fish, of multiple species, were collected from 4 major ponds in the system: the Cemex–West Pond ('Phase 1'), Cemex–East Pond ('Phase 3-4'), Teichert–Reiff Pond, and Syar–B1 Pond. Two smaller ponds that had also been slated for monitoring could not be sampled this year because of inaccessibility issues that should be resolved in the future (Teichert–Mast and Storz Ponds).

- A total of 101 larger, angling-sized fish were sampled individually for fillet muscle mercury in this 2015 monitoring. A total of 360 small, young-of-year fish were split into 41 multi-individual composite samples by site, species and size. These were also analyzed for mercury.

- The new data from the 4 sampled off-channel, aggregate-mining ponds were compared between the ponds for corresponding samples, and between the ponds and corresponding 'baseline' fish collections conducted previously from adjacent Cache Creek.

- A set of 'baseline' fish samples were collected from Cache Creek, prior to this project, in Fall 2011 and Spring 2012 (Slotton et al. 2013). The baseline fish collections and analyses were made to provide new data for Yolo County and to satisfy requirements to test mercury concentrations in Cache Creek biota. They were also made to provide updated, more extensive comparison mercury data, from in-channel Cache Creek, for nearby off-channel aggregate mining pits and future reclaimed ponds. The 2011-2012 baseline samples had mercury levels similar to various earlier Cache Creek monitoring. All of these are summarized in this report.

- The 4 ponds sampled in Fall 2015 were found to show distinct, individual mercury signatures that were broadly consistent across the different fish types.

- The Cemex–West (Phase 1), was notably low in mercury across all of the samples available. It was statistically lower than the other tested ponds for nearly every corresponding sample type and was statistically lower than or similar to all of the comparable baseline creek samples.

- The Teichert–Reiff Pond had fish mercury levels similar to the baseline creek samples, with some samples lower, some statistically the same, and some higher.

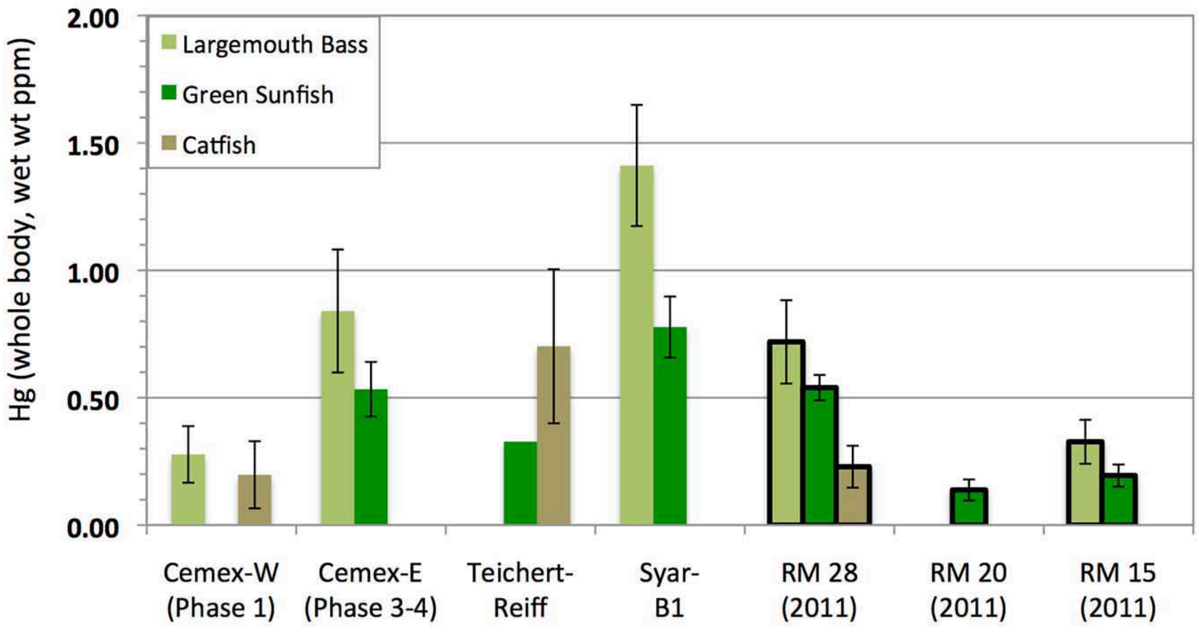
- The Cemex–East Pond (Phase 3-4) was higher in fish mercury than the Teichert–Reiff and Cemex–West ponds. Relative to the baseline creek samples, it was higher in most comparisons (8 of 11) and statistically similar in the other 3.

- Fish from the Syar–B1 Pond were higher in mercury than all of the comparable baseline creek samples. Fish from this pond also had statistically higher mercury than corresponding samples from the other ponds tested, except in juvenile Green Sunfish and Mosquitofish from the Cemex–East Pond (Phase 3-4) which were statistically similar.

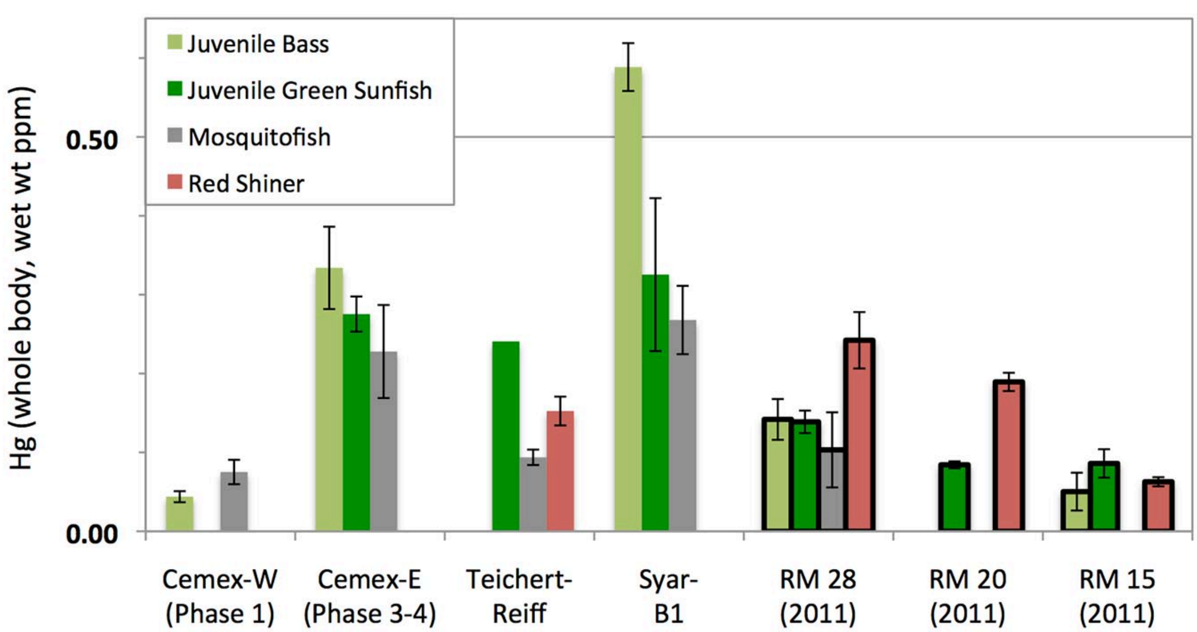
- So, of the four ponds monitored, two were found to be low or similar in fish mercury to the base-line Cache Creek samples (Cemex–West and Teichert–Reiff). Two appeared to be in an elevated range that may require attention (Syar–B1 and Cemex–East).

- This range of results may present an opportunity to help identify what is driving the high mercury levels at some locations and the low levels at others. Ultimately, if these factors can be identified, it may be possible to reduce levels at the elevated mercury sites through realistic and cost-effective modifications. The Yolo County Ordinance sets out requirements for investigating likely contributing factors which can guide potential mitigation approaches. Those protocols are in the process of being updated. The 2015 results are being tested for consistency with ongoing annual monitoring, as laid out in the ordinance. At the time of this report finalization (May 2017), those fall 2016 collections have been conducted. Laboratory work is in process and analytical results will be presented later in 2017.

- Summary figures (5a-b) and tables (1c-4c) from the body of the report are reproduced below, before the introduction. These provide a condensed presentation of the 2015 monitoring results, showing the fish mercury levels in each of the ponds, the pond results relative to each other, and relative to corresponding 2011-2012 baseline levels in adjacent Cache Creek.



(Figure 5a). Large Fish Mercury: Comparison of Ponds and 2011 Baseline Creek Samples
(All comparable species; average mercury and standard deviation for each site)
(RM refers to River Mile of baseline Cache Creek sites)



(Figure 5b). Small Fish Mercury: Comparison of Ponds and 2011 Baseline Creek Samples
(All comparable species; average mercury and standard deviation for each site)

Summary Comparisons With Comparable Samples From the Other Tested Ponds and Baseline Cache Creek Collections.

(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

(Table 1c). Cemex–West Pond (Phase 1)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–E (Phase 3-4)**	**Teichert–Reiff**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	<		<	<		=
Channel Catfish		<		=		
Small fish whole body, composite mercury						
Largemouth Bass (juv)	<		<	<		=
Mosquitofish	<	=	<			=

(Table 2c). Cemex–East Pond (Phase 3-4)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Teichert–Reiff**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	>		<	=		>
Green Sunfish			<	=	>	>
Small fish whole body, composite mercury						
Largemouth Bass (juv)	>		<	>		>
Green Sunfish (juv)			=	>	>	>
Mosquitofish	>	>	=			=

Summary Comparisons With Comparable Samples From the Other Monitored Ponds and Baseline Cache Creek Collections *(continued).*
(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

(Table 3c). Teichert–Reiff Pond.

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Cemex–E (Phase 3-4)**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
White Catfish	>			>		
Carp						=
Small fish whole body, composite mercury						
Mosquitofish	=	<	<			=
Red Shiner				<		>

(Table 4c). Syar–B1 Pond.

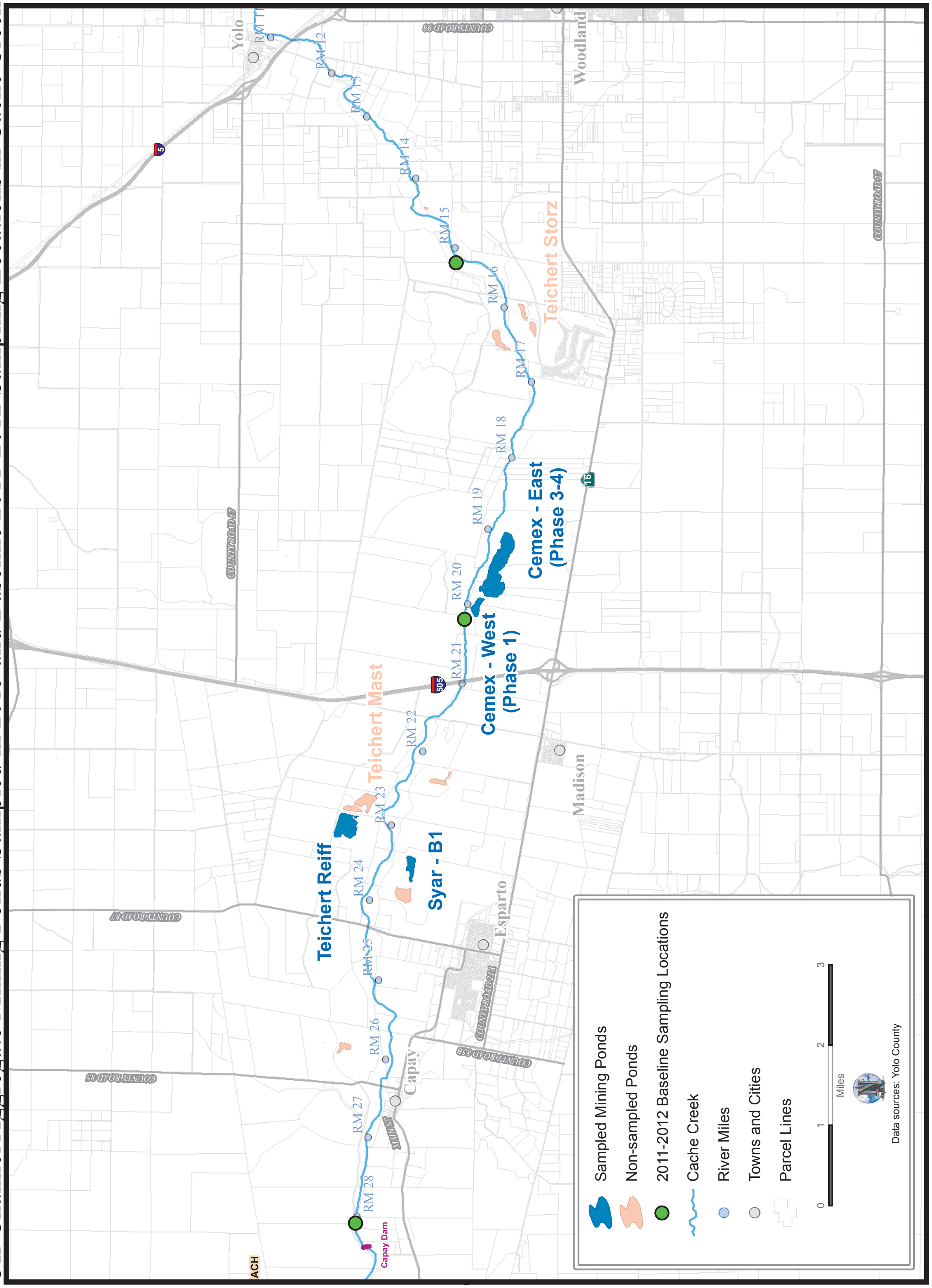
	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Cemex–E (Phase 3-4)**	**Teichert–Reiff**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	>	>		>		>
Green Sunfish		>		>	>	>
Small fish whole body, composite mercury						
Largemouth Bass (juv)	>	>		>		>
Green Sunfish (juv)		=		>	>	>
Mosquitofish	>	=	>			>

INTRODUCTION

This monitoring was conducted for Yolo County in the fall of 2015, to provide new fish mercury information from a set of aggregate mining ponds located adjacent to lower Cache Creek. The monitoring was triggered by Section 10.5.517 of the Yolo County Reclamation Ordinance (Yolo County Code).

The ordinance (Section 10-5.517(b)) specifies that wet pits approved for eventual reclamation to permanent lakes must be evaluated annually for five years after creation and biennially for ten years after reclamation is completed, for "conditions that could result in significant methylmercury production". The "statistically verified average mercury concentrations" of comparable fish in the creek is the baseline for measurement of the "average mercury content" for fish in the wet pits/lakes. If the average mercury content of fish in a wet pit exceeds the ambient mercury content for fish in the creek over two consecutive years of measurement, the operator is required to take certain actions. Sections 10-5.517 (c) through (h) identify the methodology for the pit studies and the required actions dependent on the analysis results.

In May of 2015, the County identified six aggregate mining ponds for monitoring. The primary criteria for these ponds was that they were "wet" (had filled with groundwater), had active mining permits, and were approved for reclamation to permanent lakes/ponds. There are currently four aggregate mining operations (Cemex, Teichert Esparto, Teichert Woodland, and Syar) that require the initial five years of monitoring. The six identified ponds included two from Cemex (Phase 1 (West) and Phase 3-4 (East)), two from Teichert Esparto (Reiff and Mast), one from Teichert Woodland (Storz), and one from Syar (B1). Locations of these ponds, as well as the baseline Cache Creek sampling sites from 2011-2012, are shown in Figure A. Mast Pond was inaccessible because of mining operations. Storz Pond was made accessible too late for effective sampling (December). We made several attempts, but the fish were in winter hibernation mode. The 4 larger, more significant ponds were all sampled successfully for both large and small fish of multiple species.



Off-Channel Aggregate Mining Ponds Sampled in 2015 and Baseline 2011-2012 Sampling Locations in Cache Creek

Figure A

The purpose of this report is to present the new fish mercury data from the tested aggregate mining ponds and to compare levels between the ponds and between the ponds and comparable 'baseline' samples taken from adjacent Cache Creek in 2011-2012. Following, below, are the methods we used and then a presentation of the new mercury data. The data are first presented for each specific pond site, for both large and small fish samples. The information is presented numerically in tables and graphically in plots. Discussions of the site data and comparisons are in these front sections, by site. Following the individual pond sections are a series of tables and graphs that compare mercury levels between the ponds and between the ponds and the 2011-2012 baseline creek data. Earlier comparison data from Cache Creek are also summarized.

Photos of the pond sites and many of the collected samples can be found in the Appendix at the end of the report.

METHODS

Field sampling was coordinated with staff of the three mining companies, Teichert, Cemex, and Syar. Access ramps for boat launching were constructed at some of the ponds, which was a big help. We used our sampling boat to get around each of the ponds and collect the fish.

The fish samples were taken with a variety of techniques. Adult fish were collected with experimental gill nets that have a variety of mesh sizes, also with baited set lines laid at the bottom of ponds (catfish), and by angling (bass). Gill nets and set lines, deployed in both daylight and nighttime conditions, were carefully monitored to quickly remove captured fish. Small fish were collected with a variety of seines and hand nets.

Large fish were field identified, weighed and measured, and sampled for mercury analysis using a non-destructive biopsy technique we developed that allows us to return the fish back to the water in good condition (Slotton et al. 2002). In this technique, laboratory digestion tubes, to be used in the analysis, are pre-weighed, empty, to ± 0.0001 g. In the field, several scales are removed from each fish on the left side above the lateral line and a small biopsy sample of app. 0.2000 g (about the size of a raisin) is taken from the left fillet. The sample is carefully placed into a pre-weighed digestion tube. Tubes are sealed with Parafilm™ and stored on ice in a sealed, freezer-weight bag. Later, at the laboratory, the tubes with sample pieces are again weighed and the exact weight of each sample is determined by subtracting the empty tube weight.

