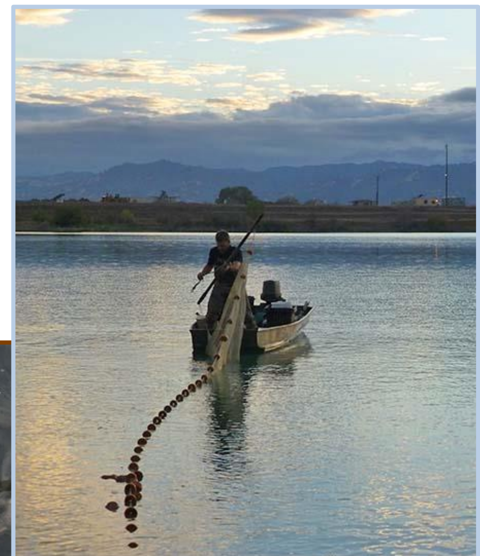
CACHE CREEK OFF-CHANNEL AGGREGATE MINING PONDS – 2016 MERCURY MONITORING



Final Report
May 2018

Monitoring and Report by

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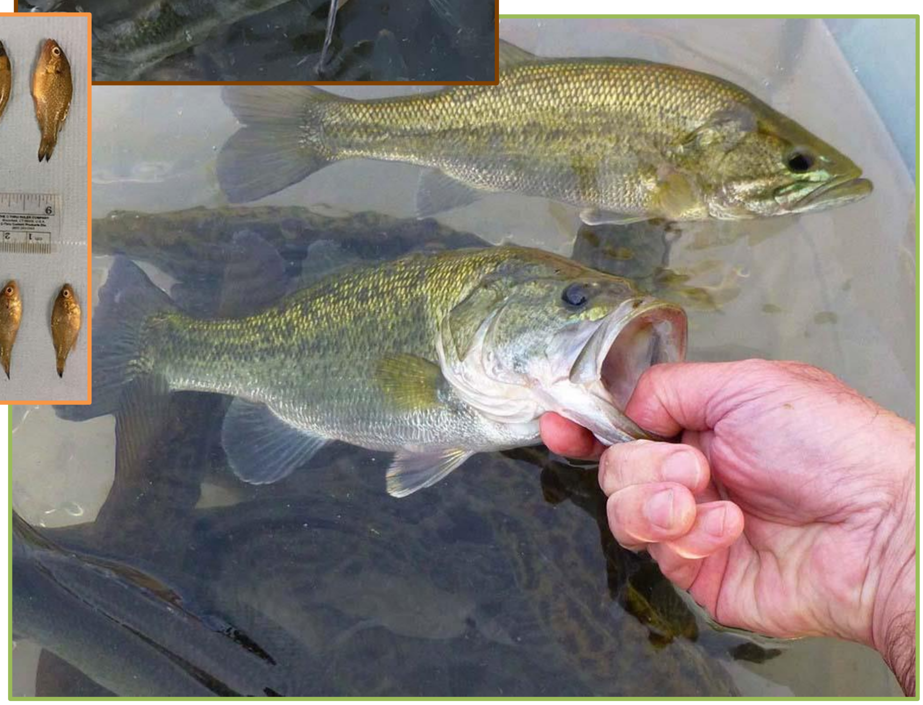

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SUMMARY OF THE 2016 MONITORING AND ITS FINDINGS

- This Fall 2016 monitoring was the second year of fish mercury testing (Year 2) for four off-channel wet pit aggregate mining ponds adjacent to lower Cache Creek between Capay and Woodland: Cemex–Phase 1 (West), Cemex–Phase 3-4 (East), Teichert–Reiff, and Syar–B1 ponds. A fifth pond, Teichert–Storz, was tested for the first time (Year 1). The monitoring is required by Section 10-5.517 of the Yolo County Code. That Ordinance requires 5 years of annual pre-reclamation mercury monitoring for mining ponds and then bi-annual monitoring for 10 years following reclamation to permanent water bodies.

- 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, 'biosentinel' fish were analyzed whole-body, relevant to wildlife consumption and inter-annual comparisons, in replicate multiple-individual composite samples.

- Samples of both large and small fish, of multiple species as available, were collected from the 4 larger ponds in the system: the Cemex–Phase 1 Pond, Cemex–Phase 3-4 Pond, Teichert–Reiff Pond, and Syar–B1 Pond. Two smaller ponds that had also been slated for monitoring could not be fully sampled in 2016 because of access issues (Teichert–Mast and Teichert–Storz Ponds). Mast Pond was completely inaccessible, with surrounding shear cliffs and active mining, but we were able to wade-seine the Storz Pond for small fish.

- A total of 95 larger, angling-sized fish were sampled individually for fillet muscle mercury analysis in this 2016 monitoring. And a total of 284 small, young fish were split into 40 multi-individual, whole fish composite samples by site, species, and size. These were also analyzed for mercury.

- The new, 2016 data were compared with results from 2015, and with the most closely corresponding 'baseline' and historic fish collections conducted previously in Cache Creek (from the stretch of creek within the planning and aggregate-mining area). As in 2015, the ponds sampled in Fall 2016 were found to show distinct, individual mercury signatures that were broadly consistent across the different fish types. With two years of monitoring data now in hand, the County Ordinance requires a determination of the mercury status of the monitored ponds, relative to corresponding fish mercury in Cache Creek. If higher levels are found across the initial two monitoring years at a given pond, mitigation action is called for.

- The **Cemex–Phase 1 (West) Pond** was sampled in 2016 for Largemouth Bass, Channel Catfish, and White Catfish, and small, young Largemouth Bass and Mosquitofish. The small fish data indicate a relative increase in mercury availability and uptake there in 2016, though to levels still similar to the low-mid range of historic creek comparisons. The adult Largemouth Bass sample was consistent with this increase, but remained low relative to corresponding creek samples. The Channel Catfish sample averaged lower than in 2015, possibly due to the smaller size of fish sampled. White Catfish were sampled for the first time here in 2016, so there is no 2015 comparison. They averaged higher mercury than available creek catfish comparisons, though the much smaller-sized creek samples make comparisons difficult for all the catfish samples from the ponds monitoring. All other samples across two years were consistently below or similar to corresponding creek samples. This pond is considered low relative to the Ordinance.

- The **Cemex–Phase 3-4 (East) Pond** was sampled in 2016 for Largemouth Bass, Green Sunfish, and small, young Largemouth Bass, Green Sunfish, and Mosquitofish. Mercury concentrations were similar in both years sampled, with slight increases in some sample types and slight decreases in others, none of which were statistically significant. Relative to comparable samples from Cache Creek, they remained similar to the upper concentration range of creek samples for adult Largemouth Bass, adult Green Sunfish, and Mosquitofish; and statistically higher than all available creek comparisons for juvenile bass and juvenile sunfish. Relative to the County Ordinance, the pond was placed in the 'elevated over the creek' category.

- The **Teichert–Reiff Pond** was sampled in 2016 for White Catfish, Carp, and small, young Mosquitofish and Red Shiners. The Reiff Pond showed an increase in fish mercury in all sample types that had comparative data from both 2015 and 2016 (White Catfish, Carp, Mosquitofish, and Red Shiner). The increase was statistically significant for all of these except Carp, which had too low of a 2015 sample size to assess. Relative to available creek comparison data, the 2016 Reiff Pond average fish mercury levels were significantly higher for White Catfish, Carp, and Red Shiner; and similar to the upper range in Cache Creek for Mosquitofish. Relative to the County Ordinance, the pond was placed in the 'elevated over the creek' category.

- The **Teichert–Storz Pond** was sampled for the first time in 2016, with a partial collection made without the use of a boat. A set of Mosquitofish was taken. These were characterized with 4 size-class composite samples, each containing 10 fish. The Mosquitofish average mercury level was higher than the 3 historic sample sets from the creek. The differences were not statistically significant, though this was mainly due to the large change in mercury concentration with increasing fish size seen in the Storz Pond samples, and the resulting high statistical variability. With a single year of partial monitoring information from this pond, it is not at a decision point at this time.

- The **Syar–B1 Pond**, half of a 2 pond site, was sampled in 2016 for Largemouth Bass, Green Sunfish, and small, young Largemouth Bass and Green Sunfish. Fish mercury levels remained similar in 2016 to corresponding levels found in 2015. Among sample types with strong collections in both years, adult Largemouth bass were unchanged, juvenile bass were down slightly, and juvenile Green Sunfish were up slightly. The differences were not statistically significant. In comparison to corresponding baseline/historic samples from Cache Creek, the B1 Pond fish in 2016 remained significantly higher in mercury. This pond consistently had the highest mercury levels found to date in the monitoring, and was clearly in the 'elevated over the creek' category. Because of this, and the observation of extensive fishing by nearby Esparto residents at this and the neighboring pond, it is recommended that the neighboring pond be added to the routine monitoring.

- For ponds found to have higher fish mercury than corresponding samples from Cache Creek over 2 years, the Ordinance calls for suspension of wet pit mining and preparation of a plan to either (1) back-fill the pit in reclamation to "five feet above the average seasonal high groundwater level with a suitable backfill material" or (2) "present a mitigation plan to the Yolo County Community Development Agency".

- Two of the identified higher mercury ponds (Syar–B1 and Teichert–Reiff) are not currently being mined, so mining suspension there is probably not an issue. The third pond identified with higher mercury levels (Cemex–Phase 3-4) is still being actively mined. At this point, suspension of mining is not seen as a remedy and could actually be counter-productive. This is discussed in the report.

- As a first phase of mitigation, it is recommended that key information first be collected to guide potential future strategies. This includes testing bottom sediments and initiating a water column profiling program. Water column profiling is called for in the Ordinance during all fish monitoring years, but it was felt that this was premature until and unless elevated levels were found. With three ponds now identified as elevated in fish mercury relative to the creek, it is recommended that this work be started. Timing and parameters to test are detailed in the Discussion/Conclusions section of the report. It is recommended that this work be conducted at the three identified higher mercury ponds, as well as at the identified lower mercury Cemex Phase 1 pond. The range of fish mercury concentrations across these ponds presents an opportunity to help identify what is driving the high levels at some locations and lower levels at others. If these factors can be identified, it may be possible to develop realistic mercury reduction strategies for the elevated mercury sites.

INTRODUCTION

This monitoring was conducted for Yolo County in the fall of 2016, to provide ongoing 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), which was enacted in 1996. In this introduction, we will present and discuss the various sections of the Ordinance, to explain the County history with this issue and to place the current monitoring into context. The Ordinance is reproduced without breaks in Appendix A. Below, Ordinance text is shown in ***bold italics***, with discussion and commentary in regular text.

Yolo County, CA Code of Ordinances
Sec. 10-5.517. Mercury bioaccumulation in wildlife.

Prior to the approval of reclamation of aggregate mining areas to permanent lakes, the County shall commission a sampling and analysis program, to be implemented in one existing wet pit mining area within the OCMP planning area, to evaluate the potential for increased methylmercury production associated with wet pit mining and reclamation of mining areas to permanent lakes. The program shall include the sampling of water and sediments from the bottom of the existing pit and analysis of the samples for organic content; pH; dissolved oxygen content; dissolved carbon content; and total mercury. In addition, samples of predatory fish (preferably largemouth bass) shall be collected and analyzed for mercury and methylmercury content.

If the initial sampling indicates either of the following conditions, the County shall perform verification sampling:

(a) Average concentrations of total mercury in excess of 0.000012 milligrams per liter (mg/l) in the water; and
(b) Average mercury levels in fish samples in excess of 0.5 milligrams per kilogram (mg/kg).

If verification sampling indicates exceedance of these mercury criteria, the County shall approve the reclamation of mining areas to permanent lakes only if the average level of mercury in fish collected from the existing mining pits is shown to be equal to or less than ambient (background) mercury levels determined from a representative sample of similar species of fish (of similar size) collected in the Cache Creek channel within the planning area.

A mercury assessment program, as listed above, was conducted at the time the Ordinance was developed at two then-active off-channel mining ponds (OCMP 1996). These ponds were located just east of Highway 505, on the current Cemex property, formerly owned by Solano Gravel. The ponds were moderately deep (app. 40 feet) and representative of proposed future off-channel gravel mining ponds. Water, sediment, fish, and aquatic invertebrates were analyzed for mercury and methylmercury. Related analyses included water column profiling of the specified parameters and analysis of associated water and sediment components. The 1996 assessment of the representative off-channel mining ponds found water mercury concentrations of <0.000002-0.000004 mg/l from all depths, which was lower and less variable than corresponding water mercury in Cache Creek. The fish collections included 24 angling-sized fish of several species found to be present in the ponds. Average mercury concentration for these fish was 0.39 mg/kg, lower than the 0.50 mg/kg threshold level listed for average fish mercury levels in the ordinance. A set of comparison fish from lower Cache Creek averaged a similar, and statistically indistinguishable, 0.36 mg/kg. It is notable that the initial Cache Creek comparison fish were primarily taken in the Settling Basin, located downstream of the planning area. Subsequent baseline comparison creek fish collected within the planning area included fish with significantly higher mercury concentrations.

Based in part on the results of the initial 1996 study, the planning process and aggregate mining operations went forward.

> ***The determination of the ambient mercury level shall be performed by the County prior to the excavation of any new wet pit mine and at years ten (10), twenty (20) and thirty (30) in the permit time period, and shall be paid for by the mining permit operators on a fair-share basis. The County shall evaluate available data to determine any significant change in ambient concentrations of mercury in fish within the Cache Creek channel.***

The initial ambient (baseline) testing in Cache Creek was conducted for fish and water mercury in 1995 and more extensively for fish in 1997, though, as noted above, the fish were primarily taken from the downstream Settling Basin. The 10-year reassessment was inadvertently missed in 2007 and was conducted in 2011 when the oversight was discovered by County staff. Results of that updated baseline fish monitoring are reported in Slotton and Ayers (2013). The 2011 baseline collections were made at 3 creek sites within the planning and aggregate mining zone, between River Miles 15 (downstream of County Road 94B) and 28 (below Capay diversion dam). Those collections found a range of fish mercury concentrations, including significantly higher levels at some of the creek sites, as compared to the earlier findings from the downstream Settling Basin. The highest concentrations were found in adult bass, pikeminnows, and green sunfish.

In the event of approval of reclamation of mined areas to permanent lakes, each mining area to be reclaimed to a permanent lake as part of each approved long-range mining plan shall be evaluated annually by the operator for five (5) years after creation of the lake for conditions that could result in significant methylmercury production.

An additional ten (10) years of biennial monitoring shall be performed after reclamation of each lake has been completed.

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 include two from Cemex (Phase 1 and Phase 3-4), 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. The monitoring history of the subject ponds is summarized in Table A.

The evaluations shall be conducted by a qualified aquatic biologist or limnologist acceptable to the County and shall include the following analyses:

(c) Lake condition profiling during the period of June through September, including measurements of pH; eH (or redox potential); temperature; dissolved oxygen; and total dissolved carbon.

This type of analysis can be very useful in sorting out the possible sources of high methylmercury exposure, if a problem exists. Rather than initiating water column profiling immediately, it was decided that lake profiling of relevant water column parameters should be conducted *if* significantly elevated fish mercury is found in subject ponds in repeated years. This is discussed in more detail in the Discussion/Conclusions section.

(d) Collection of a representative sample of fish specimens (including a minimum of five (5) predator fish if available) and analysis of the specimens for mercury content. Sampling and analysis shall be conducted using methodologies which are consistent with the California State Water Resources Control Board Toxic Substances Monitoring Program procedures, or more stringent procedures.

Fish sampling is the core of most modern mercury monitoring. Fish represent the direct potential exposure to human and wildlife fish-consumers. They also provide an ideal measure of relative mercury exposure, for comparison between ponds and Cache Creek. A fish mercury monitoring program for the Yolo County aggregate mining ponds was initiated in 2015, using methodologies consistent with the programs of government agencies and other institutions that have developed in the region since the original drafting of the Ordinance.

(e) The results of the evaluation shall be summarized in a report and submitted to the County. The report shall include a comparison of the site-specific data to available data on the background concentrations of mercury in fish within the Cache Creek watershed. The County shall be responsible for submitting the data on mercury levels in fish to the California Department of Fish and Game and the Office of Environmental Health Hazard Assessment for a determination of whether a fish advisory should be issued.

The first year of mercury monitoring for this program was 2015, conducted in the fall. Results and discussion of the first year work can be found in Slotton and Ayers (2017). The report that follows, here, summarizes the second year monitoring (and Year 1 for the Teichert–Storz Pond), conducted in Fall 2016.

(f) If a fish advisory is issued, the owner/operator shall be required to post warnings on fences surrounding the mining pit lakes which prohibit fishing in the lakes and describe the fish advisory.

The County is advised to initiate this action, based on the 2 years of fish monitoring data now available.

If the average fish specimen mercury content exceeds the statistically verified ambient mercury concentrations for comparable fish species (of similar size) collected within the CCRMP planning area for two (2) consecutive years, wet pit mining on property controlled by the mining operator/owner shall be suspended and the owner/operator shall either:

(g) Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material; or

(h) Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible and reliable method or reducing methylmercury production or exposure to elevated mercury levels. Potential mitigation could include permanent aeration of the bottom levels of the lake, alteration of the water chemistry (increasing pH or dissolved organic carbon levels), control of anaerobic bacteria populations, or removal and replacement of affected fish populations. The mitigation plan would require review by the Regional Water Quality Control Board, California Department of Fish and Game, and the Yolo County Department of Environmental Health. (The removal and replacement of fish is not intended to be a long-term solution.)