Small fish were field identified, cleaned and sorted by species, bagged in labeled freezer weight, zip-close bags with air removed, and transported on ice to the laboratory. Samples were then weighed, measured, and assembled into composite groupings of similar-sized fish. Each composite sample was frozen in doubled freezer weight bags with water surrounding and air removed, a technique our group has found to maintain natural moisture levels through the freezing process, something that can be a major problem for small fish samples (Slotton et al. 2015). Preanalytical processing included weighing each composite group and drying the sample to constant weight in a laboratory oven at 55 °C. Solids percentage was calculated during this process, through sequential weighings of empty weigh pans, pans with wet sample, and pans with dry sample. Dried samples were homogenized to fine powders using a laboratory grinder.

Large fish fillet muscle samples were analyzed for mercury directly, on a wet (fresh) weight basis. Small fish composite samples were analyzed whole body, homogenized into dry powders for consistency, as described above. Dry weight results were converted to original wet/fresh weight concentrations using the calculated % solids values. For all mercury analyses, samples were weighed into 20 ml digestion tubes and digested at 90 °C in a mixture of concentrated nitric and sulfuric acids with potassium permanganate, in a two stage process. Digested samples were then analyzed for total mercury by standard cold vapor atomic absorption (CVAA) spectrophotometry, using a dedicated Perkin Elmer Flow Injection Mercury System (FIMS) with an AS-90 autosampler. The method is a variant of EPA Method 245.6, with modifications developed by our laboratory (Slotton et al. 2015).

Extensive Quality Assurance / Quality Control (QAQC) samples were included in all analytical runs and tracked with control charts. Results for this project were all well within control limits.

RESULTS AND DISCUSSION

CEMEX–WEST POND ('Phase 1') *(Tables 1a-b, Figures 1a-b)*

This pond is the older of the 2 current Cemex ponds. It is located just south of Cache Creek and east of Highway 505. The Phase 1 Pond is an oval shaped, fairly deep bowl that is app. 400 m long and 150 m wide. Depths range to 12+ m (40+ feet). Photos of this and the other sites, and many of the samples taken, can be found in the Appendix at the end of this report.

We sampled the pond during daytime, twilight, and night conditions with a full range of techniques, and were able to obtain good samples of most of the fish species present (Tables 1a and 1b, Figures 1a and 1b). These included, for large, angling-sized fish, samples of 18 Largemouth Bass (*Micropterus salmoides*) and 2 large Channel Catfish (*Ictalurus punctatus*). The small fish present were juvenile Largemouth Bass (4-5") and Mosquitofish (1-2", *Gambusia*

Table 1a. Cemex–West Pond (Phase 1): Large fish sampled, Fall 2015

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	197	7.8	110	0.2	**0.124**
Largemouth Bass	200	7.9	120	0.3	**0.110**
Largemouth Bass	205	8.1	125	0.3	**0.105**
Largemouth Bass	309	12.2	420	0.9	**0.116**
Largemouth Bass	310	12.2	360	0.8	**0.295**
Largemouth Bass	312	12.3	360	0.8	**0.303**
Largemouth Bass	312	12.3	395	0.9	**0.309**
Largemouth Bass	319	12.6	405	0.9	**0.374**
Largemouth Bass	322	12.7	455	1.0	**0.233**
Largemouth Bass	325	12.8	465	1.0	**0.282**
Largemouth Bass	326	12.8	420	0.9	**0.429**
Largemouth Bass	328	12.9	445	1.0	**0.326**
Largemouth Bass	331	13.0	440	1.0	**0.473**
Largemouth Bass	332	13.1	490	1.1	**0.202**
Largemouth Bass	332	13.1	475	1.0	**0.312**
Largemouth Bass	332	13.1	505	1.1	**0.266**
Largemouth Bass	344	13.5	545	1.2	**0.341**
Largemouth Bass	354	13.9	540	1.2	**0.396**
Channel Catfish	530	20.9	1,410	3.1	**0.104**
Channel Catfish	660	26.0	2,850	6.3	**0.291**

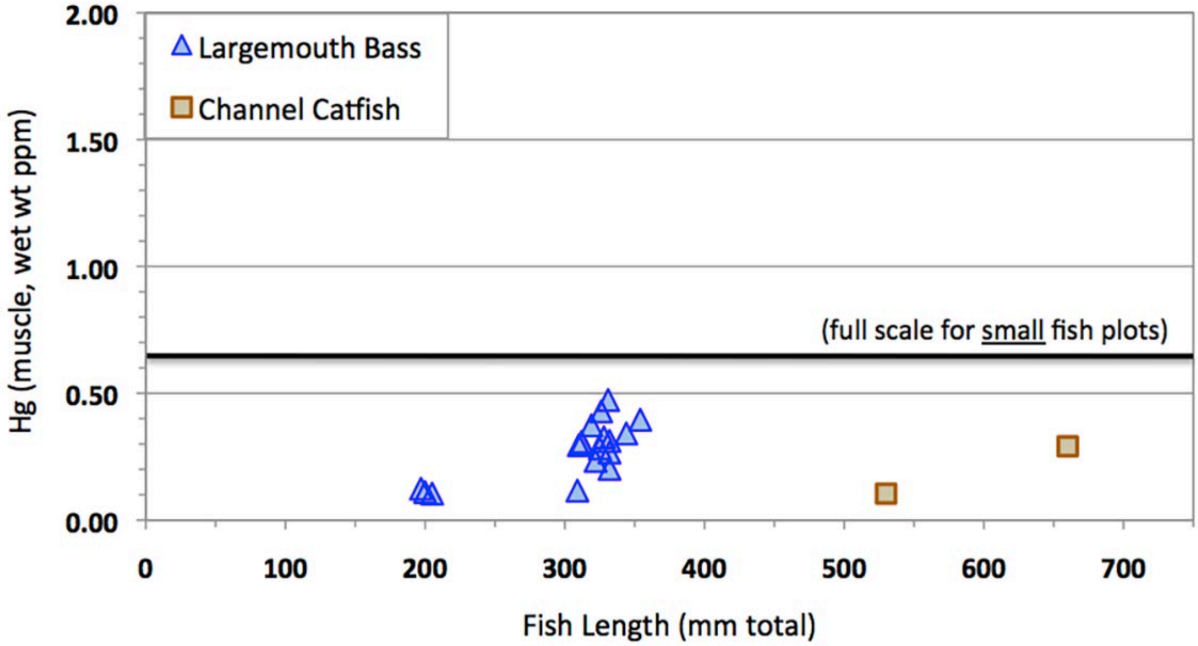


Figure 1a. Cemex–West Pond (Phase 1): Large Fish Sampled, Fall 2015
(fillet muscle mercury in individual fish)

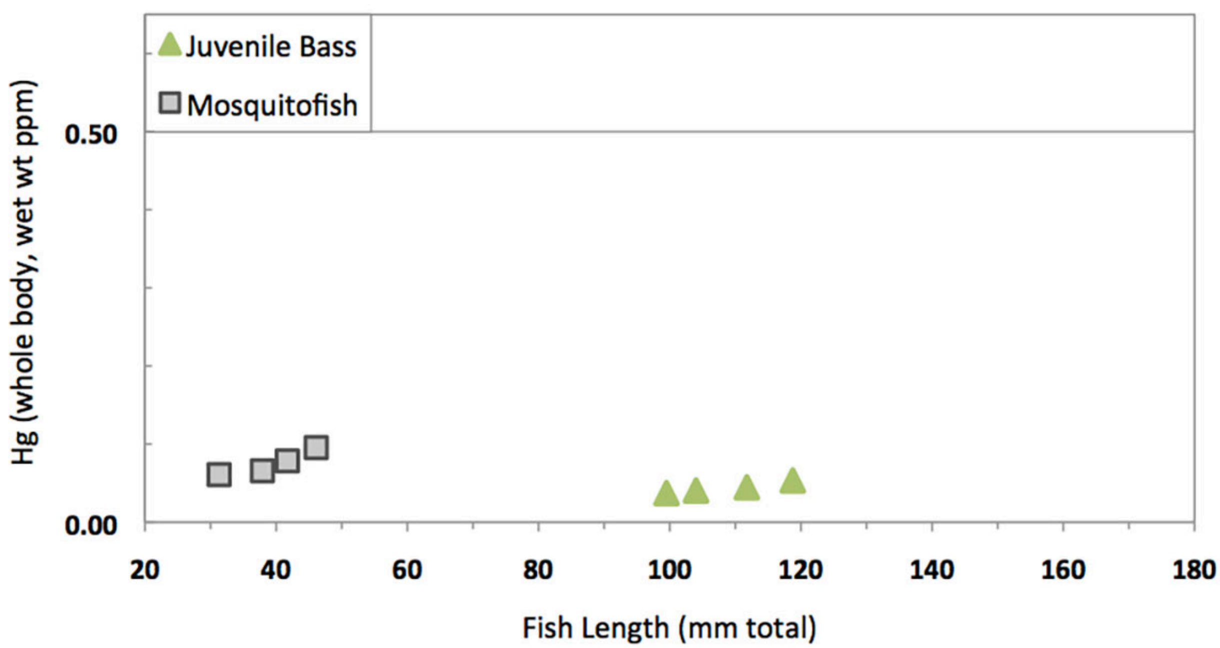


Figure 1b. Cemex–West Pond (Phase 1): Small Fish Sampled, Fall 2015
(whole-body, multi-individual composite samples)

Table 1b. Cemex–West Pond (Phase 1): Small Fish Sampled, Fall 2015
(multi-individual, whole body composite samples)

Fish Species	n (indivs. in comp)	Av. Fish Length (mm)	Av. Fish Length (inches)	Av. Fish Weight (g)	Av. Fish Weight (oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Largemouth Bass (juv)	**8**	100	3.9	12.6	0.44	**0.037**
Largemouth Bass (juv)	**8**	104	4.1	15.1	0.53	**0.040**
Largemouth Bass (juv)	**8**	112	4.4	17.5	0.62	**0.045**
Largemouth Bass (juv)	**8**	119	4.7	20.8	0.73	**0.053**
Mosquitofish	**10**	31	1.2	0.31	0.01	**0.061**
Mosquitofish	**10**	38	1.5	0.55	0.02	**0.066**
Mosquitofish	**10**	42	1.6	0.71	0.03	**0.078**
Mosquitofish	**10**	46	1.8	0.95	0.03	**0.095**

affinis). We collected 32 small bass, which were divided into 4 composite samples of 8 fish each. The Mosquitofish collected were split into 4 composite samples of 10 fish each.

In total, this added up to 28 separate mercury samples analyzed from the Cemex-West Pond.

CEMEX–WEST POND (PHASE 1): FISH MERCURY LEVELS, AND COMPARISONS WITH OTHER 2015 POND SITES AND WITH 2011-2012 BASELINE SAMPLES

(Tables 1c, 5a-b, and Figures 5-12)

The Phase 1 Pond adult Bass samples had fillet muscle mercury ranging from 0.110-0.473 ppm, averaging 0.278 ppm. Adult Bass represent the top predator fish in this region and will typically have the highest mercury levels at any given site. These West Pond bass had the lowest levels found among the 3 bass-containing mining ponds sampled in 2015 (significantly lower at the 95% statistical confidence level). They were also lower than similar baseline samples from Cache Creek (statistically lower than the upstream, River Mile 28 site). The West Pond bass were in fact among the lowest mercury top predator fish samples we have collected in California across many studies.

The Cemex–West Pond (Phase 1) Channel Catfish had fillet muscle mercury of 0.104 and 0.291 ppm, averaging 0.198 ppm. With only 2 fish collected, this was not as strong a sample as we would like, but they were both large fish that had been exposed to the local pond conditions for years, making them strong indicators. We have ideas of how to increase our take in future collections. As with the Bass, despite their large size, these Catfish had statistically lower mercury, relative to the other pond with Catfish (Reiff). They were at a similar level as the baseline comparison Catfish taken at the River Mile 28 site, but note that the West Pond fish, averaging over 2 kg (4.7 pounds), were 20 times larger than the baseline catfish (0.1 kg, 0.2 lbs). Comparably-sized baseline creek fish could be expected to have much higher mercury levels.

The juvenile Bass multiple-fish composites had whole-body mercury ranging from 0.037-0.053 ppm, averaging 0.044 ppm. These levels were statistically well below those of similar samples taken from the Cemex–Phase 3-4 Pond (0.285-0.408 ppm) and the Syar–B1 Pond (0.545-0.613 ppm). They were significantly lower than baseline Creek juvenile bass samples from the upstream, River Mile 28 site (averaging 0.142 ppm) and lower, though not significantly, than the downstream, River Mile 15 sample (averaging 0.050 ppm).

The Mosquitofish Phase 1 Pond multiple-fish composites had whole-body mercury ranging from 0.061-0.095 ppm, averaging 0.075 ppm. Mosquitofish were taken in all 4 of the ponds monitored in 2015. Consistent with the other samples, the Phase 1 Pond Mosquitofish had the lowest mercury of the ponds sampled. They were significantly lower, at the 95% confidence level, than comparable fish from the Cemex–East (Phase 3-4) Pond (average = 0.228 ppm) and the Syar–B1 Pond (average = 0.268 ppm). They were lower, but not significantly, than the one comparison set of baseline creek samples we have, from River Mile 15 (average = 0.103 ppm).

Table 1c summarizes statistical comparisons of the Cemex–West (Phase 1) Pond fish data with corresponding data from the other tested aggregate mining ponds and from the 2011-2012 baseline Cache Creek samples. Detailed comparison tables (5a-b) and figures (5-12) can be found beginning on page 33. This pond had clearly the lowest fish mercury levels of the four tested mining sites. It was similar to the lowest mercury baseline creek site (River Mile 15) and was lower than the River Mile 28 baseline site. The Cemex–West (Phase 1) Pond may provide clues about the factors leading to lower, rather than higher, mercury exposure conditions.

Table 1c. Cemex–West Pond (Phase 1): Summary Comparisons With Comparable Samples From the Other Monitored Ponds and Baseline Cache Creek Collections
(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–E (Phase 3-4)**	**Teichert–Reiff**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	<		<	<		=
Channel Catfish		<		=		
Small fish whole body, composite mercury						
Largemouth Bass (juv)	<		<	<		=
Mosquitofish	<	=	<			=

CEMEX–EAST POND ('Phase 3-4') *(Tables 2a-b, Figures 2a-b)*

This pond is the more recent, and currently active, of the 2 Cemex ponds. It is also located just south of Cache Creek and east of Highway 505. It is immediately east of the Cemex-West (Phase 1) Pond. The Phase 3-4 Pond is a large, elongated water body that is app. 1,200 m long (1.2 km) and 300 m wide. Depths range from extensive areas of 0-2 m shallows to deep areas of 10+ m (40+ feet). Active mining was occurring in the northwest part of the pond when we sampled.

Table 2a. Cemex–East Pond (Phase 3-4): Large fish sampled, Fall 2015

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	302	11.9	340	0.7	**0.531**
Largemouth Bass	307	12.1	370	0.8	**0.388**
Largemouth Bass	317	12.5	370	0.8	**0.526**
Largemouth Bass	326	12.8	405	0.9	**0.481**
Largemouth Bass	332	13.1	515	1.1	**0.919**
Largemouth Bass	333	13.1	480	1.1	**1.255**
Largemouth Bass	335	13.2	450	1.0	**0.801**
Largemouth Bass	338	13.3	445	1.0	**0.997**
Largemouth Bass	339	13.3	495	1.1	**0.825**
Largemouth Bass	341	13.4	610	1.3	**0.876**
Largemouth Bass	342	13.5	455	1.0	**1.069**
Largemouth Bass	346	13.6	470	1.0	**0.677**
Largemouth Bass	346	13.6	545	1.2	**0.554**
Largemouth Bass	353	13.9	520	1.1	**0.895**
Largemouth Bass	357	14.1	620	1.4	**0.892**
Largemouth Bass	366	14.4	610	1.3	**0.962**
Largemouth Bass	368	14.5	605	1.3	**1.131**
Largemouth Bass	369	14.5	630	1.4	**0.983**
Largemouth Bass	379	14.9	715	1.6	**0.918**
Largemouth Bass	392	15.4	870	1.9	**1.123**
Green Sunfish	100	3.9	15	0.03	**0.588**
Green Sunfish	103	4.1	17	0.04	**0.648**
Green Sunfish	107	4.2	21	0.05	**0.612**
Green Sunfish	107	4.2	22	0.05	**0.479**
Green Sunfish	118	4.6	28	0.06	**0.461**
Green Sunfish	125	4.9	34	0.07	**0.314**
Green Sunfish	130	5.1	37	0.08	**0.481**
Green Sunfish	134	5.3	42	0.09	**0.655**
Green Sunfish	135	5.3	41	0.09	**0.492**
Green Sunfish	267	10.5	415	0.91	**0.605**

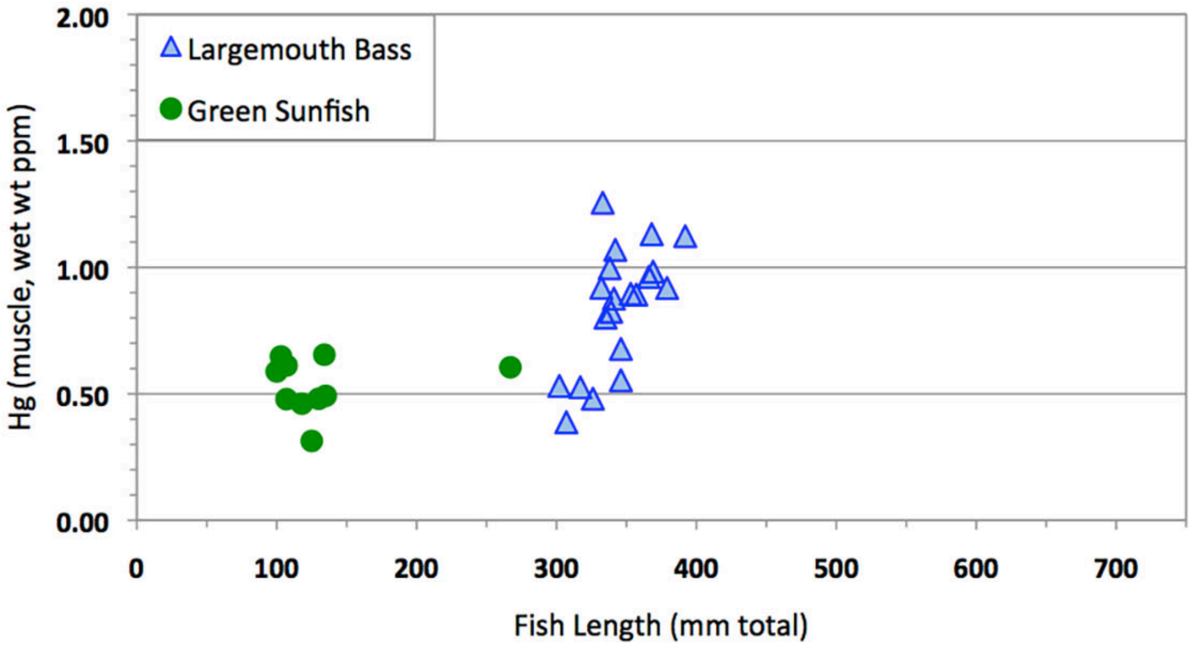


Figure 2a. Cemex–East Pond (Phase 3-4): Large Fish Sampled, Fall 2015
(fillet muscle mercury in individual fish)

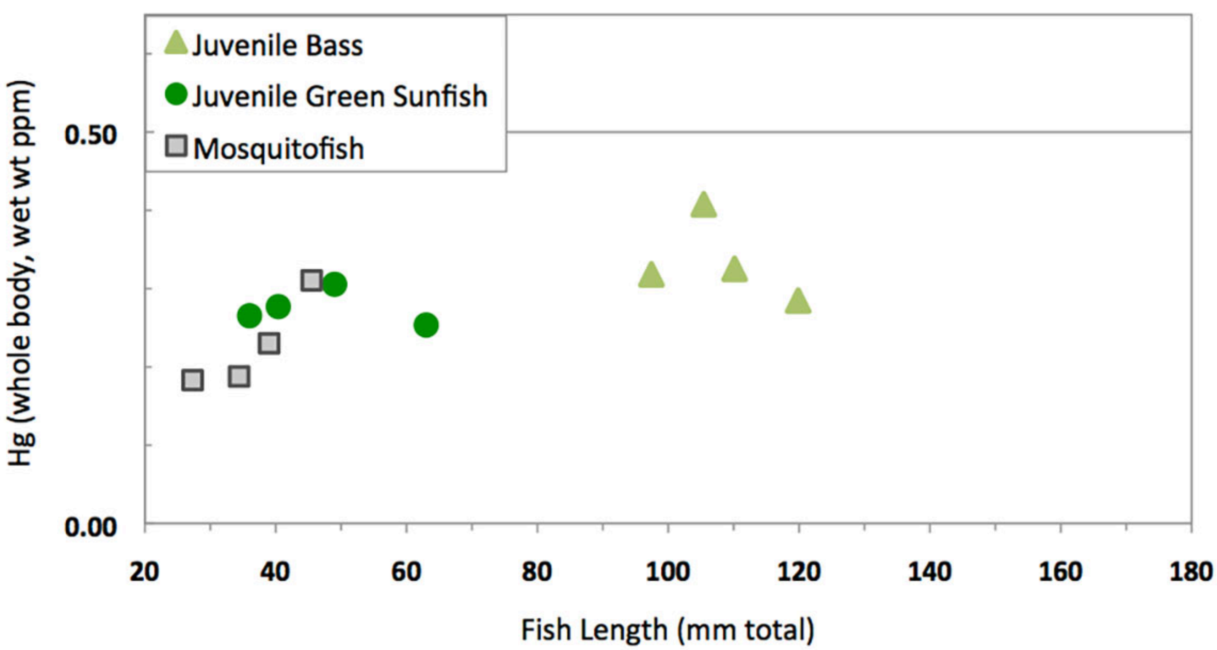


Figure 2b. Cemex–East Pond (Phase 3-4): Small Fish Sampled, Fall 2015
(whole-body, multi-individual composite samples)

Table 2b. Cemex–East Pond (Phase 3-4): Small Fish Sampled, Fall 2015
(multi-individual, whole body composite samples)

Fish Species	n (indivs. in comp)	Av. Fish Length (mm)	(inches)	Av. Fish Weight (g)	(oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Largemouth Bass (juv)	**7**	97	3.8	12.0	0.42	**0.318**
Largemouth Bass (juv)	**7**	105	4.2	14.1	0.50	**0.408**
Largemouth Bass (juv)	**7**	110	4.3	16.6	0.59	**0.325**
Largemouth Bass (juv)	**7**	120	4.7	20.7	0.73	**0.285**
Green Sunfish (juv)	**10**	36	1.4	0.80	0.03	**0.265**
Green Sunfish (juv)	**10**	40	1.6	1.15	0.04	**0.277**
Green Sunfish (juv)	**10**	49	1.9	1.81	0.06	**0.306**
Green Sunfish (juv)	**10**	63	2.5	3.43	0.12	**0.254**
Mosquitofish	**10**	27	1.1	0.21	0.01	**0.183**
Mosquitofish	**10**	34	1.4	0.40	0.01	**0.188**
Mosquitofish	**10**	39	1.5	0.60	0.02	**0.230**
Mosquitofish	**10**	46	1.8	0.99	0.03	**0.311**

We sampled the pond during daytime, twilight, and night conditions with a range of techniques, and were able to obtain good samples of the fish species present (Tables 2a and 2b). These included individual fillet muscle samples of 20 Largemouth Bass (*Micropterus salmoides*) and 10 Green Sunfish (*Lepomis cyanellus*). Catfish and other large species were not found. The small fish present were juvenile Largemouth Bass (4-5"), juvenile Green Sunfish (1-3") and Mosquitofish (1-2", *Gambusia affinis*). We collected 28 small bass, which were divided into 4 composite samples of 7 fish each. Forty juvenile Green Sunfish were placed into 4 composite samples of 10 fish each. The Mosquitofish collected were also split into 4 composite samples of 10 fish each.

In total, 42 separate mercury samples were analyzed from the Cemex-East Pond.

CEMEX–EAST POND (PHASE 3-4): FISH MERCURY LEVELS, AND COMPARISONS WITH OTHER 2015 POND SITES AND WITH 2011-2012 BASELINE SAMPLES
(Tables 2c, 5a-b, and Figures 5-12).

The adult Bass had fillet muscle mercury ranging from 0.388-1.255 ppm, averaging 0.840 ppm. This was significantly higher than the Bass from the adjacent West (Phase 1) Pond (average = 0.278 ppm) and significantly lower than Bass from the Syar–B1 Pond (average = 1.411 ppm). As compared to Cache Creek baseline samples, the Cemex–East (Phase 1) Bass were statistically indistinguishable from samples taken at River Mile 28 and statistically higher than similarly predatory Sacramento Pikeminnows taken at River Mile 15 (average = 0.327 ppm). However, the available RM 15 baseline creek samples were relatively small fish, less than half the weight of the Phase 3-4 Pond samples (see Table 5a). Creek samples of comparably sized predatory fish could be expected to contain higher mercury levels than those available in the baseline sampling.

The Cemex–East (Phase 3-4) Pond Green Sunfish had fillet muscle mercury between 0.314 and 0.655 ppm, averaging 0.534 ppm. This was statistically lower than in comparable fish from the Syar–B1 Pond (average = 0.777 ppm). In relation to the baseline Cache Creek samples, it was statistically the same as the River Mile 28 sample (average = 0.540) and statistically higher than the samples from River Mile 20 (average = 0.138 ppm) and River Mile 15 (average = 0.195 ppm).

The juvenile Bass multiple-fish composites had whole-body mercury ranging from 0.285-0.408 ppm, averaging 0.334 ppm. This was significantly lower than in comparable fish from the Syar–B1 Pond (average = 0.589 ppm) and significantly higher than the Cemex–West (Phase 1) samples (average = 0.044 ppm). In relation to the baseline Cache Creek samples, it was significantly higher than both samples, from River Mile 28 (0.142 ppm) and River Mile 15 (0.050 ppm).

The juvenile Green Sunfish multiple-fish composites had whole-body mercury ranging from 0.254-0.306 ppm, averaging 0.275 ppm. That was lower than fish from the Syar–B1 Pond (average = 0.325 ppm), though the difference was not statistically significant. Relative to comparable baseline Cache Creek samples, the Cemex–East Pond fish had significantly higher mercury than all three creek sites: River Mile 28 (average = 0.139 ppm), River Mile 20 (0.084 ppm), River Mile 15 (0.086 ppm).

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.183-0.311 ppm, averaging 0.228 ppm. There were comparable samples from all three of the other pond sites. Levels were statistically indistinguishable from the Syar–B1 Pond (average = 0.268 ppm) and were statistically higher than at the Cemex–West (Phase 1) Pond (0.075 ppm) and the Teichert–Reiff Pond (0.094 ppm). They were higher than the single baseline creek sample set from River Mile 15 (0.103 ppm), though the difference was not significant.

Table 2c summarizes statistical comparisons of the Cemex–East (Phase 3-4) Pond fish data with corresponding data from the other tested aggregate mining ponds and from the 2011-2012 Baseline Cache Creek samples. Detailed comparison tables (5a-b) and figures (5-12) can be found beginning on page 33. This pond had significantly higher fish mercury than the other Cemex Pond (West, Phase 1) and the Teichert–Reiff Pond. Two sample sets were at levels similar to the highest mercury site, Syar–B1. Comparisons with creek baseline samples were mostly higher (8 of 11 comparisons).

Table 2c. Cemex–East Pond (Phase 3-4): Summary Comparisons With Comparable Samples From the Other Monitored Ponds and Baseline Cache Creek Collections
(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Teichert–Reiff**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	>		<	=		>
Green Sunfish			<	=	>	>
Small fish whole body, composite mercury						
Largemouth Bass (juv)	>		<	>		>
Green Sunfish (juv)			=	>	>	>
Mosquitofish	>	>	=			=

TEICHERT–REIFF POND *(Tables 3a-b, Figures 3a-b)*

This pond is the largest of the Teichert impoundments. It is located just north of Cache Creek, west of Highway 505 between 505 and County Road 87. The Reiff Pond is a fairly square-shaped pond that is app. 450 m on a side. Depths range from 0-2 m shallows along some of the margins to a deep central area to 9+ m (30 feet).

We sampled the pond during day, twilight, and night conditions with a full range of techniques. The fish collected are listed in Tables 3a and 3b. These included, for large, angling-sized fish,

Table 3a. Teichert–Reiff Pond: Large fish sampled, Fall 2015

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
White Catfish	254	10.0	180	0.4	**0.783**
White Catfish	257	10.1	195	0.4	**0.556**
White Catfish	258	10.2	190	0.4	**0.461**
White Catfish	259	10.2	170	0.4	**0.542**
White Catfish	264	10.4	190	0.4	**0.303**
White Catfish	277	10.9	230	0.5	**0.496**
White Catfish	280	11.0	250	0.6	**0.760**
White Catfish	292	11.5	265	0.6	**0.439**
White Catfish	304	12.0	305	0.7	**0.456**
White Catfish	305	12.0	353	0.8	**1.403**
White Catfish	315	12.4	385	0.8	**0.504**
White Catfish	318	12.5	390	0.9	**0.525**
White Catfish	348	13.7	530	1.2	**0.651**
White Catfish	357	14.1	555	1.2	**0.586**
White Catfish	365	14.4	545	1.2	**0.879**
White Catfish	413	16.3	770	1.7	**0.796**
White Catfish	424	16.7	895	2.0	**0.721**
White Catfish	447	17.6	1,120	2.5	**1.284**
White Catfish	463	18.2	1,180	2.6	**1.191**
White Catfish	743	29.3	4,460	9.8	**1.396**
Green Sunfish	140	5.5	40	0.09	**0.328**
Carp	350	13.8	525	1.2	**0.212**
Carp	492	19.4	1,310	2.9	**0.490**

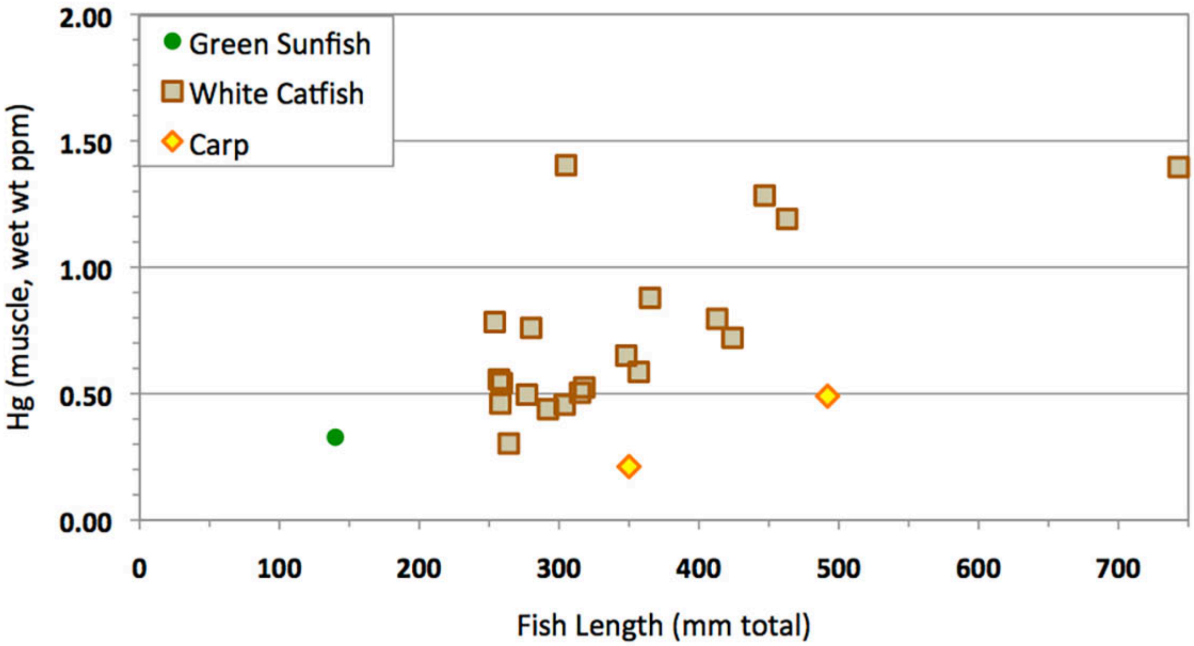


Figure 3a. Teichert–Reiff Pond: Large Fish Sampled, Fall 2015
(fillet muscle mercury in individual fish)

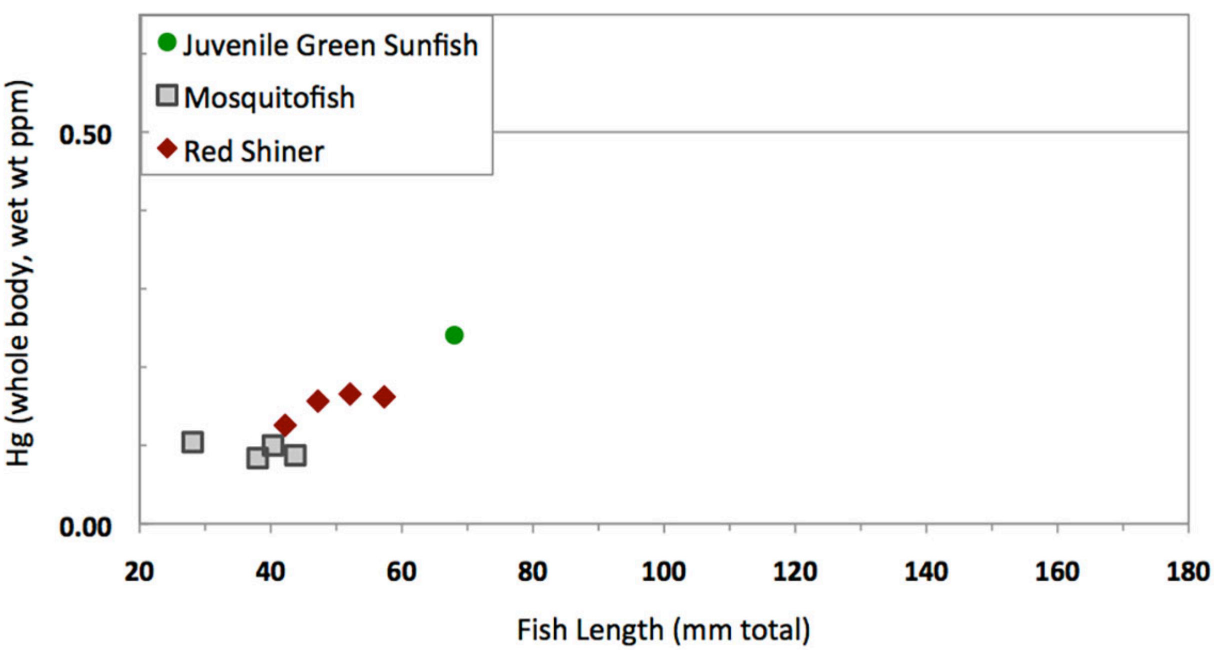


Figure 3b. Teichert–Reiff Pond: Small Fish Sampled, Fall 2015
(whole-body, multi-individual composite samples)

Table 3b. Teichert–Reiff Pond: Small Fish Sampled, Fall 2015
(multi-individual, whole body composite samples)

Fish Species	**n** (indivs. in comp)	Av. Fish Length (mm)	(inches)	Av. Fish Weight (g)	(oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Green Sunfish (juv)	**1**	68	2.7	5.10	0.18	**0.241**
Mosquitofish	**12**	28	1.1	0.29	0.01	**0.104**
Mosquitofish	**12**	38	1.5	0.51	0.02	**0.084**
Mosquitofish	**12**	40	1.6	0.60	0.02	**0.100**
Mosquitofish	**12**	44	1.7	0.86	0.03	**0.087**
Red Shiner	**10**	42	1.7	0.90	0.03	**0.126**
Red Shiner	**10**	47	1.9	1.23	0.04	**0.157**
Red Shiner	**10**	52	2.1	1.53	0.05	**0.166**
Red Shiner	**10**	57	2.3	1.67	0.06	**0.162**

samples of 20 White Catfish (*Ameiurus catus*). Nineteen of these ranged between 10 and 18 inches (250-470 mm) and 0.4-2.6 lbs (180-1,200 g). One was much larger, at 29" (743 mm) and nearly 10 lbs (4,460 g). White Catfish were by far the main large fish present. The only others taken in multiple days with multiple nets and set lines were 2 Carp (*Cyprinus carpio*) and a single Green Sunfish (*Lepomis cyanellus*). The small fish present were Red Shiners (*Cyprinella lutrensis* ~2") and Mosquitofish (*Gambusia affinis,* 1-2"). We collected 4 sets of 10 each Red Shiners and 4 sets of 12 each Mosquitofish. A single juvenile Green Sunfish was collected. In total, this added up to 32 separate mercury samples analyzed from the Reiff Pond.