The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)

These next steps, and how they relate to the currently monitored ponds, are addressed in the Discussion/Conclusions section.

Five of the six identified ponds were monitored in 2016: Cemex–Phase 1, Cemex–Phase 3-4, Teichert–Reiff, Teichert–Storz, and Syar–B1. In both 2015 and 2016, Teichert–Mast Pond was inaccessible because of mining operations. Teichert–Storz Pond was not accessible in 2015 but we were able to partially sample there in 2016, for small fish. The 4 larger, more significant ponds were all sampled in both years for both large and small fish of multiple species, as available. Fish constitute the most straightforward, clear measure of methylmercury exposure and bioaccumulation in an aquatic system, so this monitoring focuses on fish. Other sample types all have difficulties and complications associated with their collection, analysis, or interpretation. The creek baseline work also sampled aquatic invertebrates for potential comparison in the event that no fish were present in some pond sites, but all the target ponds had useful fish populations for monitoring.

The purpose of this report is to present the new 2016 fish mercury data from the tested aggregate mining ponds and, for each pond, to compare levels to similar baseline samples taken from the planning area of Cache Creek in 2011-2012 and in earlier studies. A key objective is to help the mining operators and Yolo County determine if specific pond sites are falling within or outside the general range of fish mercury concentrations seen in adjacent Cache Creek. This will help guide future remediation planning.

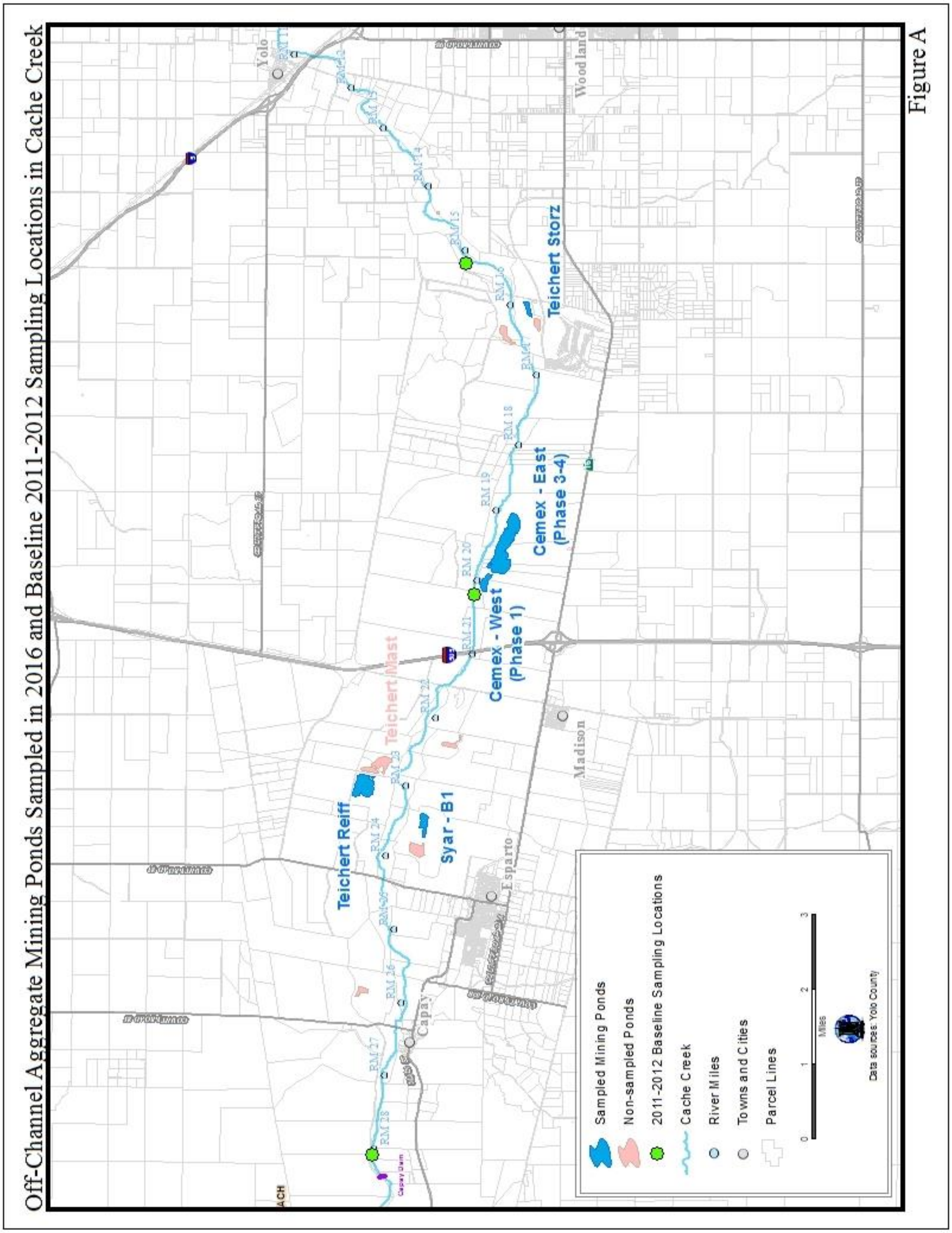
The factors that influence production of methylmercury and its uptake by fish are complex and can change from one year to the next, often leading to a range of fish mercury levels over time rather than some absolute value. Because of this, the Ordinance states that multiple years of data are needed to make assessments. So, another objective is to compare this year's data (2016) with monitoring results found at the same sites the year before (2015).

Following, below, are the methods we used and a presentation of the 2016 mercury data, by site. Each data table is accompanied by a matching figure with the same number, that graphically shows the information. For each site, we first show the analytical results from each individual large fish sample and each small fish composite sample. Then we present the new data in reduced form (means, error bars, etc.) for each sample type and compare to 2015 pond findings and the most closely comparable historic creek data. For creek comparisons, we are focusing on historic data specifically from the planning / aggregate-mining section of the creek, roughly between River Mile 28 (below the Capay diversion dam) and River Mile 15 (app. 1 km below County Road 94B). In particular, these include the 2011 Baseline collections from RM15 (River Mile 15), RM20, and RM28, which were conducted specifically to provide comparable samples for the pond monitoring, as possible. In the data tables, the 2011 Baseline comparison data are highlighted with bold text. Additional historic sampling that was coincidentally done within the planning region of Cache Creek includes a project around the Cache Creek Nature Preserve in 2000-2006 (RM15 and RM17 small fish) and a CalFed 1998-2000 UC Davis study of the entire watershed that included some fish collections in the study zone.

After the pond-specific sections, a final data section consolidates summary results from all the sites, by sample type. In the Discussion/Conclusions, the available pond data to-date are placed into the context of the Yolo County Ordinance, with next steps and recommendations. The Ordinance text is attached, without commentary, as Appendix A. Appendix B compiles representative photos of the Fall 2016 monitoring work.

Table A. Wet Pits Subject to Annual Mercury Monitoring
(modified from Yolo County Exhibit C)

Operator	Site	Pit	Year Mining Crossed Water Table (app)	End Reclamation Plan	Monitoring Year in 2015	Monitoring Year in 2016
Cemex	Madison	**Phase 1**	< 1996	Lake and habitat	Year 1	Year 2
Cemex	Madison	**Phase 3/4**	≤ 2002	Lake and habitat	Year 1	Year 2
Teichert	Esparto	**Reiff**	≤ 2002	Lake and habitat	Year 1	Year 2
Teichert	Esparto	**Mast**	2007-2008	Lake and habitat	(no access)	(no access)
Teichert	Woodland	**Storz**	2010-2011	Lake and habitat	(no access)	Year 1 (partial)
Syar	Madison	**B1**	≤ 2002	Lake and habitat	Year 1	Year 2


Off-Channel Aggregate Mining Ponds Sampled in 2016 and Baseline 2011-2012 Sampling Locations in Cache Creek
Figure A
Teichert Storz
Cemex - East
(Phase 3-4)
Cemex - West
(Phase 1)
Teichert/Mast
Teichert Reiff
Syar - B1
Yolo
Woodland
Madison
Esparto
Capay
Capay Dam
RM 12
RM 13
RM 14
RM 15
RM 16
RM 17
RM 18
RM 19
RM 20
RM 21
RM 22
RM 23
RM 24
RM 25
RM 26
RM 27
RM 28
Sampled Mining Ponds
Non-sampled Ponds
2011-2012 Baseline Sampling Locations
Cache Creek
River Miles
Towns and Cities
Parcel Lines
0
1
2
3
Miles
Data sources: Yolo County

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 move around each of the ponds and collect the fish.

The fish samples were taken with a variety of techniques. Adult fish were collected with gill nets in 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 remove captured fish, to minimize unnecessary mortality. Small, young fish samples 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 accuracy. 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. 0.200 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 sealed, freezer-weight bags. 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. Photos of this process are shown in figures A22-29 in Appendix B.

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). Pre-analytical processing included weighing and measuring the fish in 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 later 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 percentage 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 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 (QA/QC) samples were included in all analytical runs and tracked with control charts. These included an 8-point aqueous standard curve for each batch and, for each 20 field samples: 3 method blanks, 3 standard reference materials with certified levels of mercury, 3 continuing calibration samples, a laboratory duplicate, a spiked field sample, a spike duplicate, and an aqueous calibration sample. QA/QC Results for this project were all well within control limits.

PRESENTATION OF THE FALL 2016 RESULTS

1. CEMEX – PHASE 1 POND

1. CEMEX – PHASE I POND *(Tables 1-6, Figures 1-6)*

This pond is the older of the 2 current Cemex ponds, dating from the 1990s. 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 ranged to 12+ m (40+ feet). Our understanding was that active mining was no longer occurring here, but the pond received the silt and clay slurry effluent of the general plant operation, so the water was very turbid.

We sampled the pond during day, twilight, and night conditions with a full range of techniques, and were able to obtain samples of all the fish species available. These included, for large, angling-sized fish: 20 Largemouth Bass (*Micropterus salmoides*), 2 Channel Catfish (*Ictalurus punctatus*), and 3 large White Catfish (*Ameiurus catus*). White Catfish, comparable in size and age to the White Catfish from the Teichert–Reiff Pond, were taken for the first time here. We put multiple days and many techniques into capturing catfish here, but the numbers appear to be low for both species. As in 2015, the small fish present were juvenile Largemouth Bass (4-5") and Mosquitofish (1-2", *Gambusia affinis*). The juvenile bass were very sparse this year, apparently due to a poor spawn and/or intense predation by adult bass in this pond with little else to eat. The 11 young-of-year bass taken were divided into 4 composite samples of 2-3 fish each. Mosquitofish were more plentiful; collections were split into 4 composite samples of 10 fish each.

In total, this added up to 25 large fish muscle samples and 8 composite small fish samples, 33 separate fish mercury samples, analyzed from the Cemex–Phase 1 (West) Pond in the Fall 2016 monitoring. The analytical results from each individual large fish muscle sample and each small, young fish composite sample can be seen in Tables 1 and 2 and, graphically, in Figures 1 and 2. Then, for each large and small fish species taken, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015 results and the most closely comparable historic creek data (Tables 3-6, Figures 3-6).

Large, Angling-sized Fish

Largemouth Bass

The Phase 1 Pond adult Bass samples had fillet muscle mercury ranging from 0.092-0.596 ppm, averaging 0.350 ppm. This was up from 2015 (0.278 ppm), though the change was not statistically significant at the 95% level of confidence. Concentrations generally increased with fish size, as is typical. Similar to the 2015 set of bass, the 2016 bass samples ranged in size between 210 and 381 mm (about 8-15"). Adult Bass represent the top predator fish in this region and will typically have the highest mercury levels at any given site. The Phase 1 Pond bass remained lower in mercury than 6 of 7 similar baseline/historic samples from Cache Creek (statistically lower than the River Mile 28 site). As noted in the 2015 report, the Phase 1 (West) Pond bass were among the lower mercury top predator fish samples we have collected in California across many studies.

Channel Catfish

The two Channel Catfish taken had fillet muscle mercury of 0.073 ppm in a 361 mm fish (14") and 0.128 ppm in a 463 mm (18") fish, averaging 0.100 ppm. This was app. 50% lower than the 2015 average of 0.198 ppm, though with only 2 samples in each year, the difference could not be assessed statistically. The 2016 fish were considerably smaller than the pair taken in 2015 (1,150 g / 2.5 lbs vs 2,130 g / 4.7 lbs). This may largely explain the apparent decline. In 2015, the average Channel Catfish mercury was at a level similar to the baseline comparison catfish taken at River Mile 28 and River Mile 20. The 2016 average is lower than the creek averages. Again, we cannot assess statistical significance with the small number of fish available. Note that the Phase 1 Pond Channel Catfish, averaging 1,640 g (3.6 pounds) across both monitored years, were much larger and older than the catfish samples available from the creek, which averaged only 148 g (0.33 lbs). As mercury concentrations in predatory fish tend to increase with age and size, comparably-sized creek catfish, if present, could be expected to have higher mercury levels. Collections to-date have not found larger individuals within the planning stretch of the creek.

White Catfish

With the added effort put into capturing bottom fish this year at the Phase 1 Pond, we discovered and were able to sample this second catfish species in 2016. Three large fish were taken, ranging from 632-685 mm (25-27") in length and 2,600-3,150 g (5.7-6.9 pounds) in weight. Fillet muscle mercury ranged from 0.244-0.567 ppm, averaging 0.372 ppm. This was higher than the creek comparisons, though not statistically. As noted above for Channel Catfish, the Phase 1 Pond White Catfish were much larger and older than the catfish samples available from the creek, which averaged 148 g (0.33 lbs) across all samples. Comparably-sized creek catfish could be expected to have higher mercury levels.

Small, Young Fish

Juvenile Largemouth Bass

The juvenile bass multiple-fish composites had whole-body mercury ranging from 0.078-0.107 ppm, averaging 0.094 ppm. This was an increase of more than double, relative to similar-sized samples analyzed in 2015 (0.044 ppm). Relative to baseline juvenile bass comparison numbers from Cache Creek, they were intermediate between the lowest (River Mile 15, 0.050 ppm) and highest (River Mile 28, 0.142 ppm) averages.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.056-0.144 ppm, averaging 0.093 ppm. This was up somewhat, relative to larger samples analyzed in 2015 (0.075 ppm). The difference was not significant. The 2016 average remained equal to or lower than comparable Cache Creek samples from River Miles 15 and 17 (0.094-0.172 ppm).

Summary

The small, young-of-year fish samples are sensitive indicators of mercury exposure conditions in the year sampled, because that is the only time they have accumulated their mercury. Each year's new cohort can show exposure changes more distinctly than the large fish, which develop their mercury levels over multiple years of growth. The Phase 1 Pond small fish data indicate a relative increase in methylmercury availability and uptake there in 2016, though to levels still similar to the low-mid range of historic creek comparisons. The adult Largemouth Bass sample was consistent with this increase. The Channel Catfish samples averaged lower than in 2015, though this may have been due to the smaller size of fish sampled. The White Catfish samples had no 2015 comparison. They averaged higher mercury than available creek catfish comparisons, though the much smaller-sized creek samples make comparisons difficult for all the catfish samples. It would be useful to know if there were any significant changes in pond management between 2015 and 2016 that might have contributed to the moderate changes seen. Future water column profiling should provide information to link observed patterns to.

Table A1, below, summarizes the statistical comparisons between Phase 1 Pond fish and comparable Cache Creek samples, for the data sets with sufficient numbers of fish to compare statistically. This pond site was unique in showing consistently lower to similar fish mercury levels, relative to creek comparisons.