TEICHERT–REIFF POND: FISH MERCURY LEVELS, AND COMPARISONS WITH OTHER 2015 POND SITES AND WITH 2011-2012 BASELINE SAMPLES

(Tables 3c, 5a-b, and Figures 5-12).

The White Catfish had fillet muscle mercury ranging from 0.303-1.396 ppm, averaging 0.737 ppm. Omitting the 10 pound fish that was much larger than the comparison samples, the average mercury was 0.702 ppm. Using either average, this was significantly higher than the catfish taken in the Cemex–West (Phase 1) Pond (average = 0.198 ppm) or in the baseline Cache Creek collection from River Mile 28 (0.143 ppm). However, note that the Teichert Reiff Pond fish, averaging 458 g (1.0 pound) excluding the much larger 10 lb fish, were more than 4 times larger than the baseline catfish (102 g, 0.2 lbs). Comparably-sized baseline creek fish could be expected to have higher mercury levels. The difference with the Cemex–West Pond catfish, though, which were larger, is indication of a significant difference between these two ponds.

The two Carp had fillet muscle mercury of 0.212 in a 14" (350 mm) fish and 0.490 ppm in a 19" (492 mm) fish, averaging 0.351 ppm. There were no Carp in the baseline creek collections, but we can compare with the set of Sacramento Suckers taken at River Mile 15, which are similar in their diets and bottom feeding habits. The Reiff Pond Carp were significantly higher in mercury than the creek Suckers (average = 0.143 ppm). As noted above for the catfish, this difference is mitigated somewhat by the relative size/age of the fish. The Reiff Pond Carp averaged 918 g (2.0 lbs), vs. the creek Sucker samples which averaged 231 g (0.5 lb). Comparably sized creek Suckers could be expected to have higher mercury levels than the baseline samples taken.

The single Green Sunfish had fillet mercury of 0.328 ppm. Statistical comparisons can't be made with a single individual, but this concentration was considerably lower than the Green Sunfish mercury from The Cemex–East Pond (average = 0.534 ppm) or the Syar–B1 Pond (0.777 ppm). Relative to the baseline Cache Creek samples, it was lower than at River Mile 28 (average = 0.540 ppm), and higher than the fish from River Mile 20 (0.138 ppm) and River Mile 15 (0.195 ppm).

The Red Shiner multiple-fish composites had whole-body mercury ranging from 0.126-0.166 ppm, averaging 0.152 ppm. We didn't find Red Shiners in any of the other ponds, but have good comparison baseline samples from the creek. The Reiff Pond Shiners were statistically lower in mercury than the River Mile 28 fish (av. = 0.242 ppm), lower but not significantly than fish from River Mile 20 (0.189 ppm), and higher than corresponding fish from River Mile 15 (0.063 ppm).

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.087-0.104 ppm, averaging 0.094 ppm. This was statistically lower than fish from the Cemex–East Pond (average = 0.228 ppm) and the Syar–B1 Pond (0.268 ppm). It was statistically indistinguishable from the Cemex–West Pond sample (0.075 ppm) and the baseline Cache Creek sample from River Mile 15 (0.103 ppm).

The single juvenile Green Sunfish had whole-body mercury of 0.241 ppm. This was lower than the average mercury in this species from the Cemex–East Pond (average = 0.275 ppm) and the Syar–B1 Pond (0.325 ppm). It was higher than the average mercury in the baseline creek fish at River Mile 28 (0.139 ppm), River Mile 20 (0.084 ppm), and River Mile 15 (0.086 ppm).

Table 3c summarizes comparisons of the Teichert–Reiff Pond fish data with corresponding data from the other tested aggregate mining ponds and from the 2011-2012 Baseline Cache Creek samples. Detailed comparison tables (5a-b) and figures (5-12) can be found beginning on page 33. This pond was moderate relative to all the comparison samples, with some samples lower, some higher, and some the same. The pond's White Catfish definitely contained mercury at problem levels (to over 1.3 ppm), but it is not clear if this is higher than levels in Cache Creek catfish of comparable size, which were not available for the baseline sampling.

Table 3c. Teichert–Reiff Pond: Summary Comparisons With Comparable Samples From the Other Monitored Ponds and Baseline Cache Creek Collections
(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Cemex–E (Phase 3-4)**	**Syar–B1**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
White Catfish	>			>		
Carp						=
Small fish whole body, composite mercury						
Mosquitofish	=	<	<			=
Red Shiner				<		>

SYAR–B1 POND *(Tables 4a-b, Figures 4a-b)*

The Syar Cache Creek mining operation was not operating at the time of this sampling and had been idle since 2011. The B1 Pond is located south of Cache Creek and west of Highway 505, between 505 and County Road 87. After 4 years of drought conditions, it is a distinct, separate pond. With much higher water levels, the basin can link to the adjacent pond located to the west. The B1 Pond is an irregular rectangle shape app. 360 m long and 150 m wide. It is located in a steep-sided surrounding depression but, under conditions in 2015, depths were relatively shallow, ranging to about 6 m (20 feet).

Table 4a. Syar–B1 Pond: Large fish sampled, Fall 2015

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	210	8.3	105	0.2	**1.225**
Largemouth Bass	232	9.1	155	0.3	**1.021**
Largemouth Bass	246	9.7	205	0.5	**1.200**
Largemouth Bass	247	9.7	190	0.4	**1.172**
Largemouth Bass	249	9.8	200	0.4	**1.117**
Largemouth Bass	253	10.0	215	0.5	**1.369**
Largemouth Bass	256	10.1	225	0.5	**1.615**
Largemouth Bass	257	10.1	225	0.5	**1.686**
Largemouth Bass	259	10.2	250	0.6	**1.372**
Largemouth Bass	260	10.2	235	0.5	**1.302**
Largemouth Bass	263	10.4	240	0.5	**1.633**
Largemouth Bass	269	10.6	250	0.6	**1.538**
Largemouth Bass	274	10.8	260	0.6	**1.353**
Largemouth Bass	282	11.1	285	0.6	**1.593**
Largemouth Bass	296	11.7	355	0.8	**1.495**
Largemouth Bass	323	12.7	495	1.1	**1.893**
Largemouth Bass	425	16.7	1.160	2.6	**3.354**
Largemouth Bass	460	18.1	1.340	3.0	**3.363**
Green Sunfish	102	4.0	17	0.04	**0.783**
Green Sunfish	103	4.1	17	0.04	**0.935**
Green Sunfish	108	4.3	15	0.03	**0.856**
Green Sunfish	109	4.3	17	0.04	**0.750**
Green Sunfish	115	4.5	24	0.05	**0.779**
Green Sunfish	121	4.8	27	0.06	**0.640**
Green Sunfish	122	4.8	27	0.06	**0.617**
Green Sunfish	132	5.2	33	0.07	**0.863**
Green Sunfish	132	5.2	34	0.07	**0.625**
Green Sunfish	134	5.3	40	0.09	**0.927**

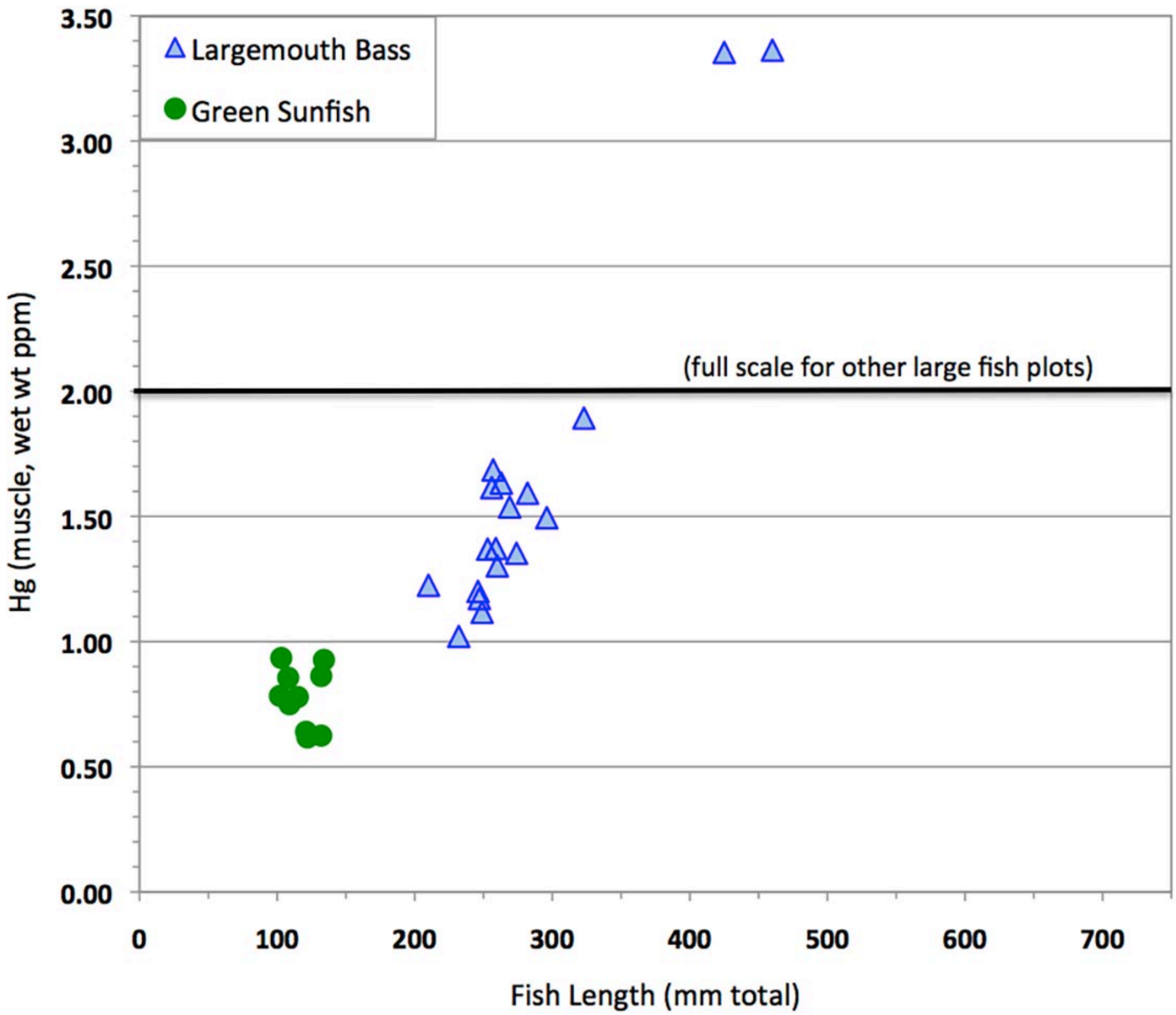


Figure 4a. Syar–B1 Pond: Large Fish Sampled, Fall 2015
(fillet muscle mercury in individual fish)

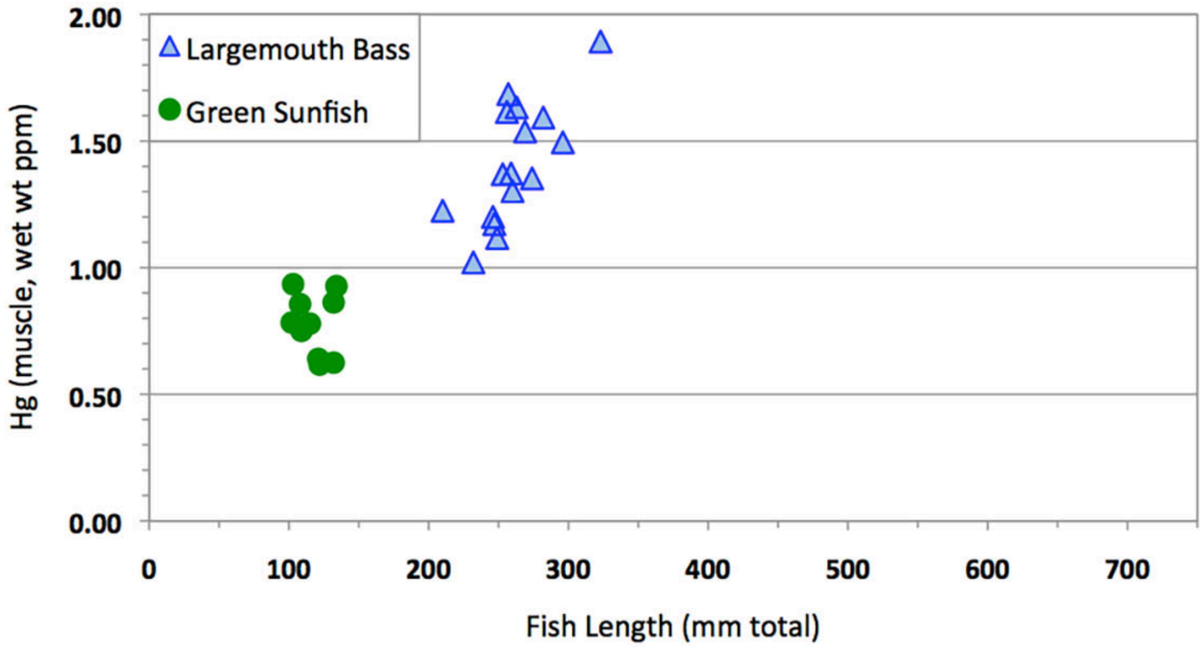


Figure 4b. Syar–B1 Pond: Large Fish Sampled, Fall 2015
(mercury scale matching other large fish plots; omitting 2 largest bass)

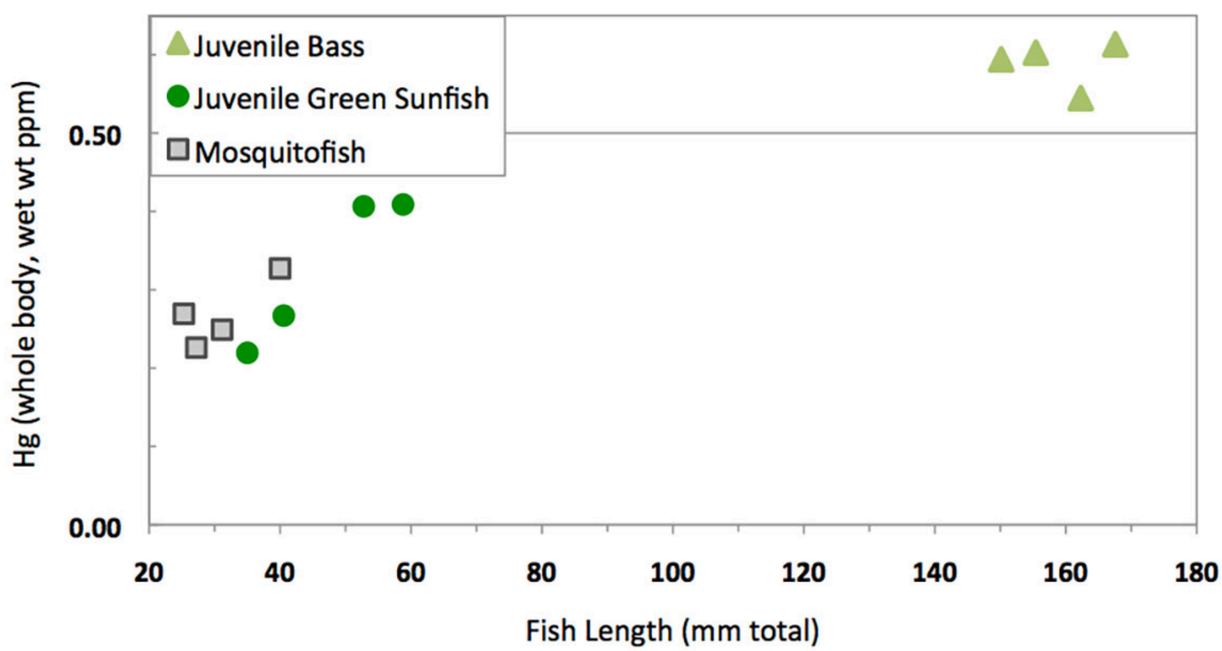


Figure 4c. Syar–B1 Pond: Small Fish Sampled, Fall 2015
(whole-body, multi-individual composite samples)

Table 4b. Syar–B1 Pond: Small Fish Sampled, Fall 2015
(multi-individual, whole body composite samples)

Fish Species	**n** (indivs. in comp)	Av. Fish Length (mm)	(inches)	Av. Fish Weight (g)	(oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Largemouth Bass (juv)	**7**	150	5.9	37.4	1.32	**0.594**
Largemouth Bass (juv)	**7**	155	6.1	39.9	1.41	**0.603**
Largemouth Bass (juv)	**7**	162	6.4	46.0	1.62	**0.545**
Largemouth Bass (juv)	**7**	168	6.6	50.6	1.79	**0.613**
Green Sunfish (juv)	**9**	35	1.4	0.69	0.02	**0.219**
Green Sunfish (juv)	**9**	41	1.6	1.06	0.04	**0.267**
Green Sunfish (juv)	**9**	53	2.1	2.25	0.08	**0.406**
Green Sunfish (juv)	**8**	59	2.3	2.91	0.10	**0.409**
Mosquitofish	**10**	25	1.0	0.14	0.01	**0.269**
Mosquitofish	**10**	27	1.1	0.18	0.01	**0.226**
Mosquitofish	**7**	31	1.2	0.29	0.01	**0.249**
Mosquitofish	**5**	40	1.6	0.62	0.02	**0.327**

As at the other sites, we sampled the B1 Pond during day, twilight, and night conditions on multiple days with a range of techniques. We were able to obtain good samples of the three fish species present (Tables 4a and 4b). These included fillet muscle samples of 18 Largemouth Bass (*Micropterus salmoides*) and 10 Green Sunfish (*Lepomis cyanellus*). The small fish present were juvenile Largemouth Bass (6-7" -- note, larger than the other small bass samples), juvenile Green Sunfish (1-2") and Mosquitofish (*Gambusia affinis*, 1-2"). We collected 28 small bass, which were divided into 4 composite samples of 7 fish each. The 35 juvenile Green Sunfish taken were put into 4 composite samples of 8-9 fish each. The 32 Mosquitofish collected were split into 4 composite samples of 5-10 fish each. In total, 40 separate mercury samples were analyzed from the Syar-B1 Pond.

SYAR–B1 POND: FISH MERCURY LEVELS, AND COMPARISONS WITH OTHER 2015 POND SITES AND WITH 2011-2012 BASELINE SAMPLES
(Tables 4c, 5a-b, and Figures 5-12).

The adult Bass had fillet muscle mercury in the very high range of 1.021-3.363 ppm, averaging 1.628 ppm. Two of the 18 bass were considerably larger (16-18") than the rest, and larger than the comparison samples. These two fish were much higher in mercury than the others (> 3.3 ppm). This is as high as we have found in any other comparable fish, including near mercury mine sites. The average, omitting these two, was somewhat lower at 1.411 ppm. Using either average, these bass were significantly higher in mercury than all the other comparison top predator fish samples, including those from the Cemex–West Pond (average = 0.278 ppm), Cemex–East Pond (0.840 ppm), baseline River Mile 28 (0.719 ppm), and baseline River Mile 15 (0.327 ppm).

Green Sunfish had fillet muscle mercury at 0.617-0.935 ppm, averaging 0.777 ppm. Consistent with the bass, the B1 pond Green Sunfish were statistically higher in mercury than all the other comparison samples, including those from Cemex–East (0.534 ppm) and the 3 baseline Cache Creek sites, River Mile 28 (0.540 ppm), RM 20 (0.138 ppm), and RM 15 (0.195 ppm).

The juvenile Bass multiple-fish composites had whole-body mercury ranging from 0.545-0.613 ppm, averaging 0.589 ppm. Consistent with the large fish samples, these were statistically higher in mercury than the comparison samples from the other ponds, Cemex–West (average = 0.044 ppm) and Cemex–East (0.334 ppm), and the baseline creek sites River Mile 28 (0.142 ppm) and River Mile 15 (0.050 ppm)

Juvenile Green Sunfish multiple-fish composites had whole-body mercury ranging from 0.219-0.409 ppm, averaging 0.325 ppm. This was statistically indistinguishable from corresponding Cemex–East fish (0.275 ppm) but was significantly higher than the three baseline Cache Creek sites, River Mile 28 (0.139 ppm), River Mile 20 (0.084 ppm), and River Mile 15 (0.086 ppm).

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.226-0.327 ppm, averaging 0.268 ppm. Similar to the juvenile Green Sunfish data, this was statistically indistinguishable from the Cemex–East fish (average = 0.228 ppm) but significantly higher than the other comparison sets, including Cemex–West (0.075 ppm), Teichert–Reiff (0.094 ppm), and the baseline Cache Creek site with Mosquitofish, River Mile 15 (0.103 ppm).

Table 4c summarizes comparisons of the Syar–B1 Pond fish data with corresponding data from the other tested aggregate mining ponds and from the 2011-2012 baseline Cache Creek samples. Detailed comparison tables (5-6) and figures (5-12) can be found beginning on page 33. This pond was the highest mercury exposure environment of those tested, significantly higher in all 11 comparisons with corresponding baseline creek samples, and higher in 7 of 9 comparisons with other tested ponds. In 4 of these comparisons, though (juvenile bass), the higher levels may be partly due to the larger sizes of the B1 Pond juveniles (they may have been 2-year-olds).

Table 4c. Syar – B1 Pond: Summary Comparisons With Comparable Samples From the Other Monitored Ponds and Baseline Cache Creek Collections
(statistically lower (<), higher (>), or indistinguishable (=) at the 95% confidence level)

	– vs *Other 2015 Pond Sites* –			– vs *Baseline Cache Creek Sites* –		
Fish Species	**Cemex–W (Phase 1)**	**Cemex–E (Phase 3-4)**	**Teichert–Reiff**	**River Mile 28**	**River Mile 20**	**River Mile 15**
Large fish fillet muscle mercury						
Largemouth Bass	>	>		>		>
Green Sunfish		>		>	>	>
Small fish whole body, composite mercury						
Largemouth Bass (juv)	>	>		>		>
Green Sunfish (juv)		=		>	>	>
Mosquitofish	>	=	>			>

COMPARISON TABLES AND FIGURES:
BETWEEN PONDS AND
BETWEEN PONDS AND BASELINE 2011 CACHE CREEK SAMPLES

Table 5a. Large Fish Summary Comparison Data (averages and standard deviations)
(from multiple individual fillet muscle samples from each site)
Comparison 2011 baseline samples from Cache Creek in blue.
* *Omitting much larger bass (x2) and catfish (x1) for comparisons*

Site	Fish Species	n (indivs)	Av. Length (mm total)	Av. Weight (grams)	Av. Hg (µg/g = ppm, wet wt)	Std. Dev.
Cemex–W (Phase 1)	Largemouth Bass	**18**	305	393	**0.278**	± 0.111
Cemex–E (Phase 3-4)	Largemouth Bass	**20**	344	526	**0.840**	± 0.241
Teichert–Reiff	–					
Syar–B1	Largemouth Bass	**18**	281	355	**1.628**	± 0.668
*Syar–B1 **	*Largemouth Bass*	***16***	*261*	*243*	***1.411***	± *0.238*
River Mile 28 (2011)	Bass + Sac. Pike.	**26**	260	236	**0.719**	± 0.163
River Mile 15 (2011)	Sac. Pikeminnow	**9**	264	145	**0.327**	± 0.086
Cemex–W (Phase 1)	–					
Cemex–E (Phase 3-4)	Green Sunfish	**10**	133	67	**0.534**	± 0.107
Teichert–Reiff	Green Sunfish	**1**	140	40	**0.328**	
Syar–B1	Green Sunfish	**10**	118	25	**0.777**	± 0.120
River Mile 28 (2011)	Green Sunfish	**3**	139	47	**0.540**	± 0.050
River Mile 20 (2011)	Green Sunfish	**10**	122	31	**0.138**	± 0.041
River Mile 15 (2011)	Green Sunfish	**10**	133	41	**0.195**	± 0.043
Cemex–W (Phase 1)	Channel Catfish	**2**	595	2,130	**0.198**	± 0.132
Cemex–E (Phase 3-4)	–					
Teichert–Reiff	White Catfish	**20**	347	658	**0.737**	± 0.333
*Teichert–Reiff **	*White Catfish*	***19***	*326*	*458*	***0.702***	± *0.302*
Syar–B1	–					
River Mile 28 (2011)	Channel Catfish	**5**	239	102	**0.229**	± 0.082
Cemex–W (Phase 1)	–					
Cemex–E (Phase 3-4)	–					
Teichert–Reiff	Carp	**2**	421	918	**0.351**	± 0.197
Syar–B1	–					
River Mile 15 (2011)	Sac. Sucker	**8**	276	231	**0.143**	± 0.014

Table 5b. Supplemental historic baseline data – large fish, including the most closely comparable data from 1997 and 2000
(fillet muscle samples, ordered from upstream to downstream site)
2011 baseline creek samples in **bold**

Fish Species	Site	Year	n (individuals)	Av Length (mm total)	Av Weight (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Smallmouth Bass	Rumsey	2000	15	271	302	0.452	± 0.215
Smallmouth Bass	**RM 28**	**2011**	**7**	**265**	**326**	**0.782**	**± 0.204**
Smallmouth Bass	RM 20	2000	7	234	183	0.444	± 0.066
Smallmouth Bass	RM 15	1997	2	383	780	0.939	± 0.390
Smallmouth Bass	RM 08	2000	2	231	165	0.390	± 0.057
Largemouth Bass	**RM 28**	**2011**	**9**	**199**	**137**	**0.663**	**± 0.150**
Largemouth Bass	RM 03	1997	2	369	730	0.375	± 0.229
Sac. Pikeminnow	Rumsey	2000	8	327	304	0.622	± 0.341
Sac. Pikeminnow	**RM 28**	**2011**	**10**	**311**	**262**	**0.726**	**± 142**
Sac. Pikeminnow	RM 20	2000	8	269	147	0.509	± 0.244
Sac. Pikeminnow	**RM 15**	**2011**	**9**	**264**	**145**	**0.327**	**± 0.086**
Sac. Pikeminnow	RM 03	1997	1	241	110	0.499	
Channel Catfish	Rumsey	2000	1	411	565	0.225	
Channel Catfish	**RM 28**	**2011**	**5**	**239**	**102**	**0.229**	**± 0.082**
Channel Catfish	RM 20	2000	1	368	380	0.225	
Channel Catfish	RM 03	1997	10	336	304	0.174	± 0.026
Black Crappie	**RM 20**	**2011**	**1**	**176**	**59**	**0.138**	
White Crappie	RM 03	1997	6	208	95	0.300	± 0.141
Green Sunfish	**RM 28**	**2011**	**3**	**139**	**47**	**0.540**	**± 0.050**
Green Sunfish	RM 20	2000	4	132	41	0.271	± 0.223
Green Sunfish	**RM 20**	**2011**	**10**	**122**	**31**	**0.138**	**± 0.041**
Green Sunfish	**RM 15**	**2011**	**10**	**133**	**41**	**0.195**	**± 0.043**
Hybrid Sunfish	**RM 28**	**2011**	**6**	**134**	**42**	**0.375**	**± 0.055**
Bluegill	**RM 28**	**2011**	**5**	**130**	**45**	**0.308**	**± 0.102**
Bluegill	RM 20	2000	1	115	30	0.350	
Bluegill Sunfish	RM 03	1997	3	125	33	0.270	± 0.140
Sac. Sucker	Rumsey	2000	6	328	396	0.198	± 0.098
Sac. Sucker	RM 20	2000	5	253	174	0.154	± 0.027
Sac. Sucker	**RM 15**	**2011**	**8**	**276**	**231**	**0.143**	**± 0.014**
Sac. Sucker	RM 08	2000	4	319	336	0.339	± 0.164
Sac. Sucker	RM 03	1997	5	343	402	0.263	± 0.055

Table 6a. Small fish summary comparison data from multi-individual, whole body composites

(means of multiple composites, each consisting of multiple individual small fish)
Comparison fall 2011, spring 2012 baseline samples from Cache Creek in blue.

Fish Species	**Site**	**n** (comps)	**n** (inds/ comp)	**Av. Length** (mm total)	**Av. Wt.** (grams)	**Hg** (ng/g = ppb, wet wt)	**Std. Dev.**
Largemouth Bass (juv)	Cemex-W (Phase 1)	**4**	8	109	16.5	**0.044**	± 0.007
Largemouth Bass (juv)	Cemex-E (Phase 3-4)	**4**	7	108	15.9	**0.334**	± 0.052
–	Teichert-Reiff	–	–	–	–	–	–
Largemouth Bass (juv)	Syar-B1	**4**	7	159	43.5	**0.589**	± 0.030
Largemouth Bass (juv)	River Mile 28 (2011)	**4**	3-5	75	5.66	**0.142**	± 0.026
Largemouth Bass (juv)	River Mile 15 (2011)	**3**	1	93	10.2	**0.050**	± 0.024
–	Cemex-W (Phase 1)	–	–	–	–	–	–
Green Sunfish (juv)	Cemex-E (Phase 3-4)	**4**	10	47	1.80	**0.275**	± 0.022
Green Sunfish (juv)	Teichert-Reiff	–	1	68	2.70	**0.241**	
Green Sunfish (juv)	Syar-B1	**4**	8-9	47	1.73	**0.325**	± 0.097
Green Sunfish (juv)	River Mile 28 (2011)	**4**	4	53	2.81	**0.139**	± 0.014
Green Sunfish (juv)	River Mile 20 (2011)	4	4	58	3.37	**0.084**	± 0.004
Green Sunfish (juv)	River Mile 15 (2011)	**4**	4-5	56	3.15	**0.086**	± 0.018
Mosquitofish	Cemex-W (Phase 1)	**4**	10	39	0.63	**0.075**	± 0.015
Mosquitofish	Cemex-E (Phase 3-4)	**4**	10	37	0.55	**0.228**	± 0.059
Mosquitofish	Teichert-Reiff	**4**	12	38	0.56	**0.094**	± 0.010
Mosquitofish	Syar-B1	**4**	5-10	31	0.31	**0.268**	± 0.043
Mosquitofish	River Mile 15 (2011)	**4**	1-10	37	0.72	**0.103**	± 0.048
–	Cemex-W (Phase 1)	–	–	–	–	–	–
–	Cemex-E (Phase 3-4)	–	–	–	–	–	–
Red Shiner	Teichert-Reiff	**4**	10	50	1.33	**0.152**	± 0.018
–	Syar-B1	–	–	–	–	–	–
Red Shiner	River Mile 28 (2011)	**4**	10	48	1.00	**0.242**	± 0.036
Red Shiner	River Mile 28 (2012)	**6**	6	51	1.63	**0.189**	± 0.012
Red Shiner	River Mile 15 (2012)	**6**	6	52	1.79	**0.063**	± 0.006

Table 6b. Supplemental historic baseline data – small fish, fall collections, including the most closely comparable fall creek data from 1997-2002

Fall 2011 baseline creek samples in **bold**
(whole body composite samples)

Fish Species	**Site**	**Year**	**n** (comps)	**n** (inds/ (comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Red Shiner	Rumsey	2000	1	3	38	0.5	0.091	
Red Shiner	**RM 28**	**2011**	**4**	**10**	**48**	**1.0**	**0.242**	**± 0.036**
Red Shiner	RM 20	2000	3	9	42	0.6	0.166	± 0.003
Red Shiner	RM 17	2000	3	10	39	0.5	0.162	± 0.020
Red Shiner	RM 17	2001	3	12	44	0.8	0.232	± 0.015
Red Shiner	RM 17	2002	6	1	44	0.7	0.164	± 0.064
Red Shiner	RM 15	1997	3	19	37	0.5	0.159	± 0.024
Red Shiner	RM 15	2000	3	10	40	0.5	0.118	± 0.005
Red Shiner	RM 15	2001	3	25	44	0.9	0.100	± 0.013
Red Shiner	RM 15	2002	6	1	46	0.8	0.106	± 0.026
Red Shiner	RM 08	2000	4	10	42	0.7	0.123	± 0.016
Green Sunfish	**RM 28**	**2011**	**4**	**4**	**53**	**2.8**	**0.139**	**± 0.014**
Green Sunfish	**RM 20**	**2011**	**4**	**4**	**58**	**3.4**	**0.084**	**± 0.004**
Green Sunfish	RM 17	2000	2	9	60	3.6	0.185	± 0.019
Green Sunfish	RM 17	2001	1	6	60	4.0	0.138	
Green Sunfish	RM 17	2002	6	1	70	6.0	0.217	± 0.060
Green Sunfish	RM 15	2000	2	6	63	4.3	0.110	± 0.000
Green Sunfish	RM 15	2001	1	8	67	6.2	0.126	
Green Sunfish	RM 15	2002	6	1	68	5.6	0.111	± 0.021
Green Sunfish	**RM 15**	**2011**	**4**	**4-5**	**56**	**3.1**	**0.086**	**± 0.018**
Bluegill Sunfish	**RM 28**	**2011**	**2**	**2**	**61**	**0.9**	**0.136**	**± 0.005**
Bluegill Sunfish	**RM 15**	**2011**	**4**	**4**	**67**	**6.0**	**0.052**	**± 0.004**
Bluegill Sunfish	RM 08	1997	3	7	52	2.5	0.079	± 0.006
Mosquitofish	RM 17	2000	1	5	32	0.3	0.146	
Mosquitofish	RM 17	2002	4	4	34	0.4	0.175	± 0.005
Mosquitofish	RM 15	2002	4	5	35	0.4	0.091	± 0.011
Mosquitofish	**RM 15**	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

Table 6c. Supplemental historic baseline data – small fish, spring collections, including the most closely comparable spring creek data from 1997-2003

Spring 2012 baseline creek samples in **bold**
(whole body composite samples)