Table A1. Cemex – Phase 1 Pond Fish Mercury: Statistical comparisons
(for sample sets with enough fish to compare statistically; 95% confidence level)

	vs	*– vs Baseline and Historic Comparable Cache Creek Data Sets –*				
Fish Species	***Same Site 2015***	**RM28 2011**	RM20 2000	RM17 00-02	RM15 00-02	**RM15 2011**
Large fish fillet muscle mercury						
Largemouth Bass 2015		<	<			=
2016	=	<	=			=
Small, young fish whole body, composite mercury						
Largemouth Bass 2015		<				=
2016	>	<				>
Mosquitofish 2015				<	=	=
2016	=			<	=	=

Table 1. Cemex – Phase 1 Pond: Large fish sampled, Fall 2016

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	210	8.3	125	0.3	**0.092**
Largemouth Bass	232	9.1	155	0.3	**0.166**
Largemouth Bass	237	9.3	175	0.4	**0.149**
Largemouth Bass	242	9.5	178	0.4	**0.200**
Largemouth Bass	300	11.8	315	0.7	**0.280**
Largemouth Bass	308	12.1	320	0.7	**0.366**
Largemouth Bass	315	12.4	333	0.7	**0.407**
Largemouth Bass	315	12.4	315	0.7	**0.236**
Largemouth Bass	319	12.6	370	0.8	**0.421**
Largemouth Bass	322	12.7	352	0.8	**0.467**
Largemouth Bass	324	12.8	435	1.0	**0.200**
Largemouth Bass	325	12.8	375	0.8	**0.528**
Largemouth Bass	327	12.9	445	1.0	**0.347**
Largemouth Bass	328	12.9	430	0.9	**0.395**
Largemouth Bass	332	13.1	405	0.9	**0.388**
Largemouth Bass	343	13.5	510	1.1	**0.339**
Largemouth Bass	352	13.9	520	1.1	**0.388**
Largemouth Bass	365	14.4	595	1.3	**0.474**
Largemouth Bass	379	14.9	610	1.3	**0.561**
Largemouth Bass	381	15.0	692	1.5	**0.596**
Channel Catfish	361	14.2	425	0.9	**0.073**
Channel Catfish	463	18.2	1,875	4.1	**0.128**
White Catfish	632	24.9	2,950	6.5	**0.305**
White Catfish	665	26.2	2,600	5.7	**0.567**
White Catfish	685	27.0	3,150	6.9	**0.244**

Table 2. Cemex – Phase 1 Pond: Small Fish Sampled, Fall 2016
(multi-individual, whole body composite samples)
'**n**' = *number: number of individual fish per composite*

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)	**3**	78	3.1	6.38	0.23	**0.095**
Largemouth Bass (juv)	**3**	88	3.5	9.12	0.32	**0.095**
Largemouth Bass (juv)	**3**	101	4.0	13.9	0.49	**0.107**
Largemouth Bass (juv)	**2**	143	5.6	38.1	1.35	**0.078**
Mosquitofish	**10**	27	1.1	0.19	0.01	**0.056**
Mosquitofish	**10**	32	1.2	0.32	0.01	**0.073**
Mosquitofish	**10**	37	1.4	0.55	0.02	**0.099**
Mosquitofish	**10**	41	1.6	0.68	0.02	**0.144**

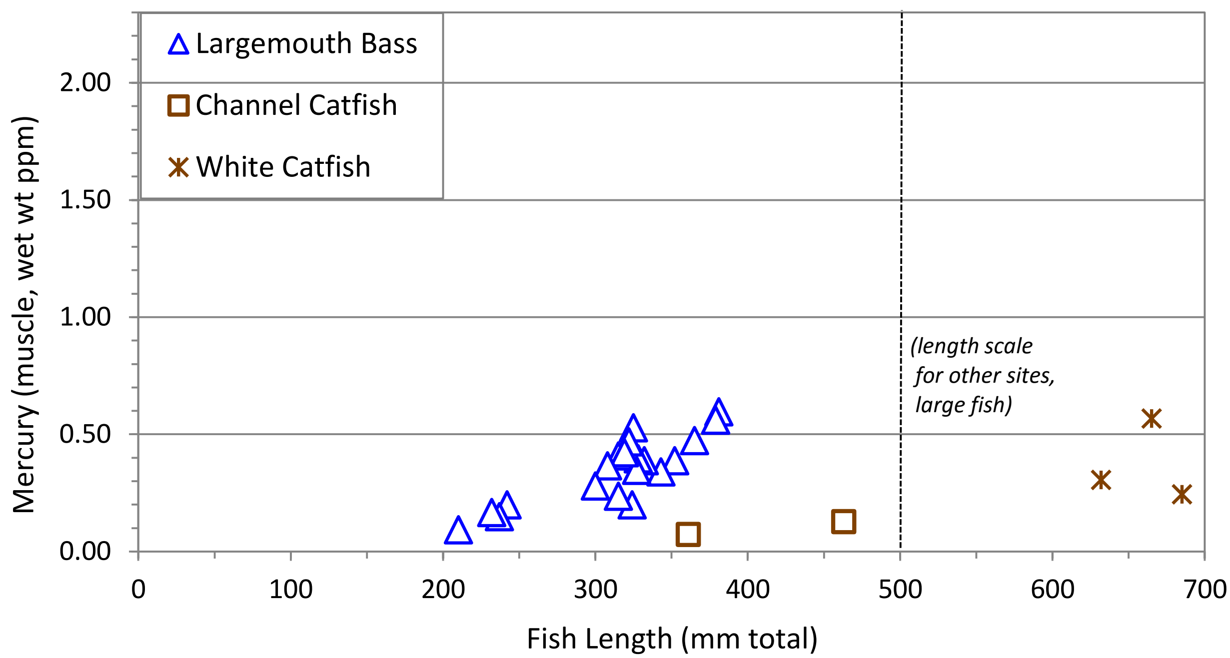


Figure 1. **Cemex – Phase 1 Pond: large fish sampled, Fall 2016**
(fillet muscle mercury in individual fish)

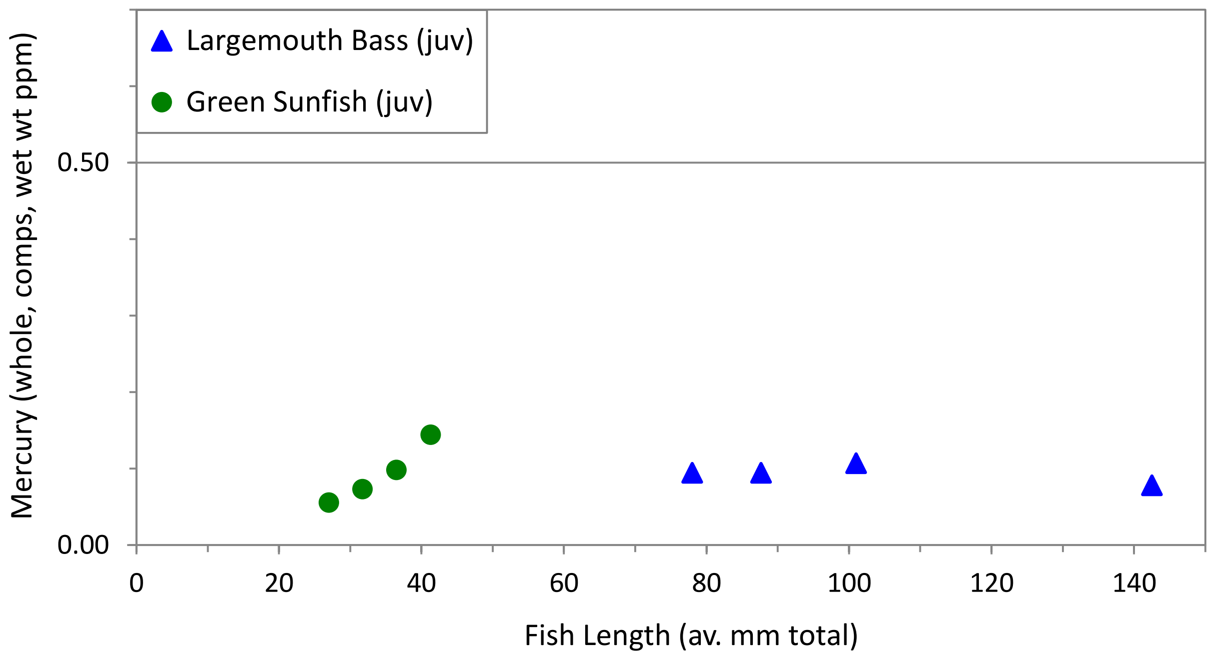


Figure 2. **Cemex – Phase 1 Pond: small, young fish sampled, Fall 2016**
(mercury in whole-body, multi-individual composite samples)

Table 3. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Cemex – Phase 1 Pond	2015	**18**	305	393	**0.278**	± 0.055
Cemex – Phase 1 Pond	2016	**20**	313	383	**0.350**	± 0.066
Historic/Baseline Data (comparable predatory species)						
Largemouth Bass						
River Mile 28	**2011**	**9**	**199**	**137**	**0.663**	**± 0.116**
Smallmouth Bass						
River Mile 28	**2011**	**7**	**265**	**326**	**0.782**	**± 0.188**
River Mile 20	2000	7	234	183	0.444	± 0.061
River Mile 15	1997	2	383	780	0.939	
Sacramento Pikeminnow						
River Mile 28	**2011**	**10**	**311**	**262**	**0.726**	**± 0.102**
River Mile 20	2000	8	269	147	0.509	± 0.204
River Mile 15	**2011**	**9**	**264**	**145**	**0.327**	**± 0.066**

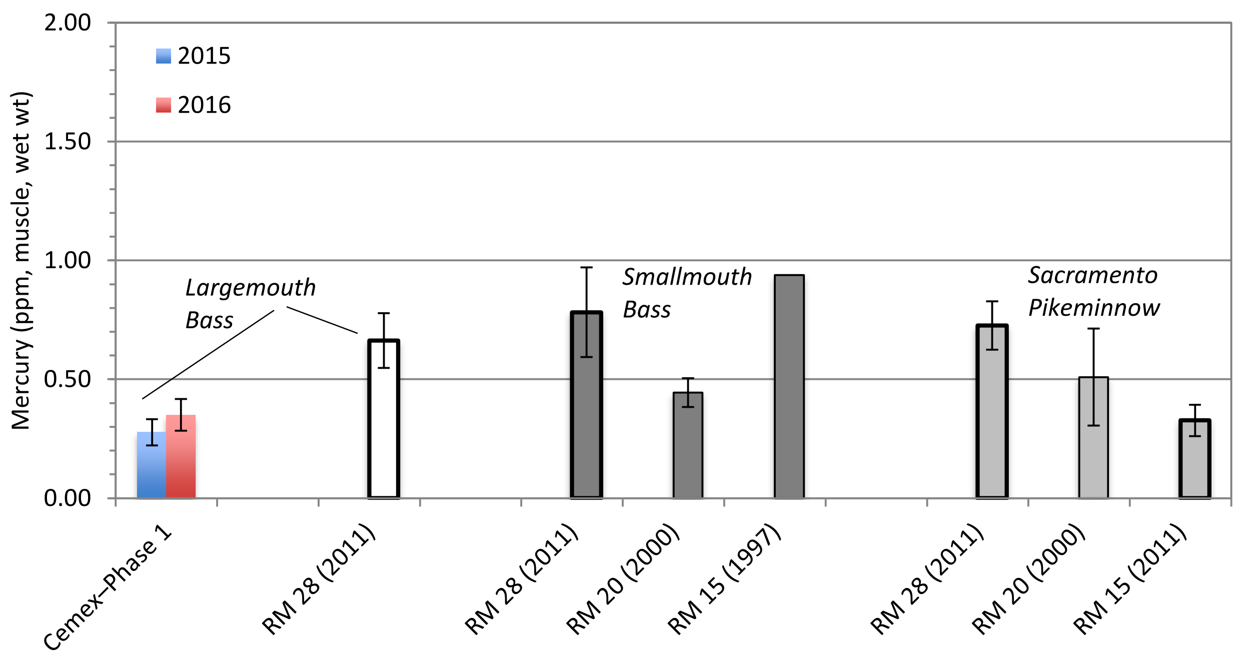


Figure 3. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 4. Channel and White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Channel Catfish						
Cemex – Phase 1 Pond	2015	**2**	595	2,130	**0.198**	
Cemex – Phase 1 Pond	2016	**2**	412	1,150	**0.100**	
White Catfish						
Cemex – Phase 1 Pond	2016	**3**	661	2,900	**0.372**	
Historic/Baseline Data						
Channel Catfish						
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	

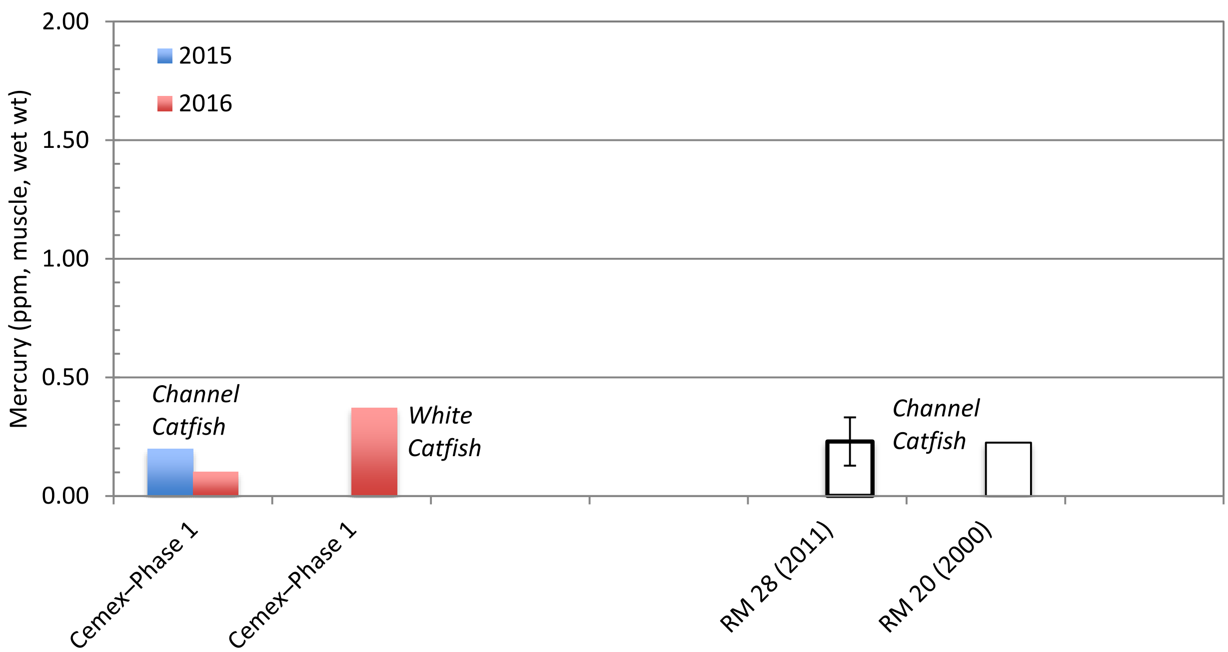


Figure 4. Channel and White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Small, Young Fish Samples *(note lower concentration scales)*

Table 5. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Largemouth Bass (juveniles)							
Cemex – Phase 1 Pond	2015	**4**	8	109	17	**0.044**	± 0.007
Cemex – Phase 1 Pond	2016	**4**	3	102	17	**0.094**	± 0.012
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**3-5**	**75**	**6**	**0.142**	**± 0.026**
River Mile 15	**2011**	**3**	**1**	**93**	**10**	**0.050**	**± 0.024**

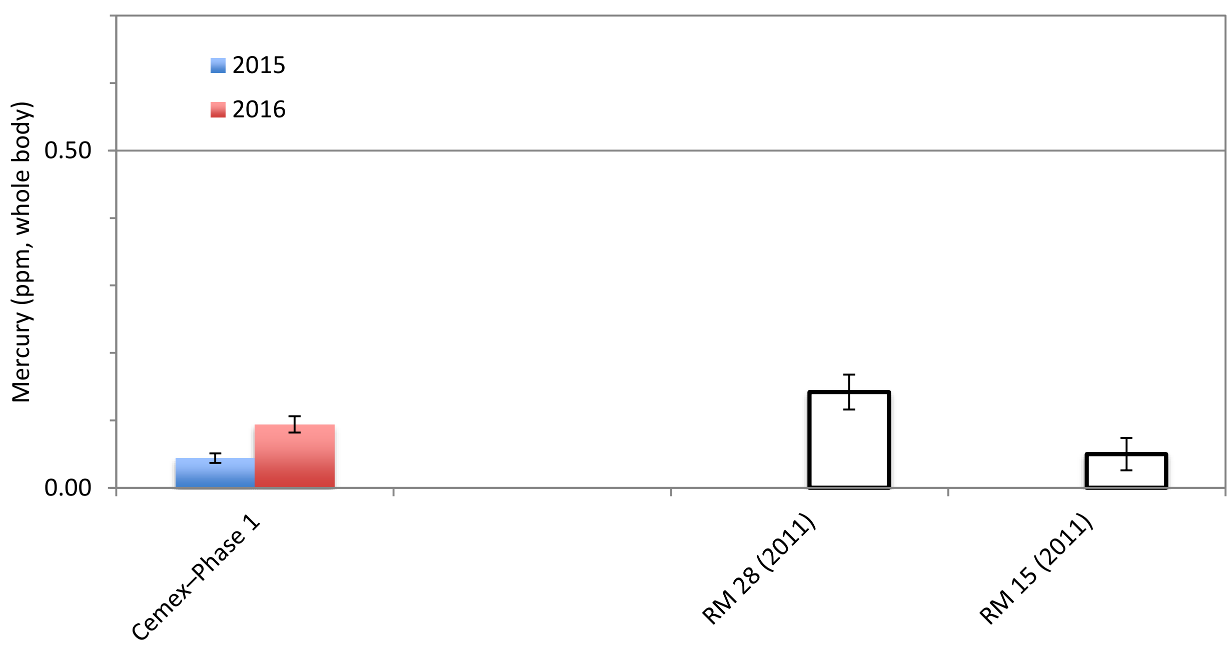


Figure 5. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 6. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Mosquitofish							
Cemex – Phase 1 Pond	2015	**4**	10	39	0.6	**0.075**	± 0.015
Cemex – Phase 1 Pond	2016	**4**	10	34	0.4	**0.093**	± 0.039
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

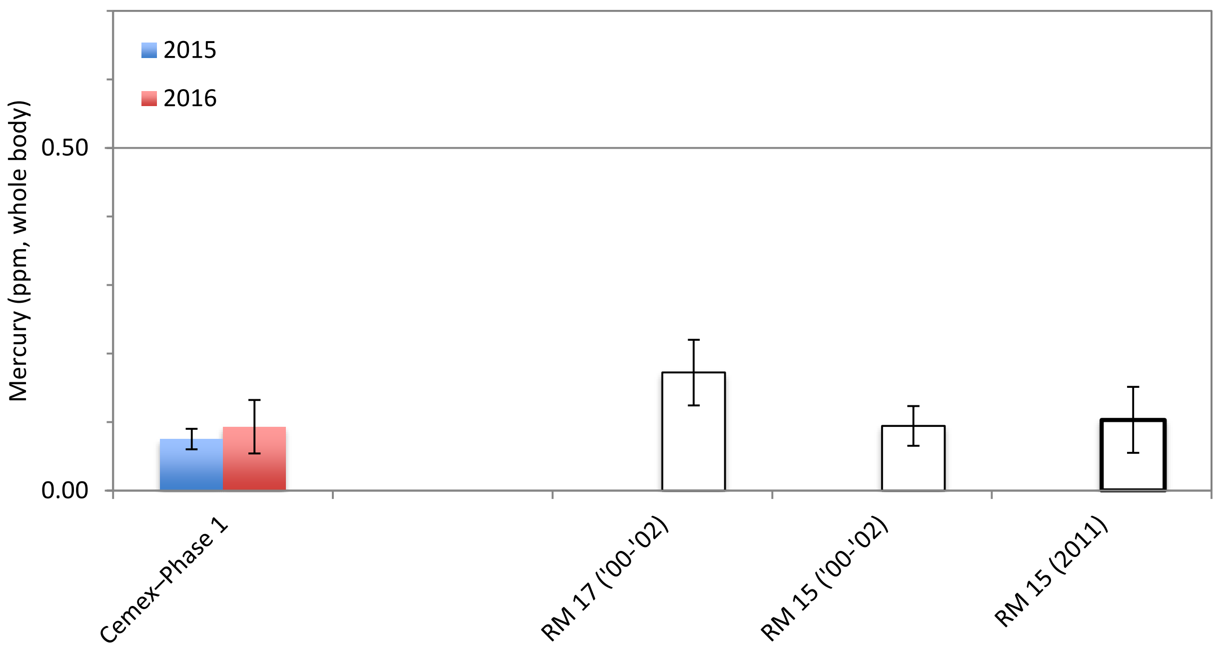


Figure 6. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

2. CEMEX – PHASE 3-4 POND

2. CEMEX – PHASE 3-4 POND *(Tables 7-13, Figures 7-13)*

This pond is the more recent (approx. 2002), 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–Phase 1 (West) 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 ranged 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.