Fish Species	**Site**	**Year**	**n** (comps)	**n** (inds/ (comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Red Shiner	Rumsey	2000	1	2	50	1.1	0.069	
Red Shiner	**RM 28**	**2012**	**6**	**6**	**51**	**1.6**	**0.189**	**± 0.012**
Red Shiner	RM 20	2000	3	9	43	0.7	0.070	± 0.011
Red Shiner	RM 17	2001	3	13	51	2.0	0.063	± 0.013
Red Shiner	RM 17	2002	4	13	58	2.2	0.067	± 0.010
Red Shiner	RM 17	2003	4	3	53	1.8	0.057	± 0.013
Red Shiner	RM 15	2001	3	12	58	2.2	0.046	± 0.003
Red Shiner	RM 15	2002	5	15	57	2.3	0.057	± 0.006
Red Shiner	RM 15	2003	4	5	53	1.9	0.061	± 0.006
Red Shiner	**RM 15**	**2012**	**6**	**6**	**52**	**1.8**	**0.063**	**± 0.006**
Red Shiner	RM 08	2000	3	10	46	1.1	0.081	± 0.011
Green Sunfish	**RM 28**	**2012**	**4**	**4-5**	**68**	**7.2**	**0.142**	**± 0.012**
Green Sunfish	**RM 20**	**2012**	**3**	**1**	**75**	**9.7**	**0.106**	**± 0.017**
Green Sunfish	RM 17	2001	1	17	75	6.4	0.079	
Green Sunfish	RM 17	2002	3	4	66	6.1	0.083	± 0.002
Green Sunfish	RM 17	2003	10	1	65	5.4	0.091	± 0.012
Green Sunfish	RM 15	2001	1	14	65	5.8	0.070	
Green Sunfish	RM 15	2002	3	2	68	6.2	0.070	± 0.010
Green Sunfish	RM 15	2003	8	1	58	3.8	0.075	± 0.016
Green Sunfish	**RM 15**	**2012**	**4**	**2-3**	**68**	**6.9**	**0.058**	**± 0.014**
Speckled Dace	Rumsey	2000	2	10	56	2.0	0.112	± 0.002
Speckled Dace	Rumsey	2001	3	12	59	2.2	0.106	± 0.010
Speckled Dace	**RM 20**	**2012**	**4**	**3-5**	**58**	**2.2**	**0.142**	**± 0.030**
Speckled Dace	RM 17	2001	3	8	61	2.5	0.113	± 0.011

Table 7. General comparison of the 2011-2012 baseline data with closely comparable historic data from 1997-2003.
(for matching sample types/sizes and closest sites)
(relative statistical differences of new data vs old, 95% confidence level)

Sample Type	River Mile 28	River Mile 20	River Mile 15
Large Fish			
Smallmouth Bass	same		
Largemouth Bass	same		
Sacramento Pikeminnow	same		same
Green Sunfish	same	same	same
Bluegill Sunfish	same		
Sacramento Sucker			same
Small Fish			
Red Shiner (Fall)	same		
Red Shiner (Spring)	**up**		same
Green Sunfish (Fall)	same	**down**	same
Green Sunfish (Spring)	**up**	same	same
Bluegill Sunfish (Fall)			**down**
Mosquitofish (Fall)			same
Speckled Dace (Spring)		same	
Aquatic Insects			
Dragonflies (Spring)		same	same
Damselflies (Fall)	same	same	**down**
Caddisflies (Spring)	**up**	same	
same			

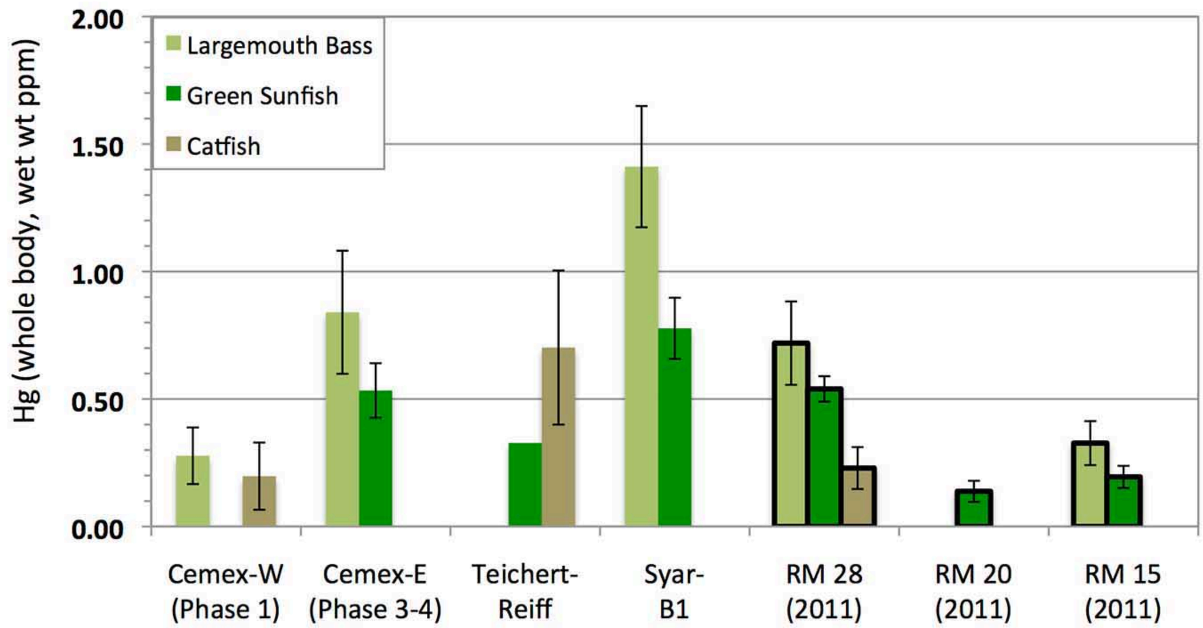


Figure 5a. Large Fish Mercury: Comparison of Ponds and 2011 Baseline Creek Samples
(All comparable species; average mercury and standard deviation for each site)
(RM refers to River Mile of baseline Cache Creek sites)

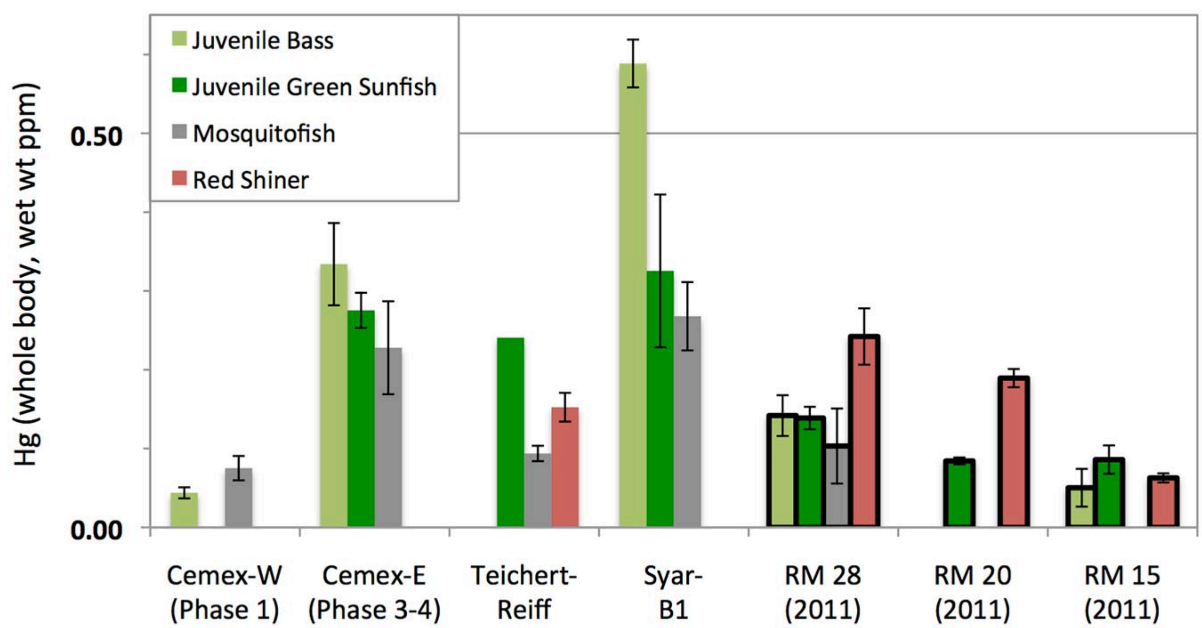


Figure 5b. Small Fish Mercury: Comparison of Ponds and 2011 Baseline Creek Samples
(All comparable species; average mercury and standard deviation for each site)

COMPARISON MERCURY PLOTS FOR INDIVIDUAL FISH SPECIES
(*large, angling-sized fish first, followed by small fish with reduced mercury scale*)

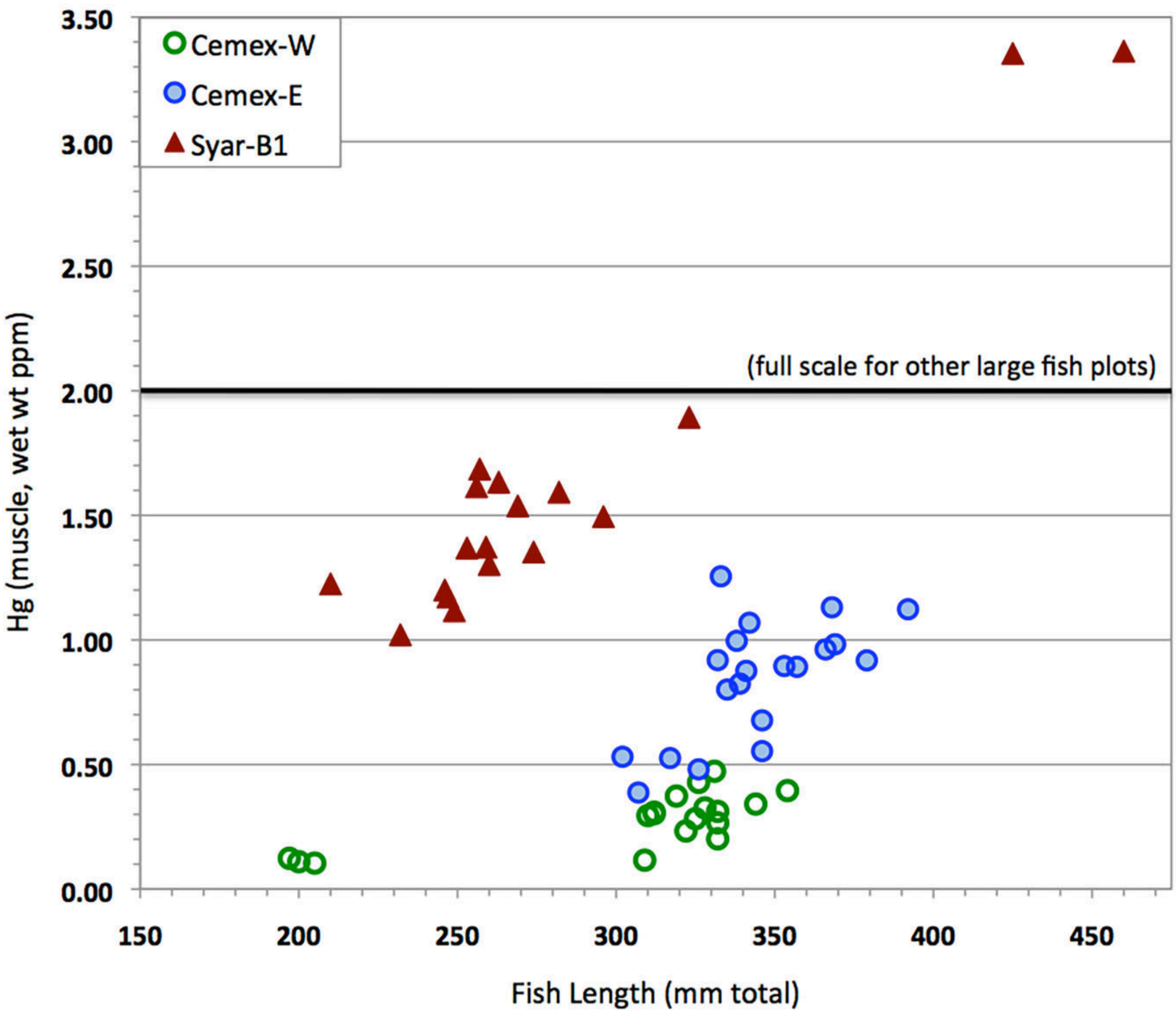


Figure 6a. Largemouth Bass Mercury: Site Comparison, Fall 2015
(fillet muscle mercury in individual fish; full scale, including all bass sampled)

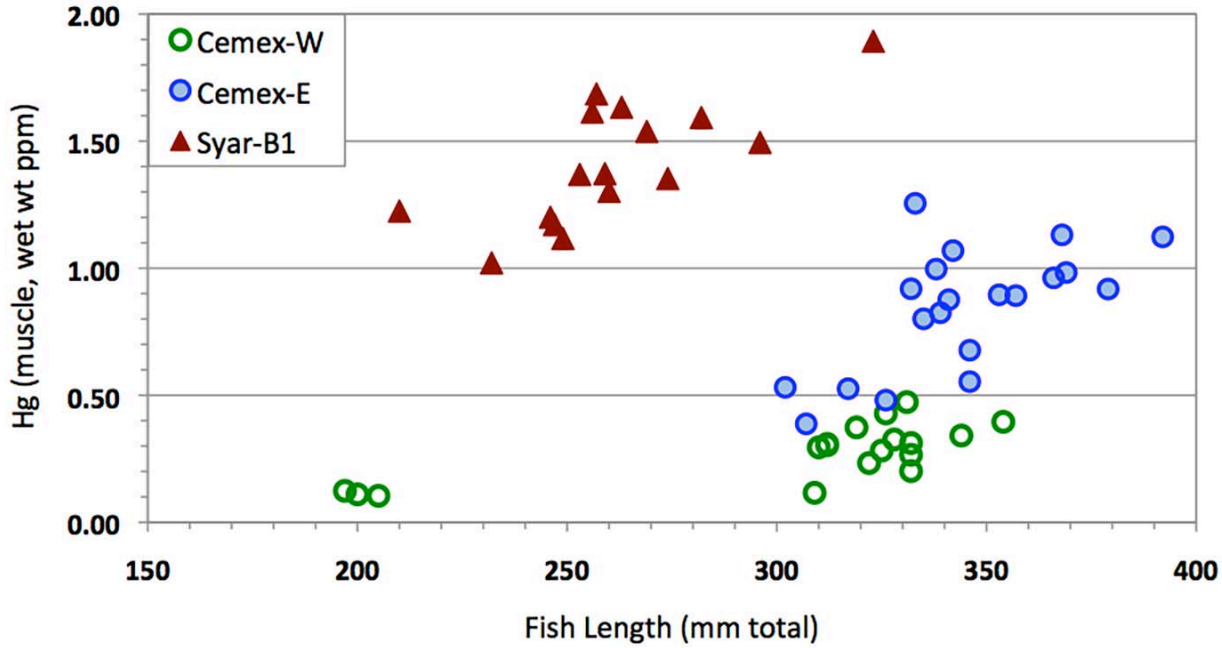


Figure 6b. Largemouth Bass Mercury: Site Comparison, Fall 2015
(Mercury scale matching other large fish plots; omitting 2 largest Syar-B1 fish)

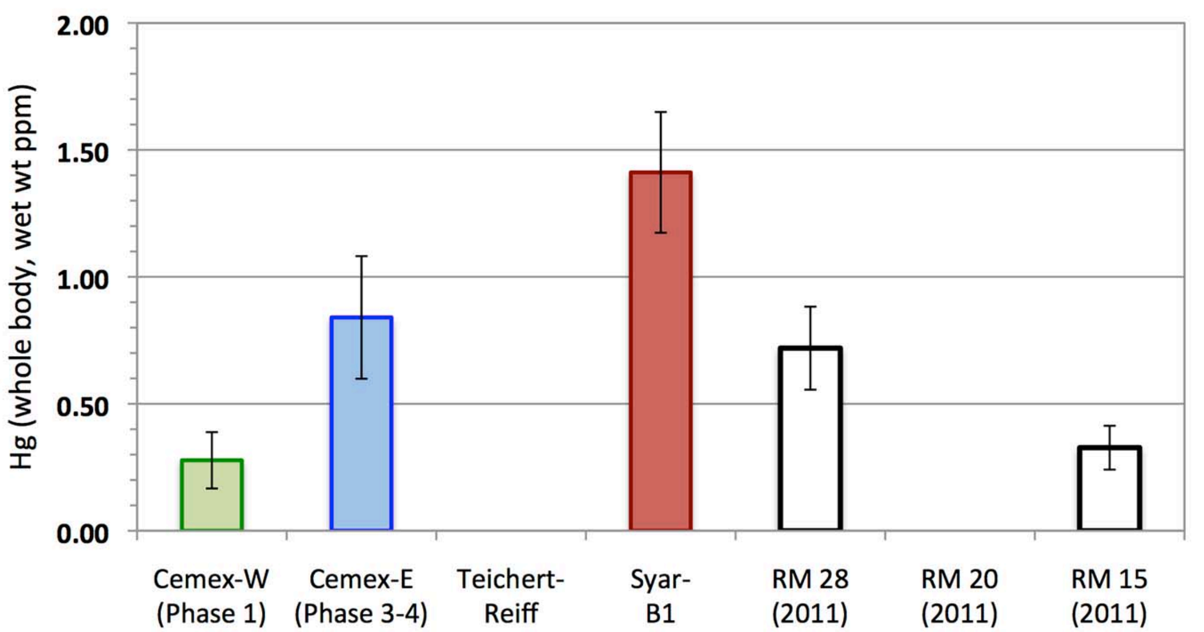


Figure 6c. Largemouth Bass: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

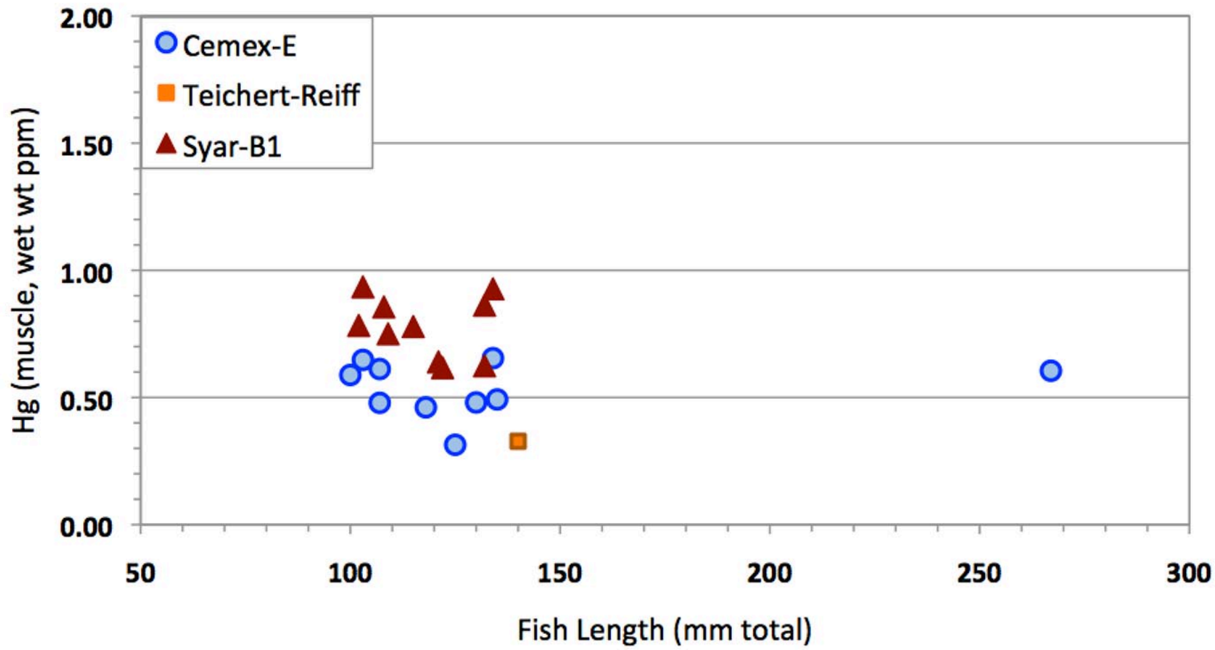


Figure 7a. Green Sunfish Mercury: Site Comparison, Fall 2015
(fillet muscle mercury in individual fish)