We sampled the pond during day and twilight conditions with a range of techniques, and were able to obtain useful samples of most of the fish species present. These included individual fillet muscle samples of 20 Largemouth Bass (*Micropterus salmoides*) and a single Green Sunfish (*Lepomis cyanellus*). As in 2015, we checked extensively for presence of catfish and other large species with gill nets and baited set lines, and again found no evidence of them. The small fish present were again juvenile Largemouth Bass (4-5"), juvenile Green Sunfish (1-3"), both sparse this year, and Mosquitofish (1-2", *Gambusia affinis*). We collected 8 young-of-year bass, which were divided into 4 composite samples of 2 fish each. Fourteen juvenile Green Sunfish were placed into 4 size group composite samples of 1-5 fish each. Mosquitofish were sampled with 4 composite samples of 10 fish each.

In total, 21 large fish muscle samples and 12 small fish composite samples, 33 separate mercury samples, were analyzed from the Cemex-Phase 3-4 Pond in the Fall 2016 monitoring. The analytical results from each individual large fish muscle sample and each small, young fish composite sample can be seen in Tables 7 and 8 and, graphically, in Figures 7 and 8. Then, for each sample type, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015 results and the most closely comparable historic creek data (Tables 9-13, Figures 9-13).

Large, Angling-sized Fish

Largemouth Bass

The Phase 3-4 Pond adult Largemouth Bass samples had fillet muscle mercury ranging from 0.366-1.322 ppm, averaging 0.858 ppm. This was virtually identical to 2015 (0.840 ppm). Concentrations generally increased with fish size, as is typical. Similar to the 2015 set of bass, the 2016 samples ranged between 239 and 409 mm (about 9-16"). Adult bass represent the top predator fish in this region and will typically have the highest mercury levels at any given site. The Phase 3-4 Pond bass remained statistically similar in mercury to the highest mercury comparable baseline/historic samples from Cache Creek, significantly higher than 4 historic sets.

Green Sunfish

The single larger Green Sunfish taken had fillet muscle mercury of 0.382 ppm. This was lower than the 2015 average of 0.534 ppm from 10 fish, though, with only the one sample in 2016, the difference cannot be assessed statistically. In 2015, the average Green Sunfish mercury level was nearly identical to the baseline comparison Green Sunfish taken at the River Mile 28 site and significantly higher than the other 2 historical creek comparisons with sufficient sample size. The 2016 fish was in an intermediate range.

Small, Young Fish

Juvenile Largemouth Bass

The juvenile bass multiple-fish composites had whole-body mercury ranging from 0.334-0.448 ppm, averaging 0.372 ppm. This was up somewhat, relative to similar-sized samples analyzed in 2015 (0.334 ppm), though the difference was not statistically significant. Relative to baseline juvenile bass comparison data from Cache Creek, they remained significantly higher than the two sample sets available: River Mile 28 (0.142 ppm) and River Mile 15 (0.050 ppm).

Juvenile Green Sunfish

The juvenile Green Sunfish multiple-fish composites had whole-body mercury ranging from 0.198-0.255 ppm, averaging 0.233 ppm. This was down somewhat, relative to similar-sized samples analyzed in 2015 (0.275 ppm). The difference was not statistically significant. Relative to baseline juvenile Green Sunfish comparison numbers from Cache Creek, they remained higher. The difference was statistically significant for 4 of 5 comparisons.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.103-0.183 ppm, averaging 0.157 ppm. This was down, relative to identically-sized samples analyzed in 2015 (0.228 ppm). The year-to-year change was not statistically significant. The 2016 average was statistically similar to 2 of 3 comparable Cache Creek sample sets from River Miles 15 and 17 (0.103-0.172 ppm) and higher than one set (0.094 ppm).

Summary

In summary, fish mercury in the Cemex Phase 3-4 Pond was similar in both years sampled, with slight increases in some sample types and slight decreases in others, none of which were statistically significant. Relative to comparable samples from Cache Creek, they remained similar to the upper range of creek samples for adult Largemouth Bass, adult Green Sunfish, and Mosquitofish; and statistically higher than all available creek comparisons for juvenile bass and juvenile sunfish. Table A2, below, summarizes the statistical comparisons between Phase 3-4 Pond fish and comparable Cache Creek samples, for the data sets with sufficient numbers of fish to compare statistically.

Table A2. Cemex – Phase 3-4 Pond Fish Mercury: Statistical comparisons
(for sample sets with enough fish to compare statistically; 95% confidence level)

	vs	*– vs Baseline and Historic Comparable Cache Creek Data Sets –*					
Fish Species	***Same Site 2015***	**RM28 2011**	RM20 2000	**RM20 2011**	RM17 00-02	RM15 00-02	**RM15 2011**
Large fish fillet muscle mercury							
Largemouth Bass 2015		=	>				>
2016	=	=	>				>
Green Sunfish 2015		=		>			>
2016	*(n=1)* *						
Small, young fish whole body, composite mercury							
Largemouth Bass 2015		>					>
2016	=	>					>
Green Sunfish 2015		>		>	>	>	>
2016	=	>		>	=	>	>
Mosquitofish 2015					=	>	=
2016	=				=	>	=

* *(n=1)* means there was only one fish taken of this species, precluding statistical comparisons

Table 7. Cemex – Phase 3-4 Pond: Large fish sampled, Fall 2016

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	239	9.4	190	0.4	**0.499**
Largemouth Bass	268	10.6	220	0.5	**0.366**
Largemouth Bass	275	10.8	260	0.6	**0.377**
Largemouth Bass	290	11.4	300	0.7	**0.638**
Largemouth Bass	315	12.4	400	0.9	**0.817**
Largemouth Bass	330	13.0	485	1.1	**0.712**
Largemouth Bass	336	13.2	440	1.0	**0.595**
Largemouth Bass	343	13.5	545	1.2	**0.738**
Largemouth Bass	344	13.5	500	1.1	**0.696**
Largemouth Bass	345	13.6	525	1.2	**0.718**
Largemouth Bass	356	14.0	595	1.3	**0.694**
Largemouth Bass	367	14.4	640	1.4	**1.284**
Largemouth Bass	367	14.4	710	1.6	**1.072**
Largemouth Bass	372	14.6	695	1.5	**1.072**
Largemouth Bass	374	14.7	655	1.4	**1.121**
Largemouth Bass	376	14.8	730	1.6	**0.960**
Largemouth Bass	383	15.1	705	1.6	**1.322**
Largemouth Bass	391	15.4	805	1.8	**1.206**
Largemouth Bass	392	15.4	865	1.9	**1.119**
Largemouth Bass	409	16.1	865	1.9	**1.146**
Green Sunfish	101	4.0	42	0.1	**0.382**

Table 8. Cemex – Phase 3-4 Pond: Small Fish Sampled, Fall 2016
(multi-individual, whole body composite samples)
'**n**' = *number: number of individual fish per composite*

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)	**2**	105	4.1	14.2	0.50	**0.448**
Largemouth Bass (juv)	**2**	110	4.3	15.6	0.55	**0.334**
Largemouth Bass (juv)	**2**	117	4.6	19.9	0.70	**0.367**
Largemouth Bass (juv)	**2**	125	4.9	23.8	0.84	**0.339**
Green Sunfish (juv)	**5**	40	1.6	0.90	0.03	**0.249**
Green Sunfish (juv)	**4**	46	1.8	1.52	0.05	**0.231**
Green Sunfish (juv)	**4**	49	1.9	1.84	0.06	**0.255**
Green Sunfish (juv)	**1**	62	2.4	3.91	0.14	**0.198**
Mosquitofish	**10**	27	1.1	0.20	0.01	**0.103**
Mosquitofish	**10**	36	1.4	0.47	0.02	**0.160**
Mosquitofish	**10**	39	1.6	0.75	0.03	**0.182**
Mosquitofish	**10**	44	1.7	0.97	0.03	**0.183**

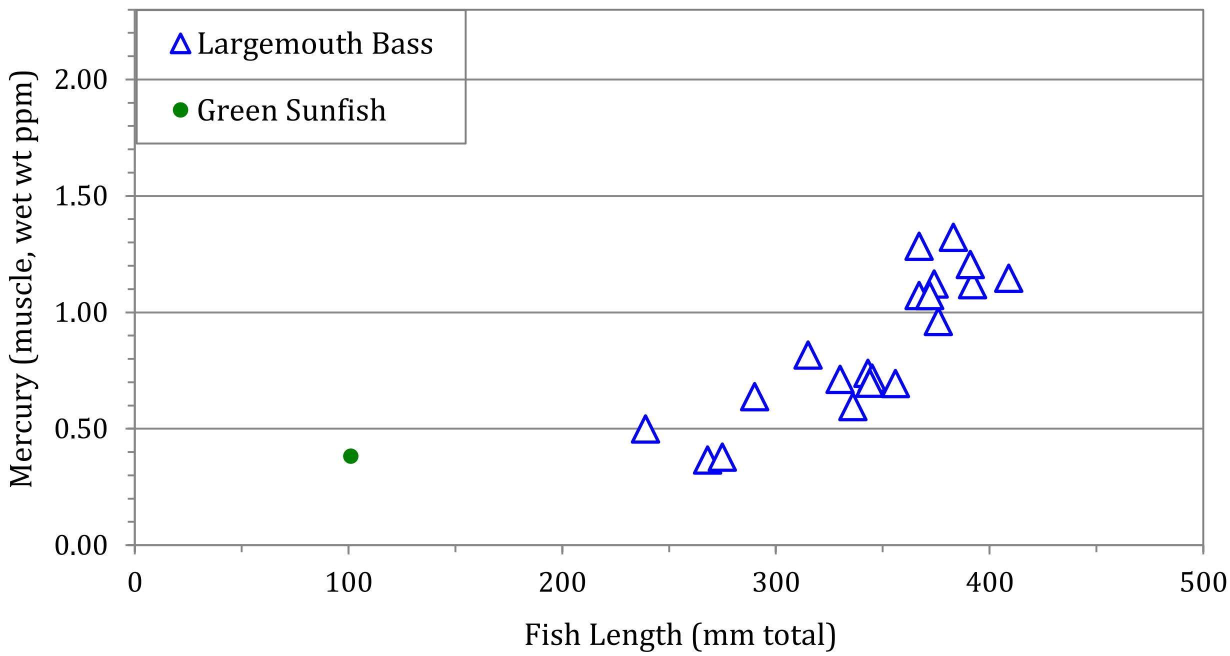


Figure 7. Cemex – Phase 3-4 Pond: large fish sampled, Fall 2016
(fillet muscle mercury in individual fish)

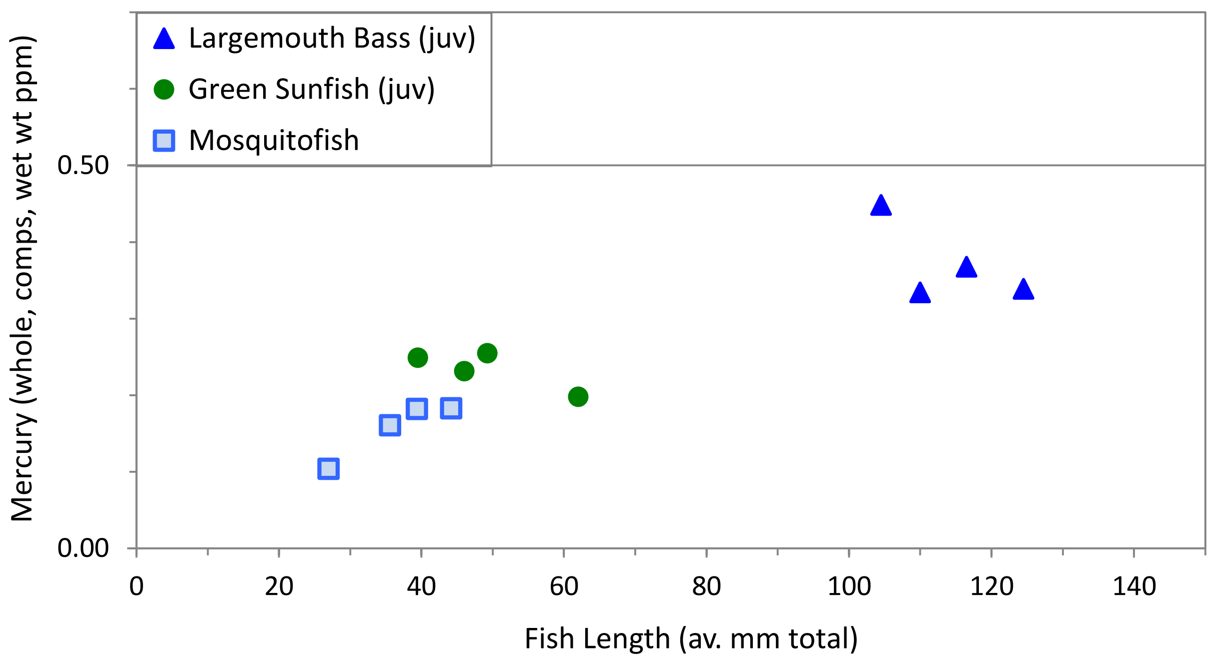


Figure 8. Cemex – Phase 3-4 Pond: small, young fish sampled, Fall 2016
(mercury in whole-body, multi-individual composite samples)

Table 9. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Cemex – Phase 3-4 Pond	2015	**20**	344	526	**0.840**	± 0.113
Cemex – Phase 3-4 Pond	2016	**20**	344	557	**0.858**	± 0.139
Historic/Baseline Data (comparable predatory species)						
Largemouth Bass						
River Mile 28	**2011**	**9**	**199**	**137**	**0.663**	**± 0.116**
Smallmouth Bass						
River Mile 28	**2011**	**7**	**265**	**326**	**0.782**	**± 0.188**
River Mile 20	2000	7	234	183	0.444	± 0.061
River Mile 15	1997	2	383	780	0.939	
Sacramento Pikeminnow						
River Mile 28	**2011**	**10**	**311**	**262**	**0.726**	**± 0.102**
River Mile 20	2000	8	269	147	0.509	± 0.204
River Mile 15	**2011**	**9**	**264**	**145**	**0.327**	**± 0.066**

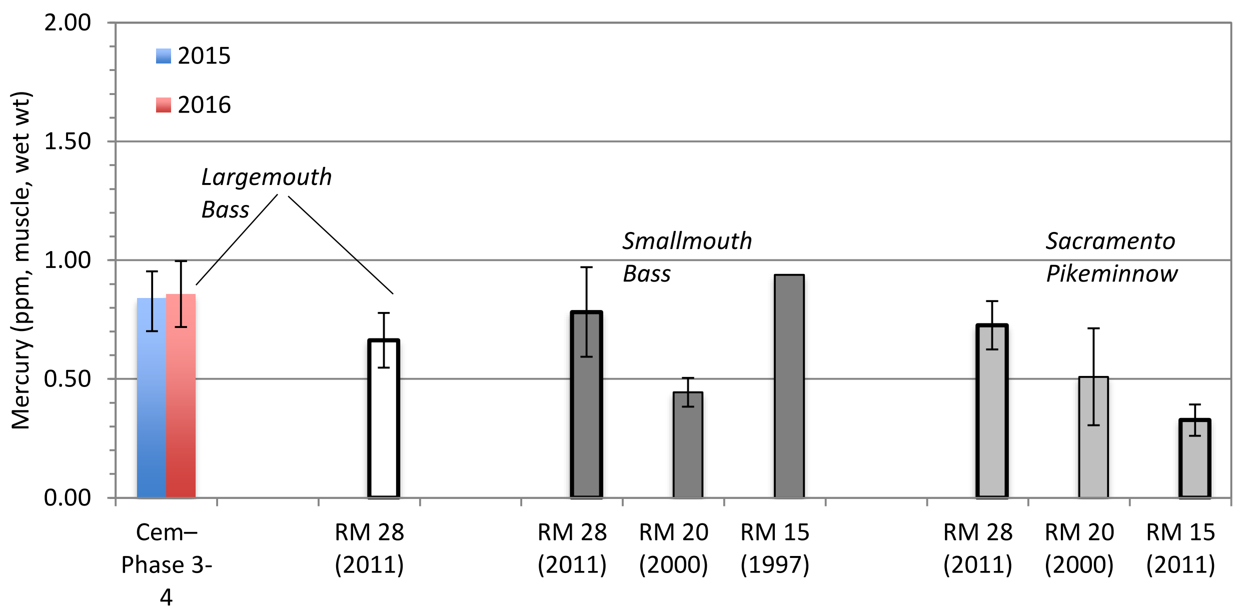


Figure 9. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 10. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Green Sunfish						
Cemex – Phase 3-4 Pond	2015	**10**	133	67	**0.534**	± 0.076
Cemex – Phase 3-4 Pond	2016	**1**	101	16	**0.382**	
Historic/Baseline Data						
River Mile 28	**2011**	**3**	**139**	**47**	**0.540**	**± 0.124**
River Mile 20	2000	4	132	41	0.271	
River Mile 20	**2011**	**10**	**122**	**31**	**0.138**	**± 0.029**
River Mile 15	**2011**	**10**	**133**	**41**	**0.195**	**± 0.031**

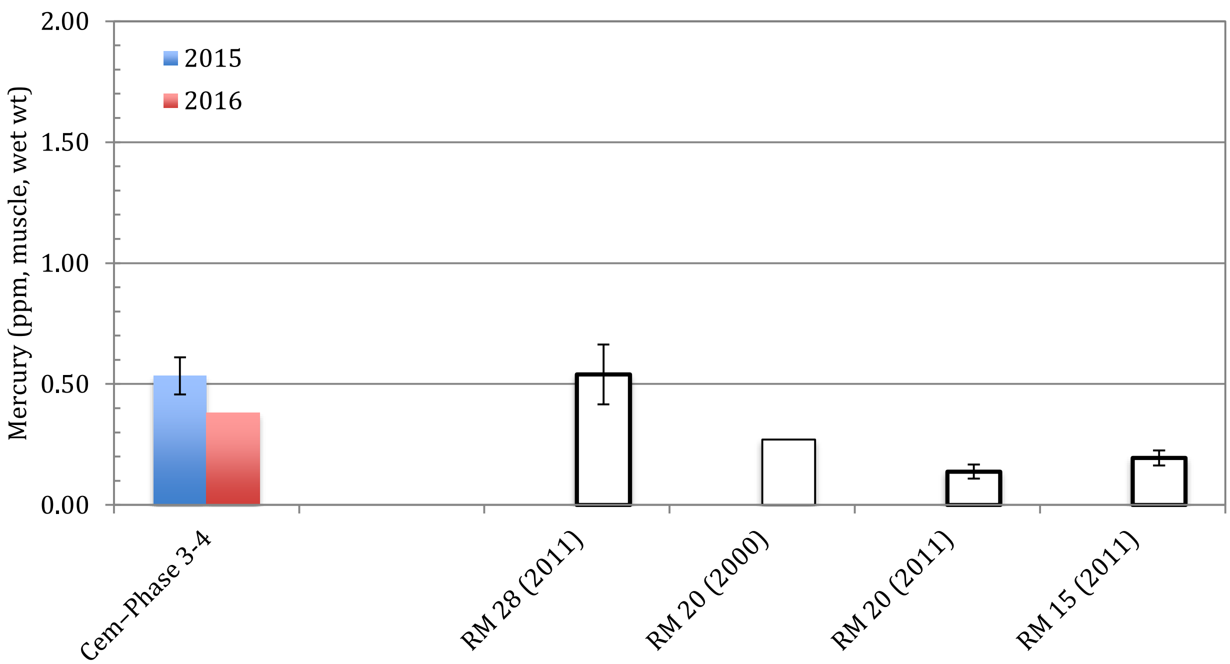


Figure 10. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Small, Young Fish Samples *(note lower concentration scales)*

Table 11. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	**Year**	**n** (comps)	**n** (inds/ comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Largemouth Bass (juveniles)							
Cemex – Phase 3-4 Pond	2015	**4**	7	108	16	**0.334**	± 0.052
Cemex – Phase 3-4 Pond	2016	**4**	2	114	18	**0.372**	± 0.053
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**3-5**	**75**	**6**	**0.142**	**± 0.026**
River Mile 15	**2011**	**3**	**1**	**93**	**10**	**0.050**	**± 0.024**

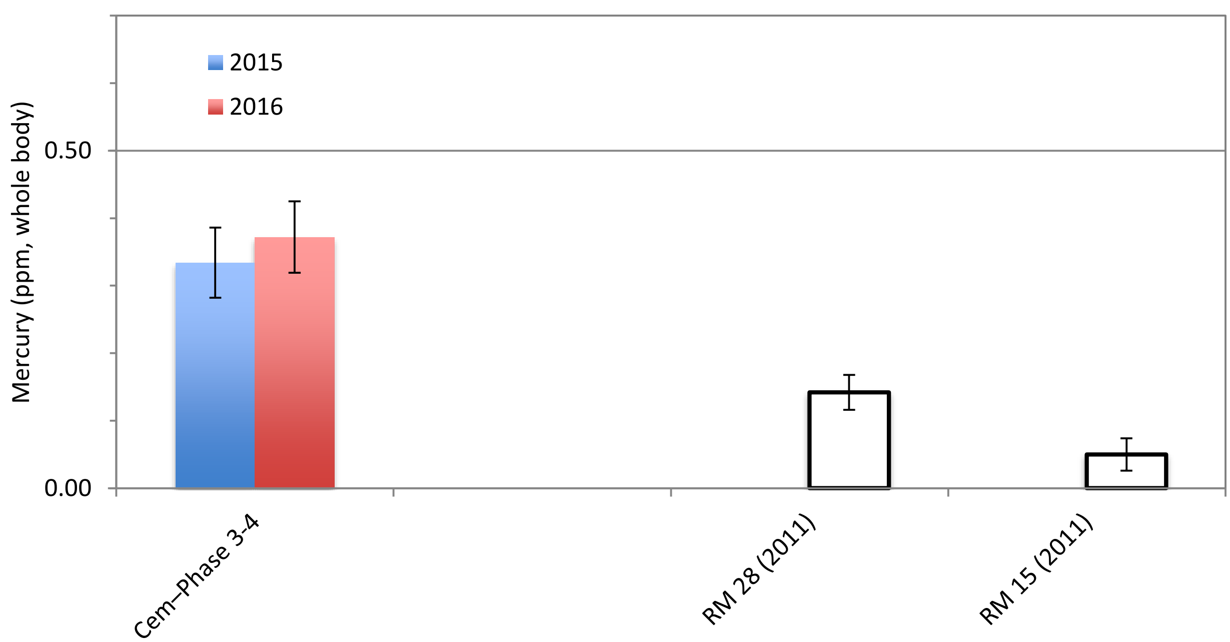


Figure 11. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 12. Juvenile Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Green Sunfish (juveniles)							
Cemex – Phase 3-4 Pond	2015	**4**	10	47	1.8	**0.275**	± 0.022
Cemex – Phase 3-4 Pond	2016	**4**	4-5	49	2.0	**0.233**	± 0.026
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**4**	**53**	**2.8**	**0.139**	**± 0.014**
River Mile 20	**2011**	**4**	**4**	**58**	**3.4**	**0.084**	**± 0.004**
River Mile 17	2000-2002	8	5-10	41-90	1-6	0.169	± 0.045
River Mile 15	2000-2002	8	4-8	40-87	1-6	0.117	± 0.028
River Mile 15	**2011**	**4**	**4-5**	**56**	**3.1**	**0.086**	**± 0.018**

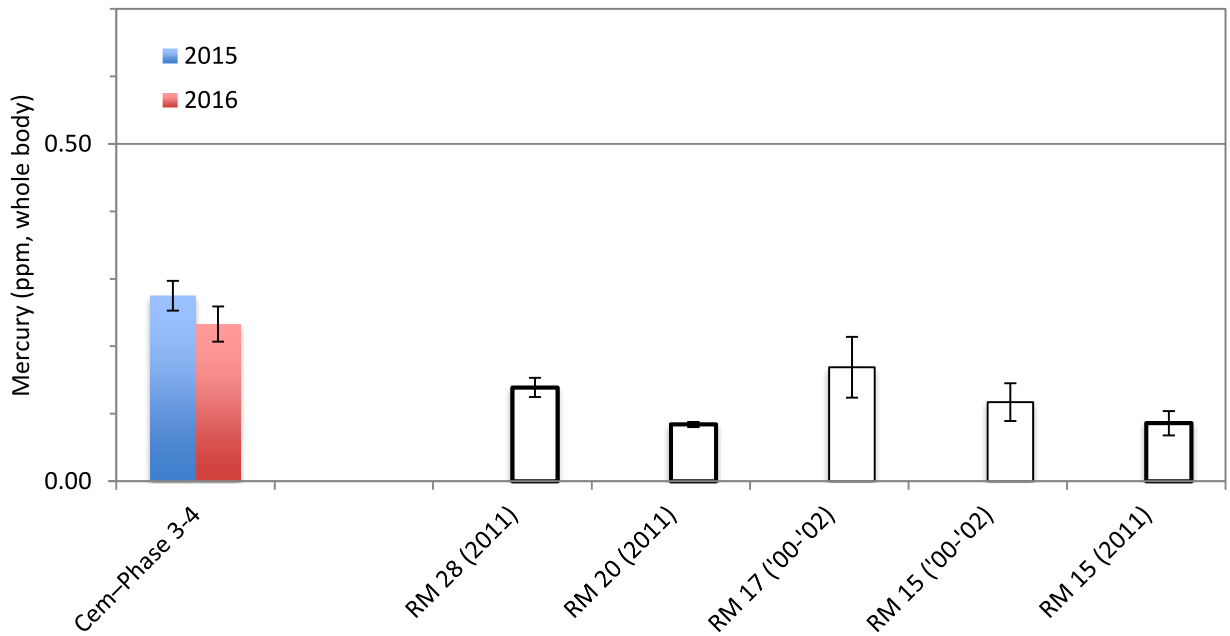


Figure 12. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 13. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	**Year**	**n** (comps)	**n** (inds/ (comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Mosquitofish							
Cemex – Phase 3-4 Pond	2015	**4**	10	37	0.6	**0.228**	± 0.059
Cemex – Phase 3-4 Pond	2016	**4**	10	37	0.6	**0.157**	± 0.037
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

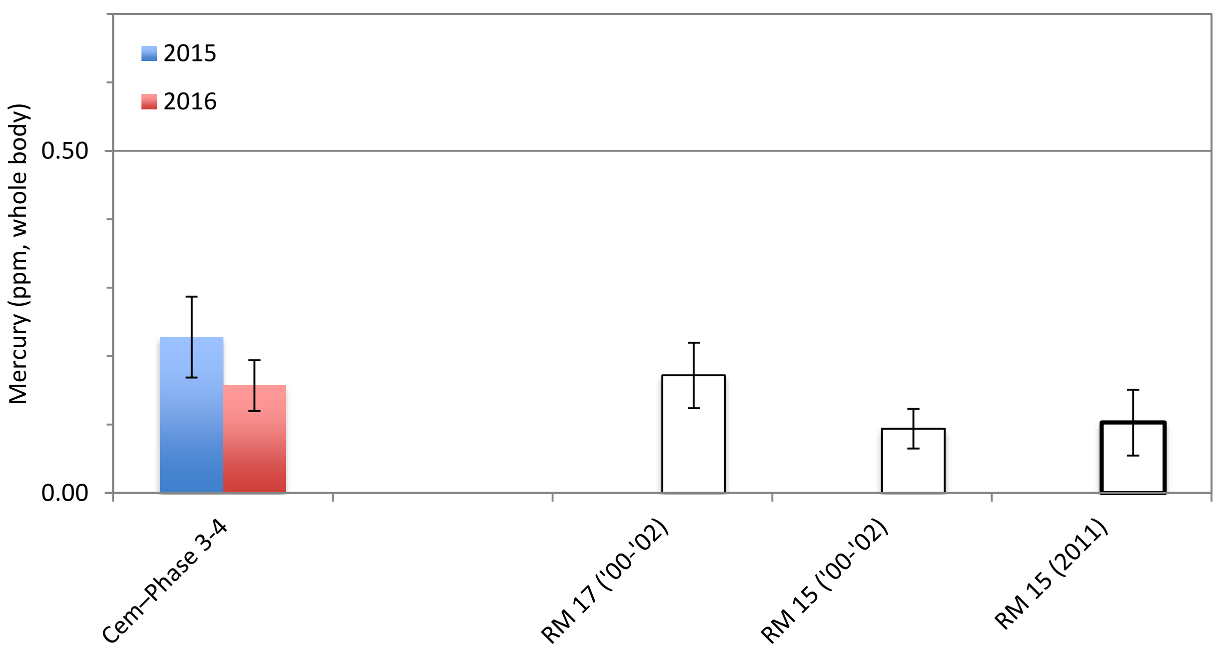


Figure 13. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

3. TEICHERT – REIFF POND

3. TEICHERT – REIFF POND *(Tables 14-21, Figures 14-21)*

This pond is the largest of the Teichert wet pits. It is located just north of Cache Creek, west of Highway 505 between 505 and County Road 87. Reiff is a square-shaped pond that is approximately half a kilometer on a side. Depths ranged from 0-2 m shallows along some of the margins to a deep central area to 9+ m (30 feet). First created in or before 2002, our understanding is that this pond did not have active mining in 2015 or 2016, but did receive plant silt/clay slurry.

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, samples of 20 White Catfish (*Ameiurus catus*). White Catfish, as in 2015, were the dominant large fish here. The only other large fish taken in multiple days with multiple nets and set lines were 5 Carp (*Cyprinus carpio*), up from 2 taken in 2015. 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 10 each Mosquitofish.

In total this added up to 25 large fish muscle samples and 8 young-of-year small fish composites, or 33 separate mercury samples, analyzed from the Reiff Pond in the Fall 2016 monitoring. The analytical results from each individual large fish muscle sample and each small fish composite sample can be seen in Tables 14 and 15 and, graphically, in Figures 14 and 15. Then, for each large and small fish species taken, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015 results and the most closely comparable historic creek data (Tables 16-21, Figures 16-21).

Large, Angling-sized Fish

White Catfish

The White Catfish samples had fillet muscle mercury ranging from 0.662-1.996 ppm, averaging 0.996 ppm. This was up from 2015 (0.737 ppm). The increase was statistically significant. In Figure 14, it can be seen that the catfish under 400 mm (16"), 18 of the 20 samples taken, clustered in a narrower range of concentrations (0.662-1.245 ppm), averaging 0.904 ± 0.081 ppm. The 2015 average for similar sized catfish (< 400 mm, 15 fish) was 0.623 ± 0.145 ppm. The difference between years is similar with either set of averages. Relative to comparative creek samples, the Reiff Pond White Catfish remained significantly higher (3-4 times higher) in mercury than the available baseline/historic samples. As noted earlier for the Cemex–Phase 1 catfish, the relatively small physical size of the available comparison catfish from Cache Creek makes comparison problematic. However, these Reiff Pond catfish mercury levels are high under any interpretation.

Carp

The Reiff Pond Carp samples had fillet muscle mercury ranging from 0.548-1.325 ppm, averaging 0.854 ppm. This was more than double the 2015 average (0.351 ppm). With the high variability in 2016 and small number of samples in 2015, this difference cannot be assessed for statistical significance. The 2016 Carp were in a similar size range as the pair of fish taken in 2015, between 400 and 477 mm (about 16-19") and 790-1,225 g (1.7-2.7 pounds). Comparative samples of this species have not been taken from Cache Creek in the Planning Area, though 5 sets of the trophically similar (similar diet, habit, and mercury accumulation) Sacramento Sucker have, between 1997 and 2011. In relation to the creek Sacramento Sucker data sets, the Reiff Pond Carp available in 2015 were similar in mercury to 3 of 5 baseline/historic samples and higher than two. The 2016 Reiff Pond Carp were higher than all 5 creek data sets. The difference was statistically significant for 4 comparisons.

Green Sunfish

A single adult Green Sunfish was taken in 2015. It had fillet muscle mercury of 0.328 ppm, in the mid-range of baseline/historic comparative creek levels. We were not able to find any of this species in the Reiff Pond in 2016.

Small, Young Fish

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.168-0.255 ppm, averaging 0.212 ppm. This was significantly higher, relative to similar-sized fish collected in 2015 (0.094 ppm). The 2015 Reiff samples averaged the same or lower mercury than the 3 historic sample sets from the creek (0.094-0.172 ppm), statistically lower than the River Mile 28 data set. In contrast, the 2016 Reiff Pond average was higher than all 3 comparable Cache Creek sample sets, with 2 of the comparisons statistically significant.