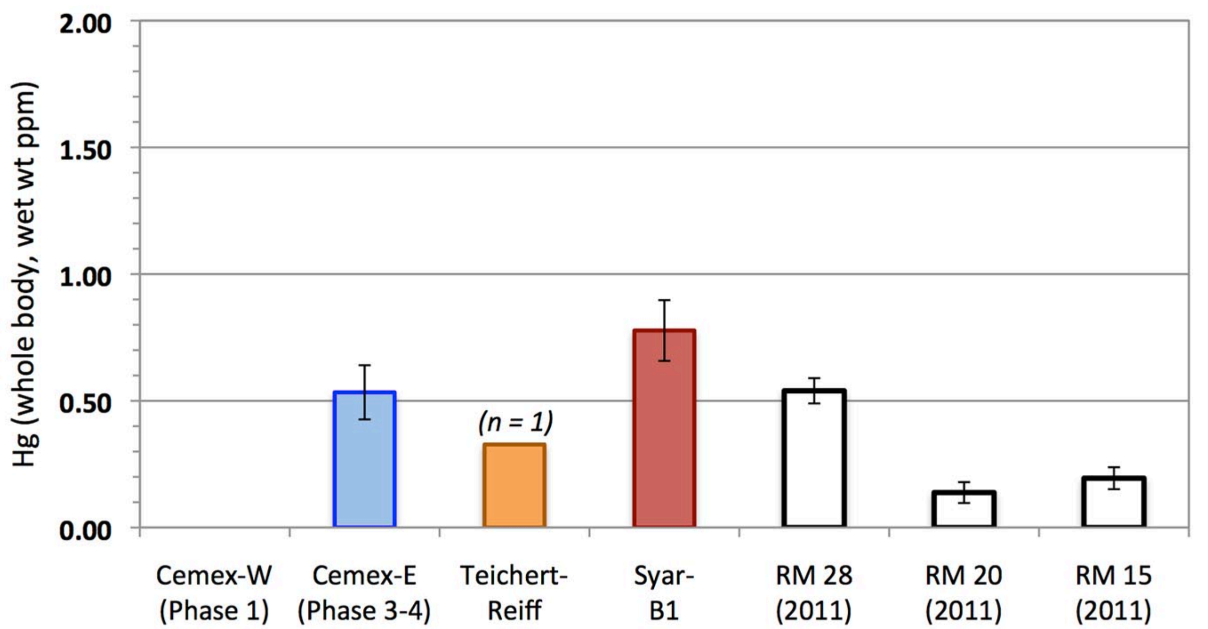


Figure 7b. Green Sunfish: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

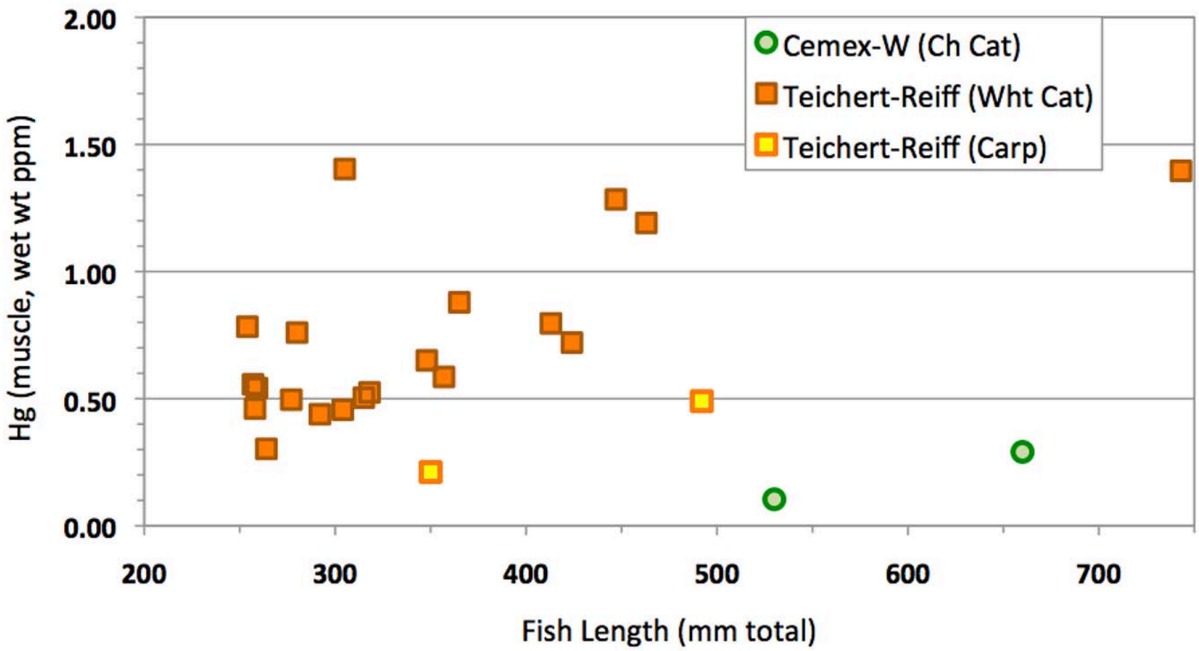


Figure 8a. Catfish and Carp Mercury: Site Comparison, Fall 2015
(fillet muscle mercury in individual fish)

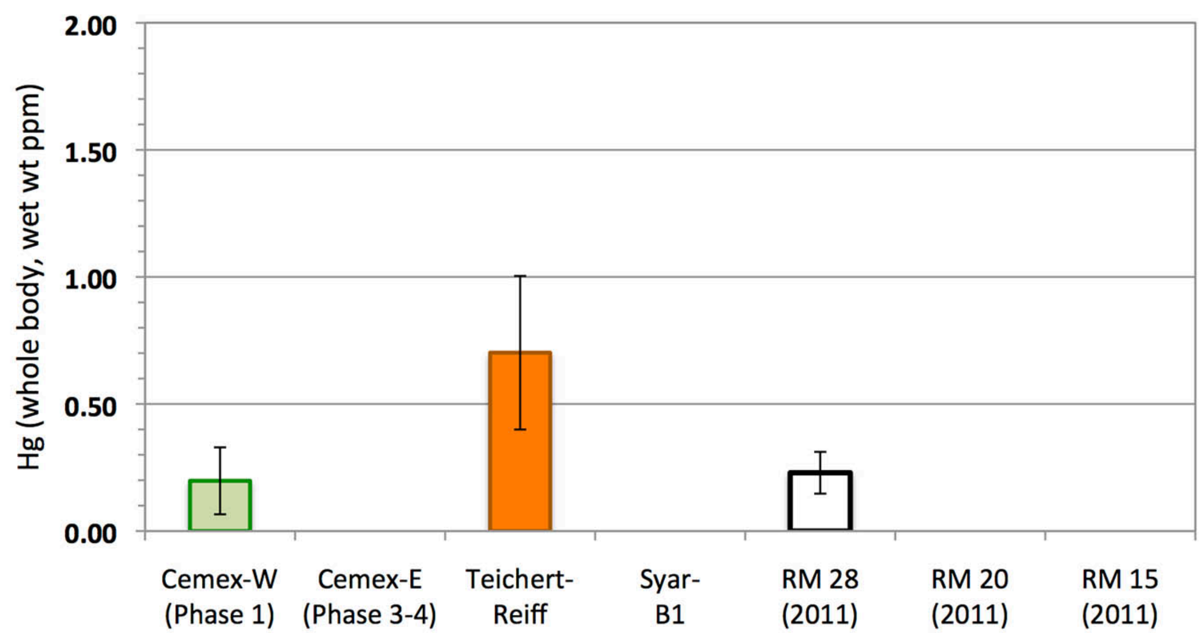


Figure 8b. Catfish: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

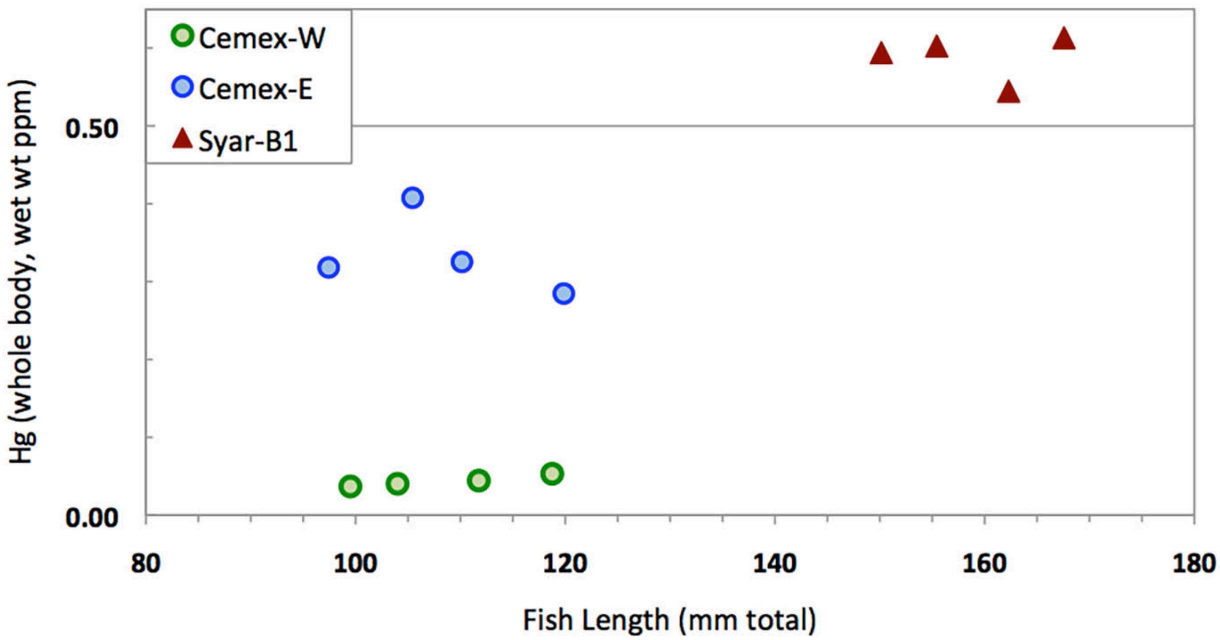


Figure 9a. Juvenile Largemouth Bass Mercury: Site Comparison, Fall 2015
(NOTE LOWER MERCURY SCALE FOR SMALL FISH PLOTS)
(whole body mercury in multi-individual composite samples)

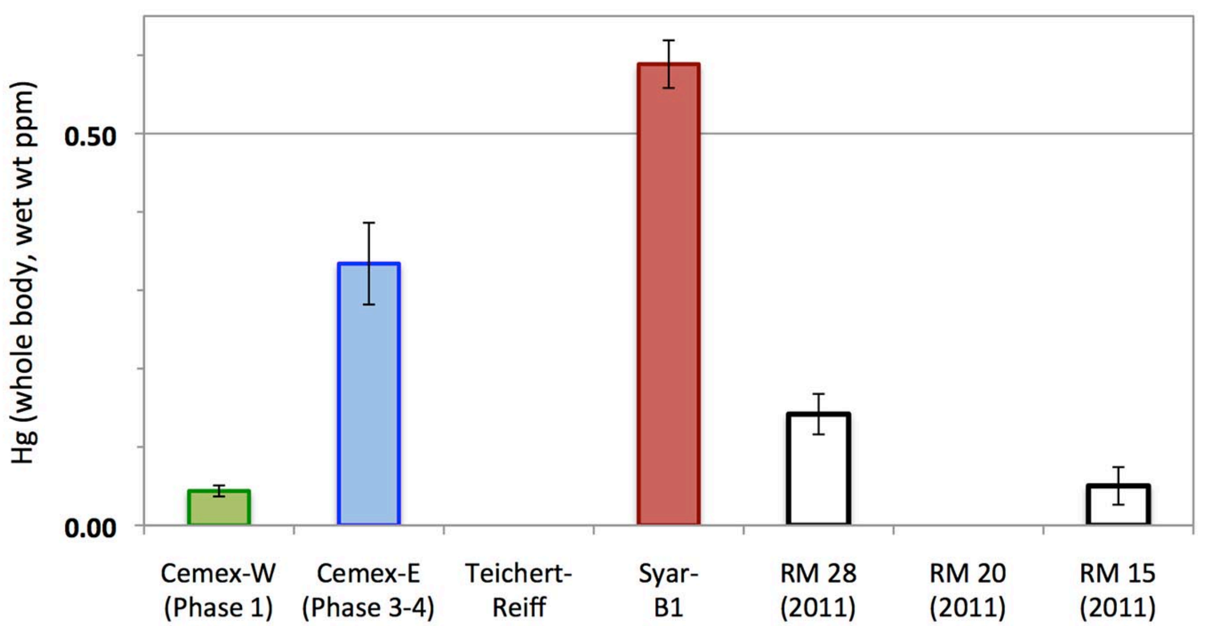


Figure 9b. Juvenile Bass: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

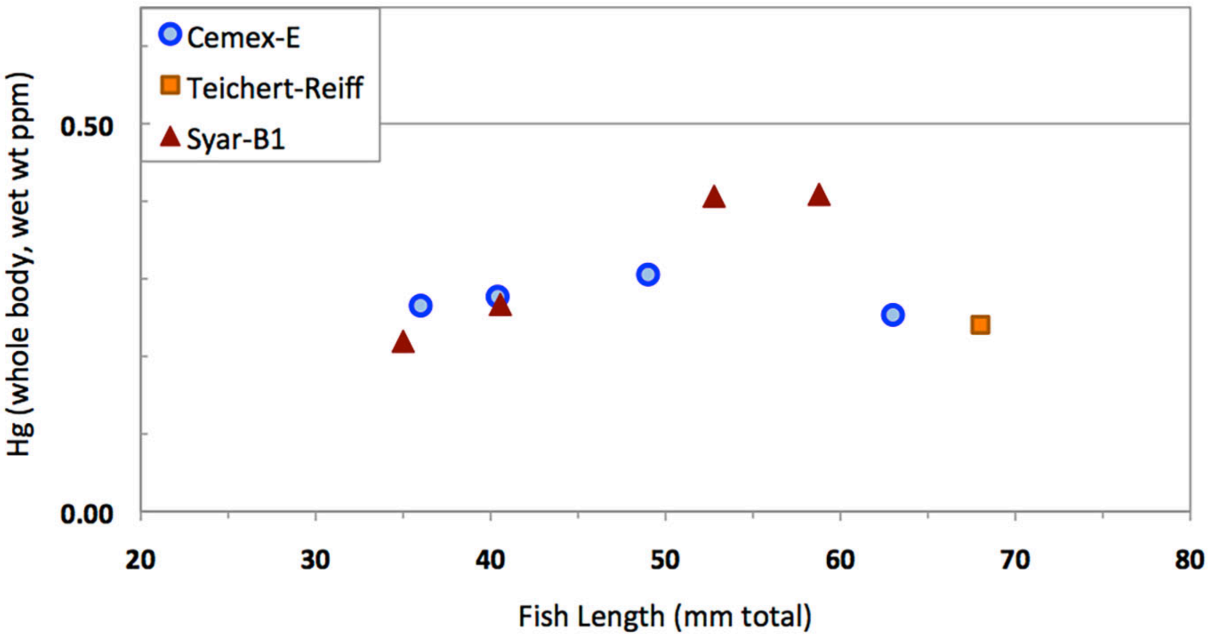


Figure 10a. Juvenile Green Sunfish Mercury: Site Comparison, Fall 2015
(whole body mercury in multi-individual composite samples)