Red Shiner

The Red Shiner multiple-fish composites had whole-body mercury ranging from 0.344-0.530 ppm, averaging 0.412 ppm. This was significantly higher, more than double, relative to similar-sized fish collected in 2015 (0.152 ppm). Like the Mosquitofish trend above, the 2015 Reiff Pond Red Shiner samples averaged similar or lower mercury than the 6 historic/baseline sample sets from the creek (0.123-0.242 ppm), statistically lower than the River Mile 28 data set. In contrast, the 2016 average was significantly higher than 5 of 6 comparable Cache Creek sample sets.

Juvenile Green Sunfish

A single young-of-year Green Sunfish was taken in 2015. It had whole-body mercury of 0.241 ppm, higher than the 5 baseline/historic comparative creek data sets, though, with just a single fish, there is no statistical comparison. As with the adult Green Sunfish noted above, we were not able to find any juveniles of this species in the Reiff Pond in 2016.

Summary

In summary, the Teichert–Reiff Pond showed an increase in fish mercury in all sample types that had comparative data from both 2015 and 2016 (White Catfish, Carp, Mosquitofish, and Red Shiner). The increase was statistically significant for White Catfish, Mosquitofish, and Red Shiner. As noted earlier in the Cemex–Phase 1 section, small, young-of-year samples like Mosquitofish and Red Shiner are particularly sensitive indicators of inter-annual changes, as they have accumulated all their mercury within the specific year they were sampled. We are very interested to know if the changes seen at Reiff Pond in 2016 might be linked to changes in pond management. Relative to available creek comparison data, the 2016 Reiff Pond average fish mercury levels were significantly higher for White Catfish, Carp, and Red Shiner; and similar to the upper range in Cache Creek for Mosquitofish. Table A3, below, summarizes the statistical comparisons between Reiff Pond fish and corresponding Cache Creek samples, for the data sets with sufficient numbers of fish to compare statistically.

Table A3. Teichert – Reiff Pond Fish Mercury: Statistical comparisons
(for sample sets with enough fish to compare statistically; 95% confidence level)

Fish Species		*vs* Same Site 2015	– *vs Baseline and Historic Comparable Cache Creek Data Sets* – RM28 2011	RM20 2000	RM17 00-02	RM15 1997	RM15 00-02	RM15 2011
Large fish fillet muscle mercury								
White Catfish	**2015**		>					
	2016	=	>					
Small, young fish whole body, composite mercury								
Mosquitofish	**2015**				<		=	=
	2016	>			=		>	>
Red Shiner	**2015**		<	=	=	=	=	
	2016	>	>	>	=	>	>	

Table 14. Teichert – Reiff Pond: Large fish sampled, Fall 2016

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
White Catfish	239	9.4	140	0.3	**0.817**
White Catfish	245	9.6	165	0.4	**0.852**
White Catfish	253	10.0	162	0.4	**0.664**
White Catfish	253	10.0	155	0.3	**1.245**
White Catfish	254	10.0	175	0.4	**0.965**
White Catfish	262	10.3	185	0.4	**1.021**
White Catfish	268	10.6	225	0.5	**1.095**
White Catfish	268	10.6	230	0.5	**0.777**
White Catfish	269	10.6	220	0.5	**0.982**
White Catfish	274	10.8	245	0.5	**1.058**
White Catfish	276	10.9	240	0.5	**0.968**
White Catfish	283	11.1	255	0.6	**0.839**
White Catfish	288	11.3	265	0.6	**0.889**
White Catfish	303	11.9	318	0.7	**0.690**
White Catfish	312	12.3	365	0.8	**0.891**
White Catfish	319	12.6	415	0.9	**0.662**
White Catfish	354	13.9	495	1.1	**0.769**
White Catfish	362	14.3	630	1.4	**1.083**
White Catfish	426	16.8	885	2.0	**1.653**
White Catfish	436	17.2	1,040	2.3	**1.996**
Carp	400	15.7	790	1.7	**0.548**
Carp	412	16.2	860	1.9	**0.898**
Carp	425	16.7	1,040	2.3	**0.906**
Carp	436	17.2	960	2.1	**0.594**
Carp	477	18.8	1,225	2.7	**1.325**

Table 15. Teichert – Reiff Pond: Small Fish Sampled, Fall 2016
(multi-individual, whole body composite samples)
'**n**' = *number: number of individual fish per composite*

Fish Species	**n** (indivs. in comp)	Av. Fish Length (mm)	(inches)	Av. Fish Weight (g)	(oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Mosquitofish	**10**	28	1.1	0.19	0.01	**0.168**
Mosquitofish	**10**	34	1.3	0.34	0.01	**0.186**
Mosquitofish	**10**	39	1.5	0.55	0.02	**0.237**
Mosquitofish	**10**	43	1.7	0.80	0.03	**0.255**
Red Shiner	**10**	42	1.6	0.67	0.02	**0.344**
Red Shiner	**10**	44	1.7	0.87	0.03	**0.361**
Red Shiner	**10**	48	1.9	1.12	0.04	**0.413**
Red Shiner	**10**	54	2.1	1.61	0.06	**0.530**

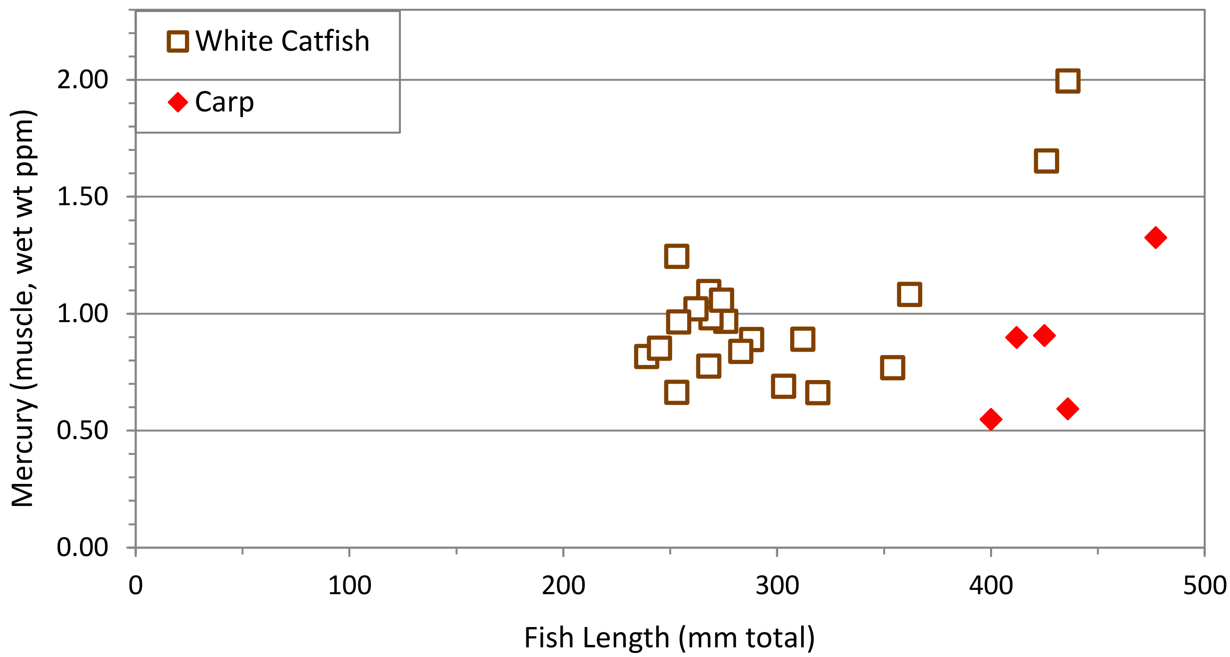


Figure 14. Teichert – Reiff Pond: large fish sampled, Fall 2016
(fillet muscle mercury in individual fish)

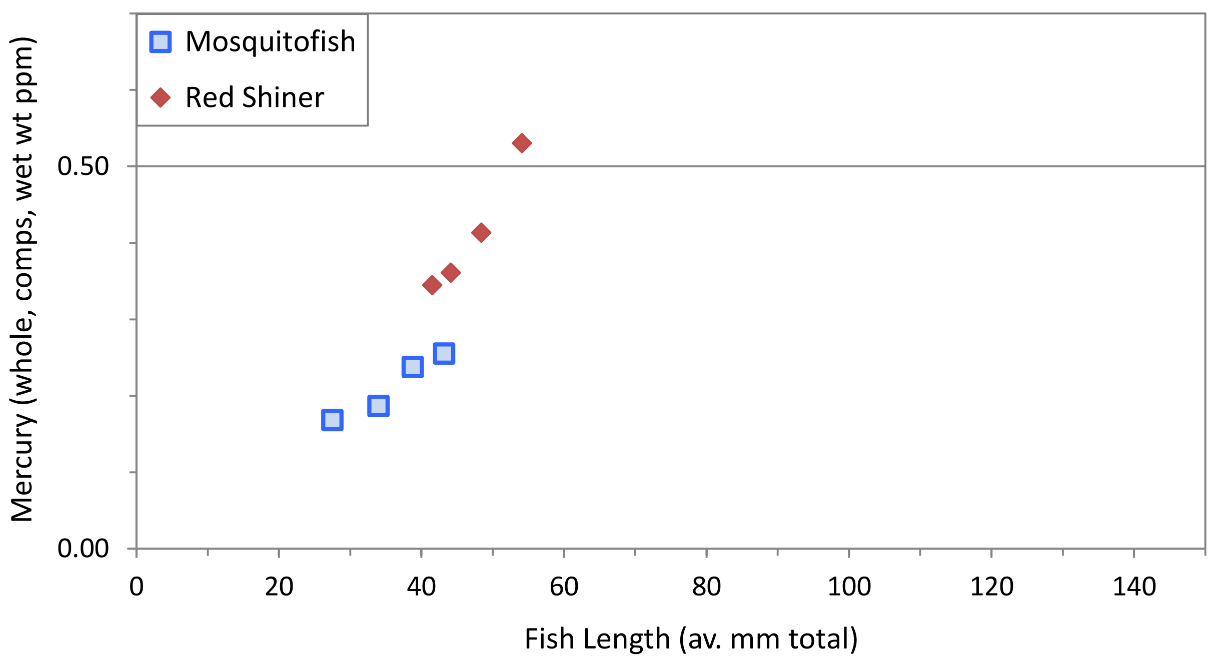


Figure 15. Teichert – Reiff Pond: small, young fish sampled, Fall 2016
(mercury in whole-body, multi-individual composite samples)

Table 16. White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
White Catfish						
Teichert – Reiff Pond	2015	**20**	347	658	**0.737**	± 0.156
Teichert – Reiff Pond	2016	**20**	297	341	**0.996**	± 0.153
Historic/Baseline Data						
Channel Catfish						
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	

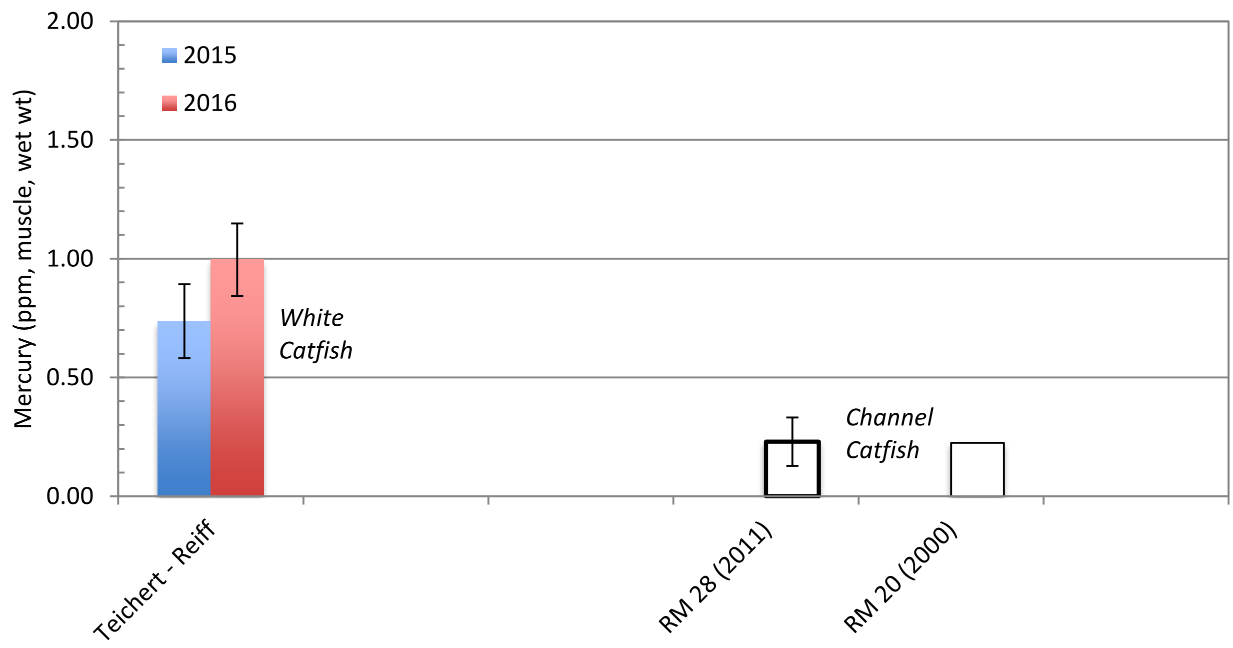


Figure 16. White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 17. Carp summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Carp						
Teichert – Reiff Pond	2015	**2**	421	918	**0.351**	
Teichert – Reiff Pond	2016	**5**	430	975	**0.854**	± 0.387
Historic/Baseline Data (most comparable species available)						
Sacramento Sucker						
River Mile 20	2000	5	253	174	0.154	± 0.034
River Mile 15	**2011**	**8**	**276**	**231**	**0.143**	**± 0.011**

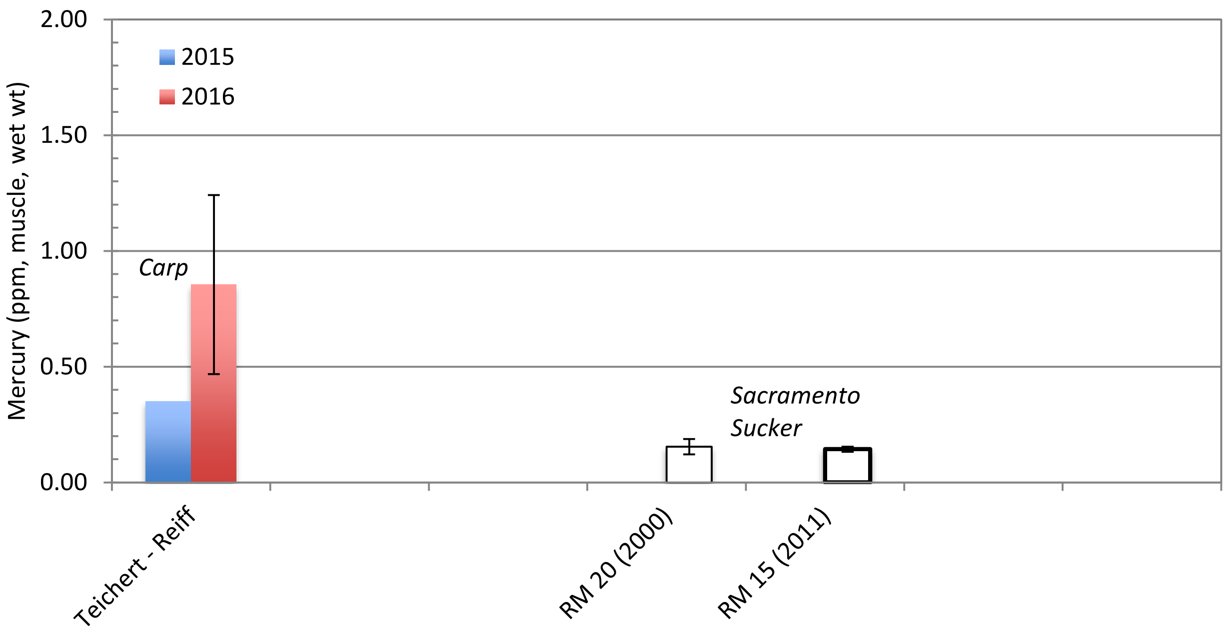


Figure 17. Carp summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 18. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Green Sunfish						
Teichert – Reiff Pond	2015	**1**	140	40	**0.328**	
Teichert – Reiff Pond	2016	–				
Historic/Baseline Data						
River Mile 28	**2011**	**3**	**139**	**47**	**0.540**	**± 0.124**
River Mile 20	2000	4	132	41	0.271	
River Mile 20	**2011**	**10**	**122**	**31**	**0.138**	**± 0.029**
River Mile 15	**2011**	**10**	**133**	**41**	**0.195**	**± 0.031**

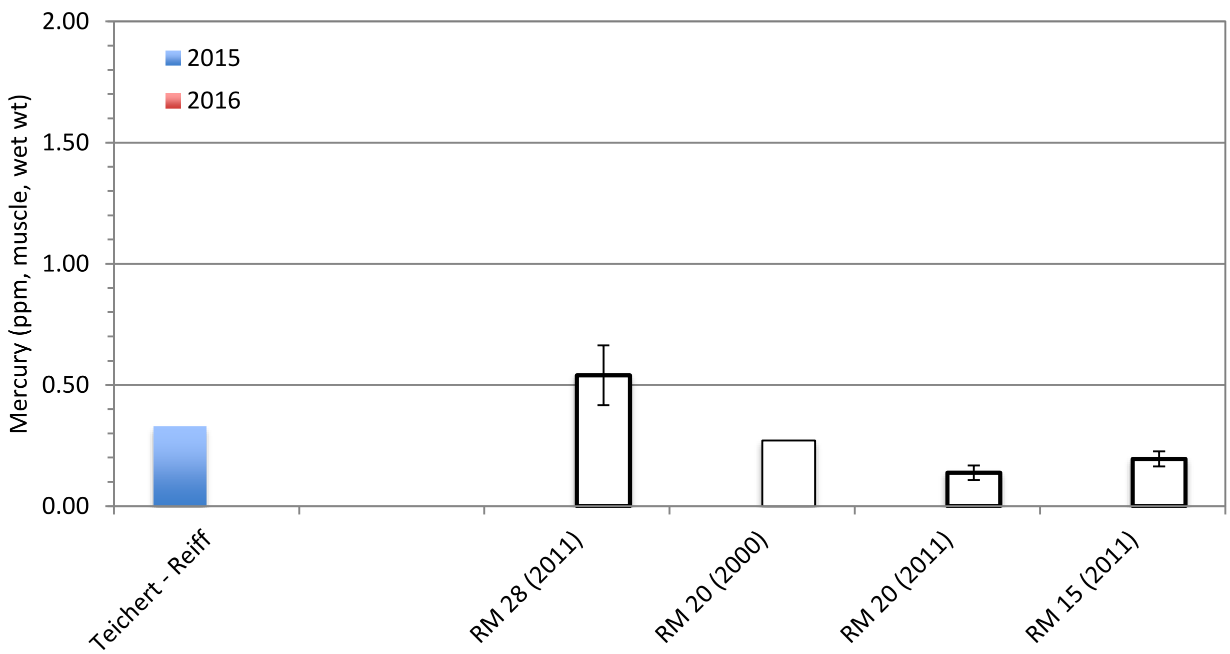


Figure 18. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Small, Young Fish Samples *(note lower concentration scales)*

Table 19. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Mosquitofish							
Teichert – Reiff Pond	2015	**4**	12	38	0.6	**0.094**	± 0.010
Teichert – Reiff Pond	2016	**4**	10	36	0.5	**0.212**	± 0.041
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

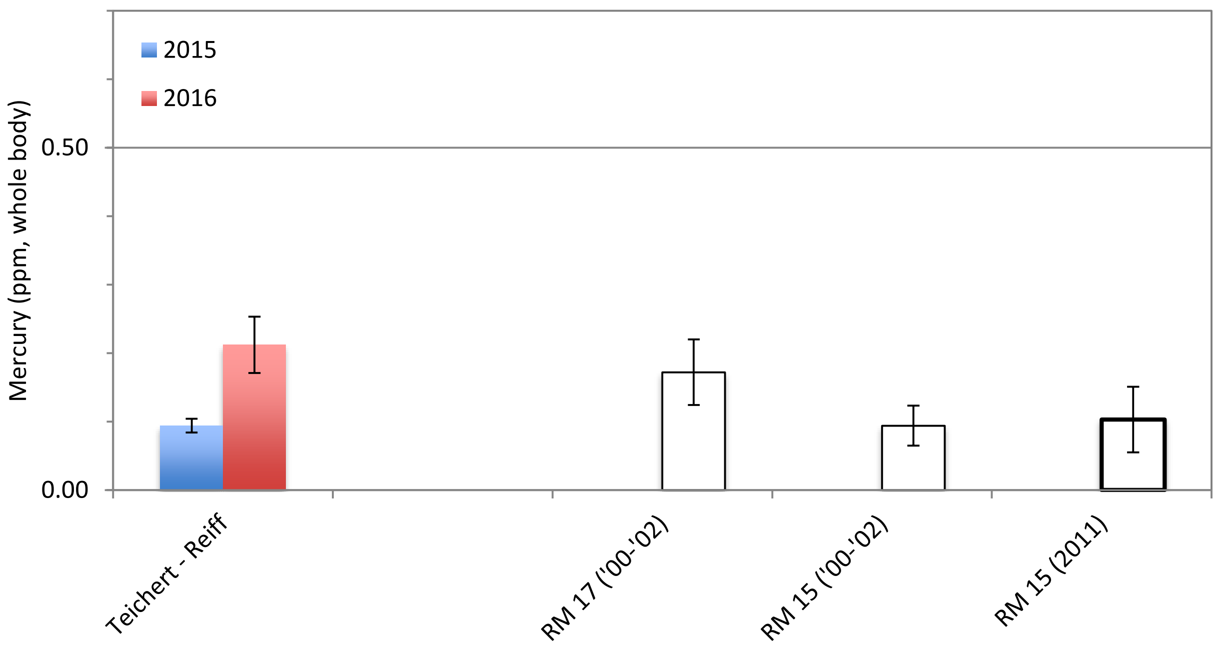


Figure 19. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 20. **Red Shiner summary data, and historic creek comparisons**
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Red Shiners							
Teichert – Reiff Pond	2015	**4**	10	50	1.3	**0.152**	± 0.018
Teichert – Reiff Pond	2016	**4**	10	47	1.1	**0.412**	± 0.084
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**10**	**48**	**1.0**	**0.242**	**± 0.036**
River Mile 20	2000	3	9	42	0.6	0.166	± 0.003
River Mile 17	2000-2002	11	6-15	27-58	0.2-1.8	0.225	± 0.086
River Mile 15	1997	3	19	37	0.5	0.159	± 0.024
River Mile 15	2000-2002	13	6-12	30-60	0.2-2.0	0.131	± 0.033

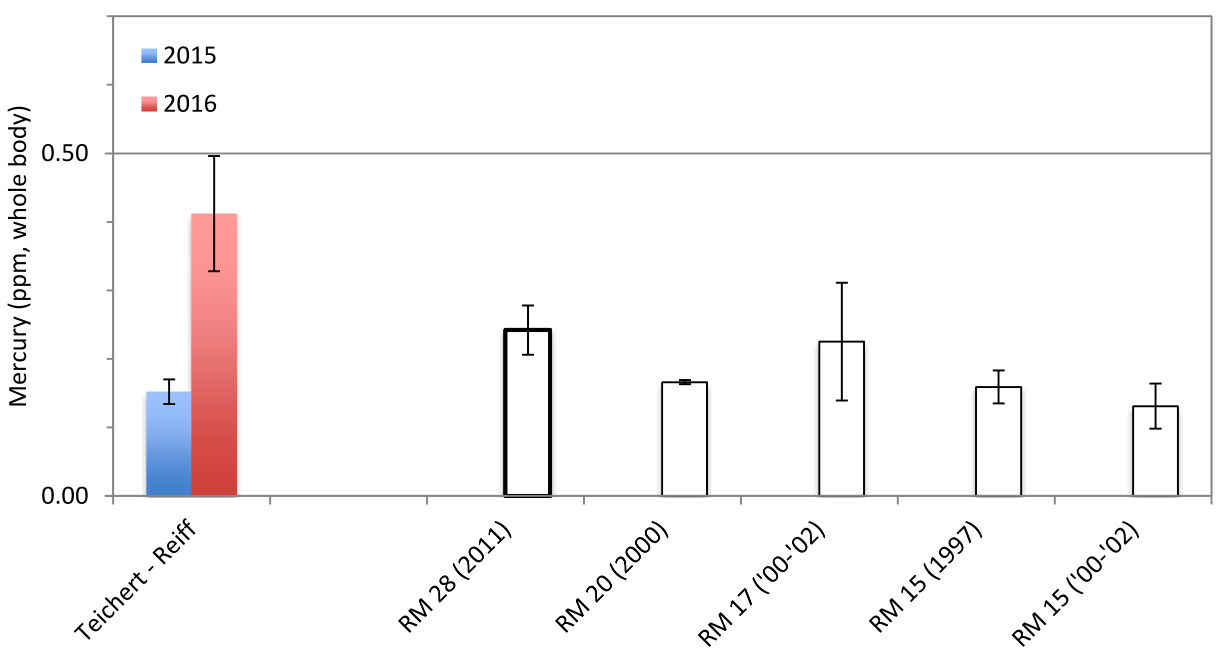


Figure 20. **Red Shiner summary data, and historic creek comparisons**
(means of multiple whole-body, multi-individual composite samples)

Table 21. Juvenile Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Green Sunfish (juveniles)							
Teichert – Reiff Pond	2015	–	1	68	2.7	**0.241**	
Teichert – Reiff Pond	2016	–	–	–	–	–	
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**4**	**53**	**2.8**	**0.139**	**± 0.014**
River Mile 20	**2011**	**4**	**4**	**58**	**3.4**	**0.084**	**± 0.004**
River Mile 17	2000-2002	8	5-10	41-90	1-6	0.169	± 0.045
River Mile 15	2000-2002	8	4-8	40-87	1-6	0.117	± 0.028
River Mile 15	**2011**	**4**	**4-5**	**56**	**3.1**	**0.086**	**± 0.018**

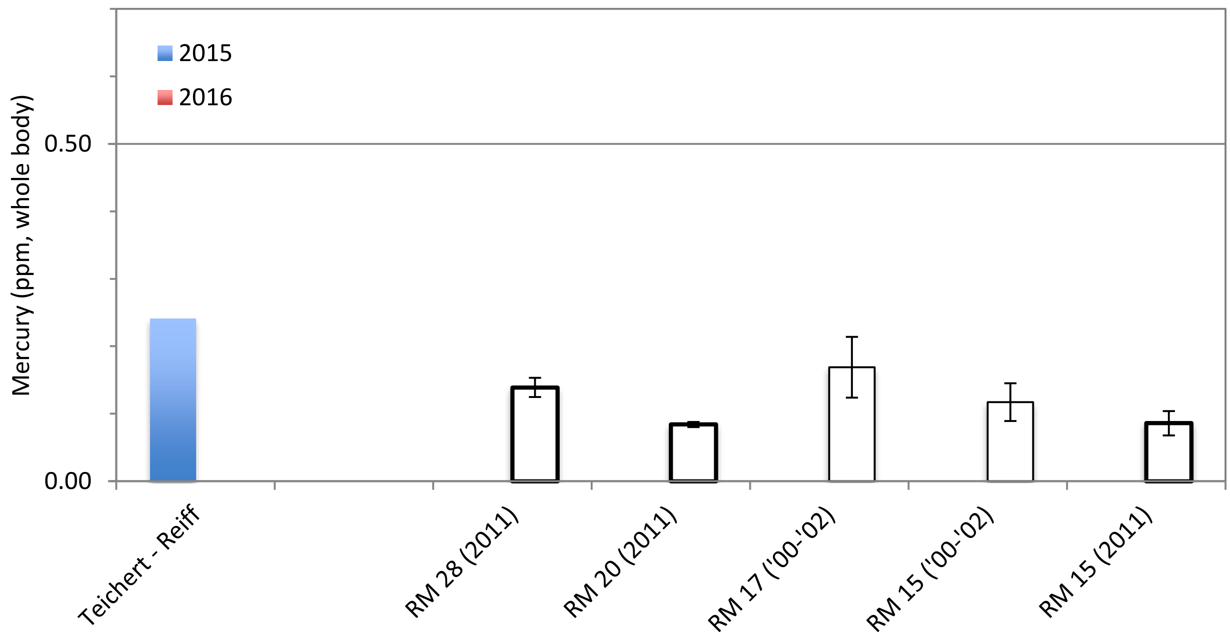


Figure 21. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

4. TEICHERT – STORZ POND

4. TEICHERT – STORZ POND *(Tables 22-23, Figures 22-23)*

This pond is part of the Teichert–Woodland operations, located approximately 7 river miles downstream from the Teichert–Reiff Pond and Esparto Plant. The Storz Pond is south of Cache Creek and just west of County Road 94b, near the Cache Creek Nature Preserve (which is located on the other, north, side of the creek). Our understanding is that it first become a wet pit in 2010-2011. Depth appears to be 10 m (33 feet) or less, though this has not been confirmed. Storz consists of 2 small sub-basins that alternate between being connected and split, depending on rainfall inputs. In Fall 2016, they were separated. Together, they are approximately 150 m x 700 m in size. Teichert graded a good boat-launch into the southwestern sub-basin for us. We spent time on the pond but were unable to locate or collect fish. The shore was steep and thickly vegetated with tule rush, so we were unable to seine. The interior was all too deep to wade. There was no sign of bass, sunfish, or other fish, though they may be present. We shifted our effort to the adjacent sub-basin to the northeast, which we could see was better set up for fish collections. There was no way to get our boat in over a steep perimeter berm at that time, but we were able to wade along the north shore and seine. We collected a good sample of Mosquitofish, (*Gambusia affinis,* 1-2"), which were split into 4 size-class sets of 10 fish each. We were not able to collect additional species at that time. However, we observed several distinctive former nest sites characteristic of Centrarchid fish, the family of bass and sunfish species. We should to be able to collect some of those in future years when we can get boat access to the pond.

The analytical results from each of the mosquitofish composite samples are shown in Table 22 and, graphically, in Figure 22. The data are shown in reduced form (means, error bars) and compared to the most closely comparable historic creek data in Table 23 and Figure 23.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.111-0.365 ppm, averaging 0.229 ppm. Concentrations increased steeply with fish size (Fig. 22). With 2016 being Year 1 of sampling for this pond, there are no same-site comparative data from 2015 as at the other 4 monitored pond sites. The 2016 Storz Pond Mosquitofish average mercury level (0.229

ppm) was higher than the 3 historic sample sets from the creek (0.094-0.172 ppm). The differences were not statistically significant, though this was mainly due to the large change in mercury concentration with size seen in the Storz Pond samples, and the resulting high statistical variability.

Summary

With a single year of partial monitoring information from this pond, it is not at a decision point at this time. Table A4, below, summarizes the statistical comparisons between the Storz Pond mosquitofish and comparable Cache Creek samples, for the data sets with sufficient numbers of fish to compare statistically. The '=' signs indicate 'not statistically differentiable', rather than necessarily identical concentrations.

Table A4. Teichert – Storz Pond Fish Mercury: Statistical comparisons
(for sample sets with enough fish to compare statistically; 95% confidence level)

Fish Species		*vs* *Same Site 2015*	*– vs Baseline and Historic Comparable Cache Creek Data Sets –* RM17 00-02	RM15 00-02	**RM15 2011**
Small, young fish whole body, composite mercury					
Mosquitofish	**2015**	*(not sampled)*			
	2016		=	=	=

Table 22. Teichert – Storz Pond: Small Fish Sampled, Fall 2016
(multi-individual, whole body composite samples)
'**n**' = *number: number of individual fish per composite*

Fish Species	**n** (indivs. in comp)	Av. Fish Length (mm)	(inches)	Av. Fish Weight (g)	(oz)	Whole-Body Mercury (µg/g = ppm, wet wt)
Mosquitofish	**10**	28	1.1	0.21	0.01	**0.111**
Mosquitofish	**10**	32	1.3	0.37	0.01	**0.182**
Mosquitofish	**10**	38	1.5	0.64	0.02	**0.258**
Mosquitofish	**10**	44	1.7	0.90	0.03	**0.365**

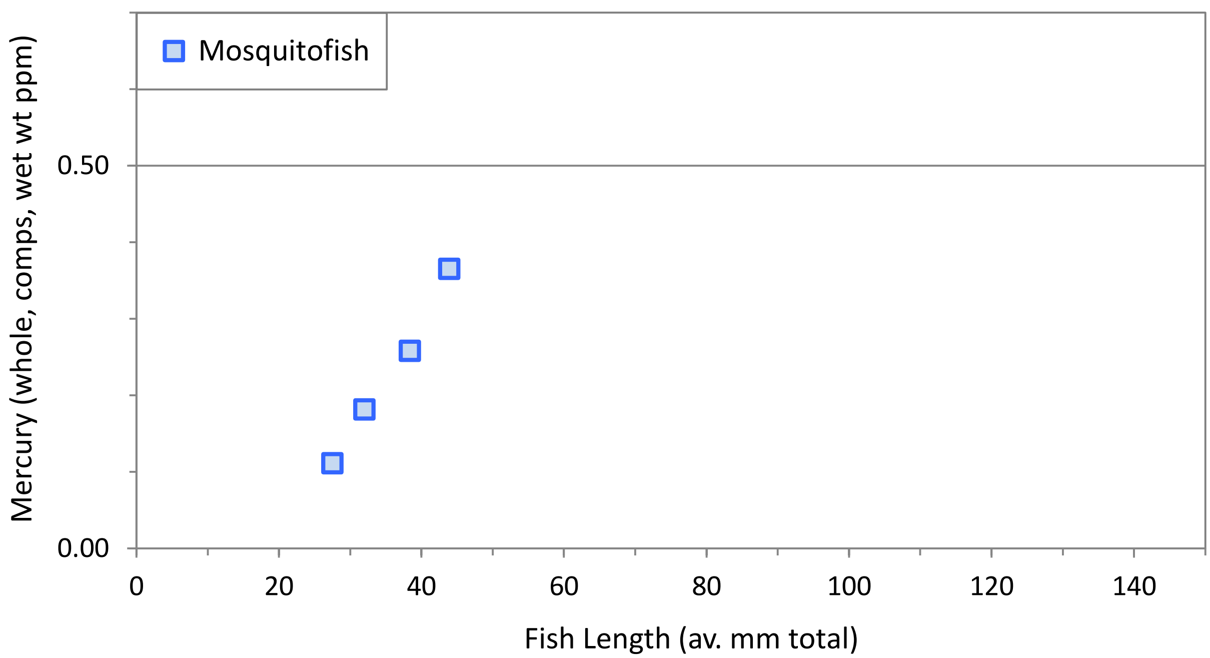


Figure 22. Teichert – Storz Pond: Small Fish Sampled, Fall 2016
(mercury in whole-body, multi-individual composite samples)