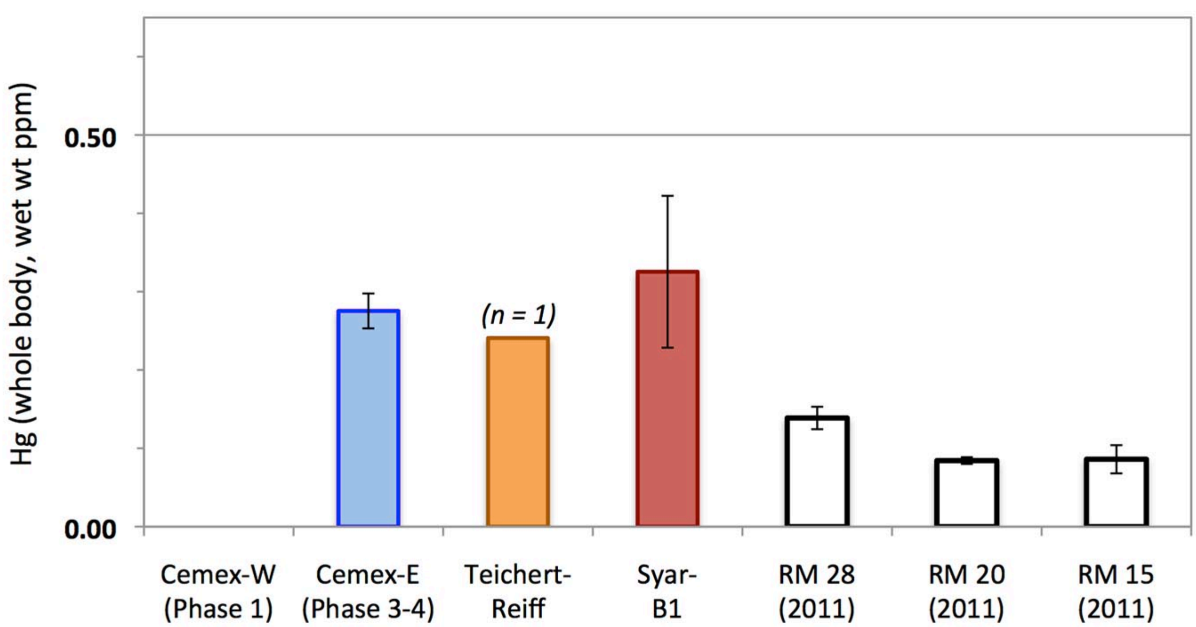


Figure 10b. Juvenile Green Sunfish: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

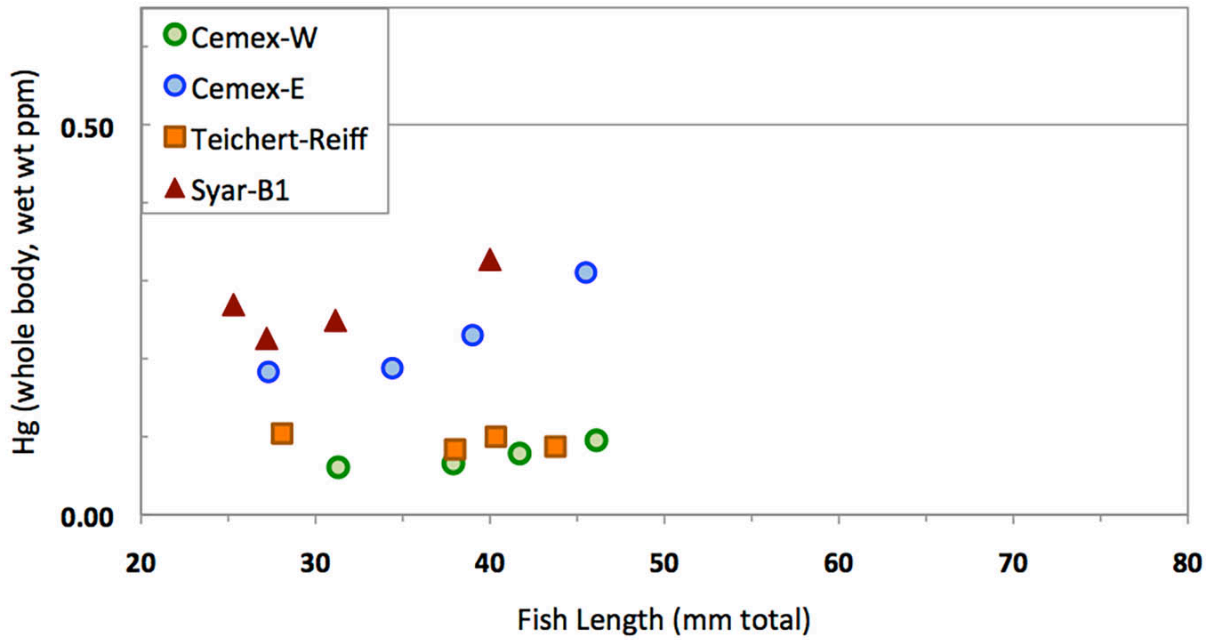


Figure 11a. Mosquitofish Mercury: Site Comparison, Fall 2015
(whole body mercury in multi-individual composite samples)

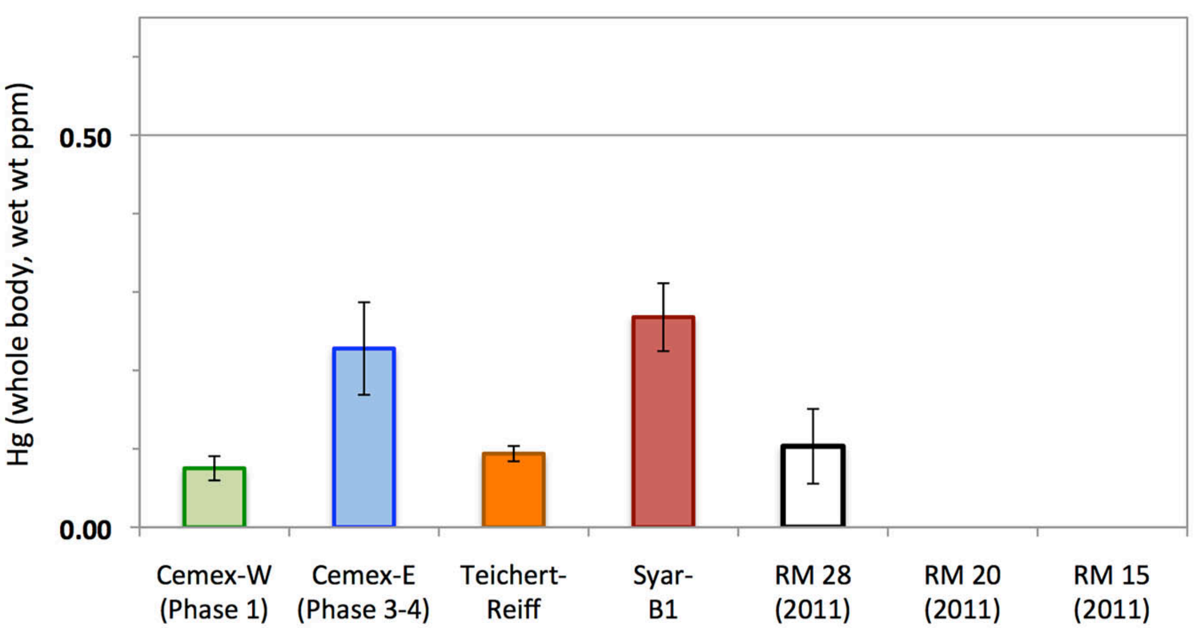


Figure 11b. Mosquitofish: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

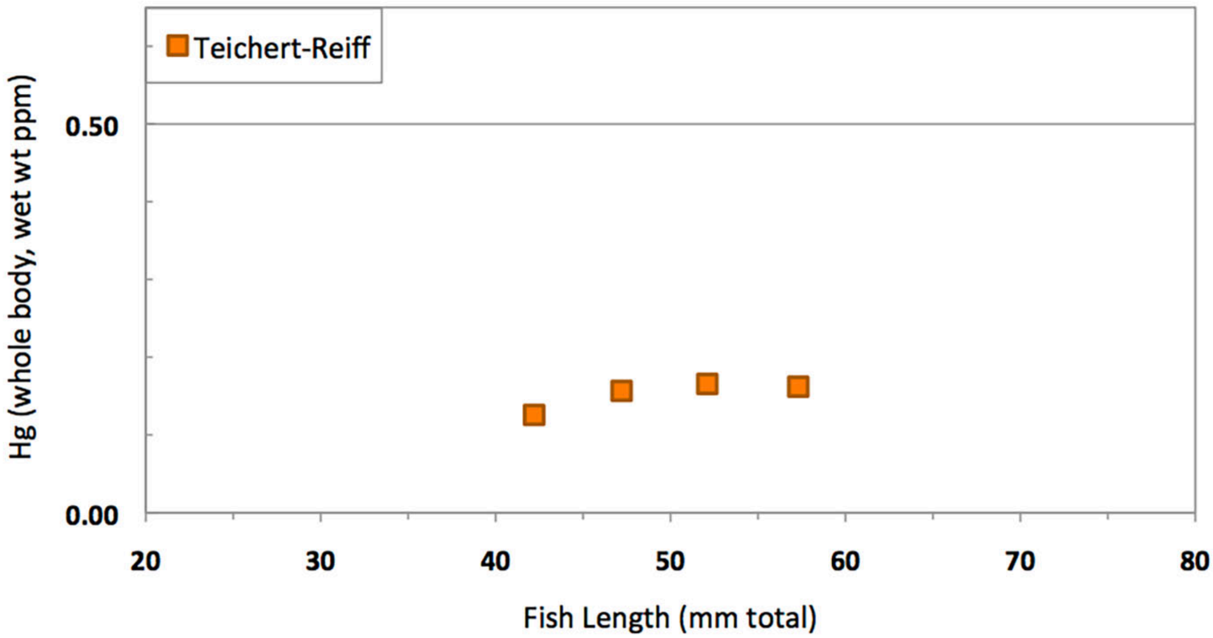


Figure 12a. Red Shiner Mercury: Fall 2015
(whole body mercury in multi-individual composite samples)

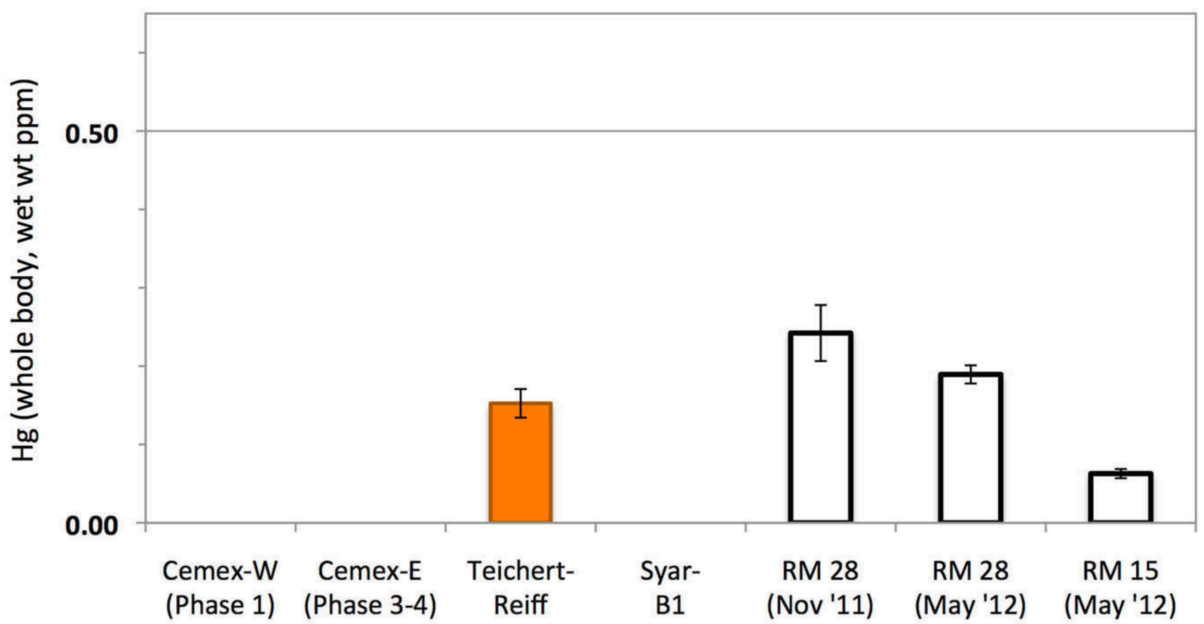


Figure 12b. Red Shiners: Comparison of Ponds and 2011 Baseline Creek Samples
(Average mercury and standard deviation for each site)

CONCLUSIONS

The four sampled ponds were found to show distinct, individual mercury signatures that were broadly consistent across the different fish species. There was a surprising range of fish mercury concentrations, with up to 5 or more times higher levels at the highest mercury sites relative to the lowest, in same sample types.

The Cemex–West Pond (Phase 1), was notably lowest in mercury across all of the samples available. It was statistically lower than all the other tested ponds for nearly every corresponding sample type and was statistically lower than or similar to all of the comparable baseline creek samples.

The Teichert–Reiff Pond had levels similar to the baseline creek samples, with some samples lower, some statistically the same, and some higher.

The Cemex–East Pond (Phase 3-4) was higher in fish mercury than the Teichert–Reiff and Cemex–West ponds. Relative to the baseline creek samples, it was higher in most comparisons (8 of 11) and statistically similar in the other 3.

The Syar–B1 Pond was higher in fish mercury than all of the comparable baseline creek samples. Fish from this pond also had statistically higher mercury than corresponding samples from the other ponds tested, except in juvenile Green Sunfish and Mosquitofish from the Cemex–East Pond (Phase 3-4) which were statistically similar.

So, of the four ponds monitored, two were found to be low or similar in fish mercury to the baseline Cache Creek samples (Cemex–West and Teichert–Reiff). Two appeared to be in an elevated range that may require future attention (Syar–B1 and Cemex–East).

This range of results may present an opportunity to help identify what is driving the high mercury levels at some locations and the low levels at others. Ultimately, if these factors can be identified, it may be possible to reduce levels at the elevated mercury sites through realistic and cost-effective modifications. The Yolo County Ordinance sets out requirements for investigating likely contributing factors which can guide potential mitigation approaches. Those protocols are in the process of being updated. The 2015 monitoring results are being tested for consistency with follow-up annual monitoring, as laid out in the ordinance. At the time of this report finalization (May 2017), those fall 2016 collections have been conducted. Laboratory work is in process and analytical results will be presented later in 2017.

REFERENCES CITED

Cooke, J., C. Foe, S. Stanish, and P. Morris. 2004. Cache Creek, Bear Creek, and Harley Gulch TMDL for Mercury, Staff Report. *California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region*. 135 pp.

Slotton, D.G., S.M. Ayers, J.E. Reuter, and C.R. Goldman. 2002. Environmental monitoring for mercury in water, sediment, and biota in Davis Creek and Davis Creek Reservoir. *Report for Yolo County*. 99 pp. (similar reports from 1997-2001).

Slotton, D.G., and S.M. Ayers. 2013. Lower Cache Creek 2011-2012 Baseline Mercury Monitoring. *Report for Yolo County*. 66 pp.

Slotton, D.G., S.M. Ayers, and R.D. Weyand. (2015 edition). Quality Assurance Project Plan (QAPP) for UC Davis Biosentinel Mercury Monitoring, including Standard Operating Procedures (SOPs). 31 pp.

Yolo County Code, Title 10. Chapter 5 (Surface Mining Reclamation), Section 10.5.517

APPENDIX

PHOTOGRAPHS OF SAMPLING SITES AND BIOLOGICAL SAMPLES ANALYZED FOR THIS REPORT

A1. Launching boat at the Teichert–Reiff Pond; one of several ramps built for this work

A2. Sampling boat and some of the gear

CEMEX – WEST POND ('PHASE 1')

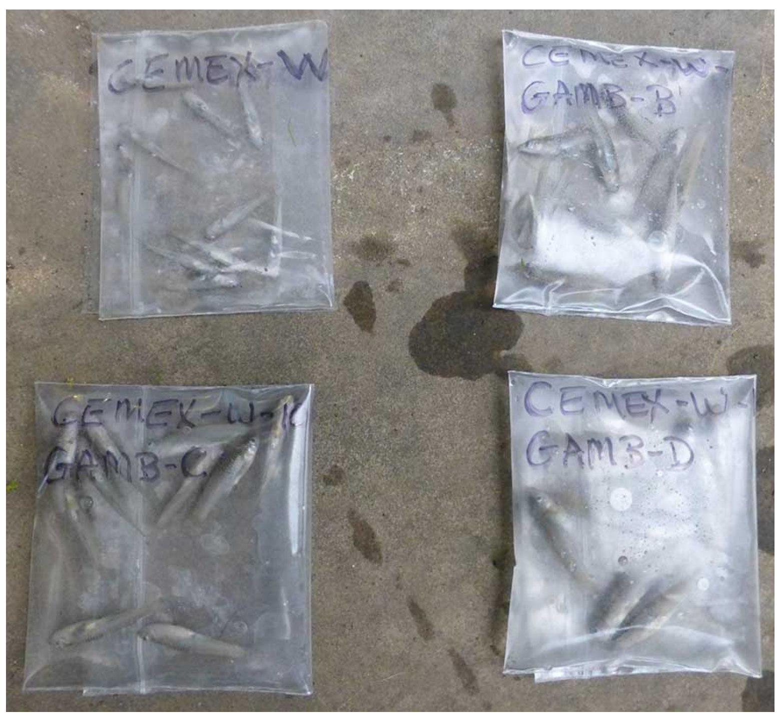
A3. View of the pond

A4. Adult Largemouth Bass

A5. One of the large Channel Catfish taken, with a bass

CEMEX – WEST (PHASE 1) POND *(continued)*

A6. Juvenile Largemouth Bass, divided into 4 composite samples



A7. Mosquitofish, divided into 4 composite samples

CEMEX – EAST POND (PHASE 3-4)

A8. View of the pond, from east side.

A9. Large Green Sunfish

A10. Some of the Largemouth Bass

CEMEX – EAST (PHASE 3-4) POND *(continued)*

A11. Juvenile Largemouth Bass, divided into 4 composite samples

A12. Juvenile Green Sunfish

A13. Mosquitofish samples

TEICHERT – REIFF POND

A14. View of the pond

A15. Carp and White Catfish

A16. More White Catfish, including the 10 pounder, and another Carp

TEICHERT – REIFF POND *(continued)*

A17. Red Shiners, divided into 4 composite samples

A18. Mosquitofish, divided into 4 composite samples

SYAR – B1 POND

A19, A20. Views of the pond

A21. Some of the Largemouth Bass samples

SYAR – B1 POND *(continued)*

A22. Juvenile Largemouth Bass, divided into 4 composite samples
Note the large size of these juveniles -- the clear tray on right held all the young bass in Figures A6 (Cemex–W) and A11 (Cemex–E)

A23. Some of the Green Sunfish samples

A24. Some of the Mosquitofish samples