Table 23. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Mosquitofish							
Teichert – Storz Pond	2016	**4**	10	35	0.5	**0.229**	± 0.109
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

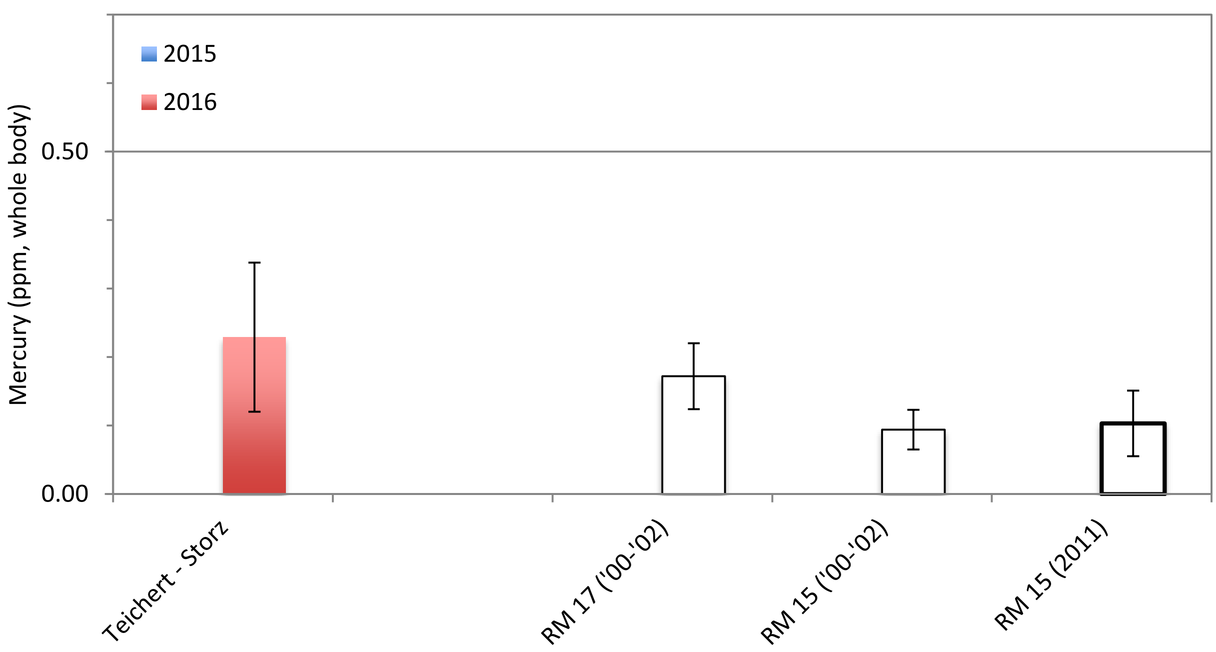


Figure 23. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

5. SYAR – B1 POND

SYAR – B1 POND *(Tables 24-30, Figures 24-30)*

The Syar Cache Creek mining operation, begun before 2002, was not active at the time of this sampling and had been idle since 2011. The site is located south of Cache Creek and west of Highway 505, between 505 and County Road 87. There are two mid-sized basins. One is approximately 300 m x 400 m. The other, located to the east, is an irregular shape about 500 m long x 75-200 m wide. There is a narrow, shallow 400 m long channel that can link the two basins under high rainfall, high water level conditions. This was not the case in 2015-2016 and throughout the previous drought years, when the ponds were independent of each other. We were provided access to the eastern pond of the two, and refer to that as the B1 Pond. It is located in a steep-sided surrounding depression but, under conditions in 2016, as in 2015, depths were relatively shallow, ranging to about 6 m (20 feet).

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 most of the fish species present. These included fillet muscle samples of 20 Largemouth Bass (*Micropterus salmoides*) and a single Green Sunfish (*Lepomis cyanellus*). The small, young-of-year fish present were juvenile Largemouth Bass (2-4"), juvenile Green Sunfish (~2") and Mosquitofish (*Gambusia affinis*, 1-2"). We collected 35 small bass, which were divided into 4 composite samples of 5-10 fish each. The 16 juvenile Green Sunfish taken were put into 4 composite samples of 4 fish each. Mosquitofish were sampled with 4 composite samples of 10 fish each.

In total, 21 large fish muscle samples and 12 young-of-year small fish composite samples, or 33 separate mercury samples, were analyzed from the Syar-B1 Pond in the Fall 2016 monitoring. The analytical results from each individual large fish muscle sample and each small, young-of-year fish composite sample can be seen in Tables 24 and 25 and, graphically, in Figures 24 and 25. Then, for each sample type, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015 results and the most closely comparable historic creek data (Tables 26-30, Figures 26-30).

Large, Angling-sized Fish

Largemouth Bass

The B1 Pond adult Largemouth Bass samples had fillet muscle mercury ranging from 0.824-2.186 ppm, averaging 1.640 ppm. This was virtually identical to the 2015 average (1.628 ppm). These are extremely high fish mercury levels. The 2016 B1 Pond bass remained statistically higher in average mercury than the 7 comparable baseline/historic samples from Cache Creek.

Green Sunfish

The single larger Green Sunfish taken had fillet muscle mercury of 1.446 ppm. This was approximately twice as high as the 2015 average of 0.777 ppm from 10 fish, though, with only the one sample in 2016, statistical comparison is not appropriate. In 2015, the average Green Sunfish mercury was higher than the 4 baseline/historic comparison Green Sunfish data sets from Cache Creek within the Planning Area, statistically significant for 2 of the 4 comparisons. The 2016 individual fish was much higher than the creek averages.

Small, Young Fish

Juvenile Largemouth Bass

The juvenile bass multiple-fish composites had whole-body mercury ranging from 0.352-0.627 ppm, averaging 0.524 ppm. This was down somewhat, relative to samples analyzed in 2015 (0.589 ppm), though the difference was not significant. However, the 2016 samples were much smaller, younger fish, at 3-8 g and 60-88 mm (2.4-3.5"), as compared to the 2015 set which averaged 44 g and 159 mm (6.3"). Relative to baseline juvenile bass comparison data from Cache Creek, they remained significantly higher than the two sample sets available: River Mile 28 (0.142 ppm) and River Mile 15 (0.050 ppm).

Juvenile Green Sunfish

The juvenile Green Sunfish multiple-fish composites had whole-body mercury ranging from 0.346-0.509 ppm, averaging 0.414 ppm. This was up, relative to similar-sized fish analyzed in 2015 (0.325 ppm). The difference was not statistically significant. Relative to baseline juvenile

Green Sunfish comparison numbers from Cache Creek, they remained higher. The difference was statistically significant for the 5 comparisons.

Mosquitofish

We were unable to locate Mosquitofish at the B1 Pond in 2016 despite extensive seining; no samples were collected. In 2015, the Mosquitofish multiple-fish composites had whole-body mercury averaging 0.268 ppm. The 2015 average was higher than the 3 comparable Cache Creek sample sets from River Miles 15 and 17 (0.094-0.172 ppm). The difference was statistically significant for the 3 comparisons.

Summary

In summary, fish mercury in the Syar–B1 Pond remained similar in 2016 to corresponding levels found in 2015. Among sample types with strong collections in both years, adult Largemouth bass were unchanged, juvenile bass were down slightly (though in smaller-sized fish), and juvenile Green Sunfish were up slightly. The differences were not statistically significant. In comparison to corresponding baseline/historic samples from Cache Creek, the B1 Pond fish in 2016 remained significantly higher in mercury. Because of this, and the observation of extensive fishing by nearby Esparto residents at this and the neighboring pond, it is recommended that the neighboring pond be added to the routine monitoring.

Table A5, below, summarizes the statistical comparisons between B1 Pond fish and comparable Cache Creek samples, for the data sets with sufficient numbers of fish to compare statistically.

Table A5. Syar – B1 Pond Fish Mercury: Statistical comparisons
(for sample sets with enough fish to compare statistically; 95% confidence level)

Fish Species	*vs* *Same Site 2015*	*– vs Baseline and Historic Comparable Cache Creek Data Sets –* **RM28 2011**	RM20 2000	**RM20 2011**	RM17 00-02	RM15 1997	RM15 00-02	**RM15 2011**
Large fish fillet muscle mercury								
Largemouth Bass 2015		>	>					>
2016	=	>	>					>
Green Sunfish 2015		>		>				>
2016	*(n=1)* *							
Small, young fish whole body, composite mercury								
Largemouth Bass 2015		>						>
2016	=	>						>
Green Sunfish 2015		>		>	=		>	>
2016	=	>		>	>		>	>
Mosquitofish 2015					=		>	>
2016	*(not available)*							

* *(n=1)* means there was only one fish taken of this species, precluding statistical comparisons

Table 24. Syar – B1 Pond: Large fish sampled, Fall 2016

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	301	11.9	435	1.0	**1.582**
Largemouth Bass	302	11.9	398	0.9	**1.420**
Largemouth Bass	303	11.9	415	0.9	**0.824**
Largemouth Bass	305	12.0	445	1.0	**1.812**
Largemouth Bass	308	12.1	415	0.9	**2.126**
Largemouth Bass	312	12.3	450	1.0	**1.148**
Largemouth Bass	314	12.4	445	1.0	**1.520**
Largemouth Bass	314	12.4	535	1.2	**1.649**
Largemouth Bass	316	12.4	490	1.1	**1.819**
Largemouth Bass	317	12.5	450	1.0	**1.716**
Largemouth Bass	318	12.5	485	1.1	**1.853**
Largemouth Bass	319	12.6	505	1.1	**1.738**
Largemouth Bass	321	12.6	495	1.1	**1.562**
Largemouth Bass	322	12.7	512	1.1	**1.963**
Largemouth Bass	322	12.7	500	1.1	**1.361**
Largemouth Bass	325	12.8	505	1.1	**1.953**
Largemouth Bass	330	13.0	550	1.2	**1.376**
Largemouth Bass	332	13.1	510	1.1	**1.648**
Largemouth Bass	337	13.3	585	1.3	**1.535**
Largemouth Bass	344	13.5	655	1.4	**2.186**
Green Sunfish	83	3.3	31	0.1	**1.446**

Table 25. Syar – B1 Pond: Small Fish Sampled, Fall 2016
(multi-individual, whole body composite samples)
'**n**' = *number: number of individual fish per composite*

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)	**10**	60	2.4	2.96	0.10	**0.558**
Largemouth Bass (juv)	**10**	70	2.7	4.11	0.14	**0.627**
Largemouth Bass (juv)	**10**	78	3.1	5.49	0.19	**0.558**
Largemouth Bass (juv)	**5**	88	3.5	8.38	0.30	**0.352**
Green Sunfish (juv)	**4**	43	1.7	1.11	0.04	**0.360**
Green Sunfish (juv)	**4**	49	1.9	1.77	0.06	**0.346**
Green Sunfish (juv)	**4**	53	2.1	2.34	0.08	**0.442**
Green Sunfish (juv)	**4**	56	2.2	2.56	0.09	**0.509**

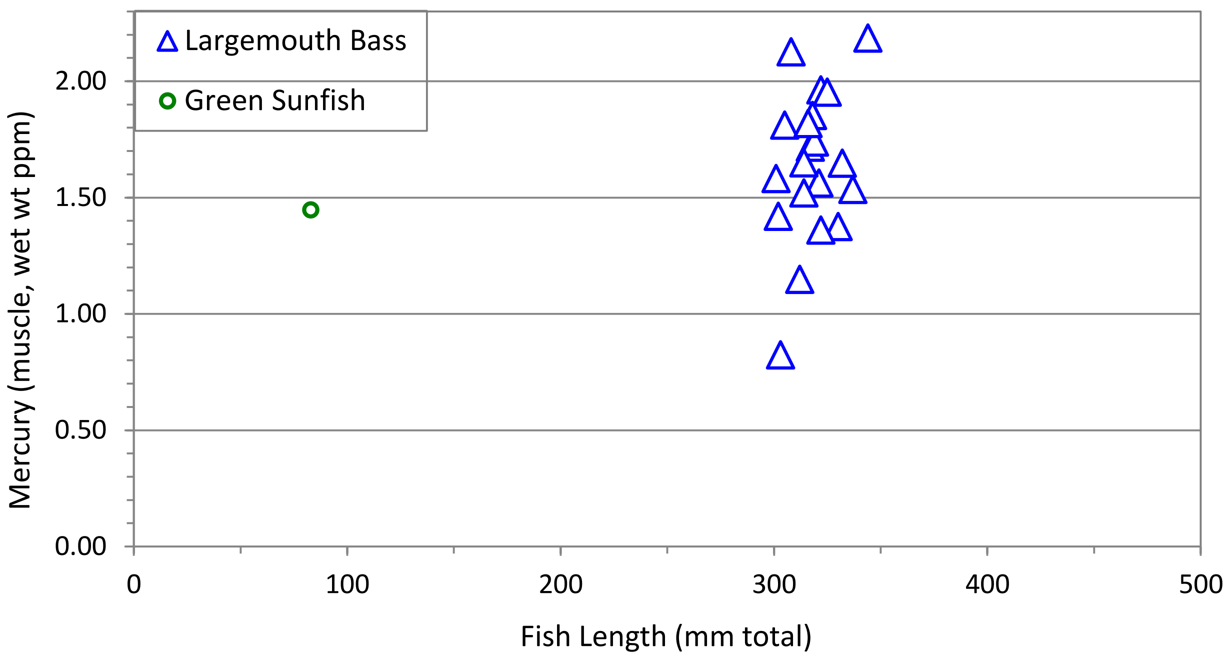


Figure 24. **Syar – B1 Pond: large fish sampled, Fall 2016**
(fillet muscle mercury in individual fish)

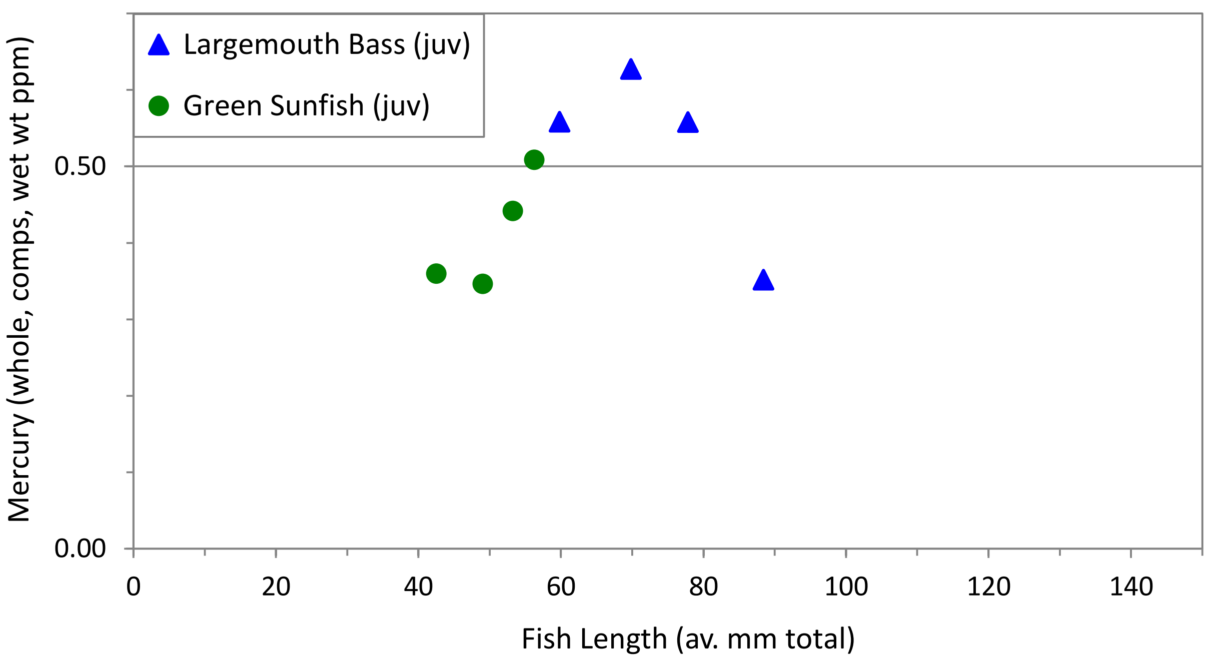


Figure 25. **Syar – B1 Pond: small fish sampled, Fall 2016**
(mercury in whole-body, multi-individual composite samples)

Table 26. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	Std. Dev.
Syar – B1 Pond	2015	**18**	281	355	**1.628**	± 0.332
Syar – B1 Pond	2016	**20**	318	489	**1.640**	± 0.152
Historic/Baseline Data (comparable predatory species)						
Largemouth Bass						
River Mile 28	**2011**	**9**	**199**	**137**	**0.663**	**± 0.116**
Smallmouth Bass						
River Mile 28	**2011**	**7**	**265**	**326**	**0.782**	**± 0.188**
River Mile 20	2000	7	234	183	0.444	± 0.061
River Mile 15	1997	2	383	780	0.939	
Sacramento Pikeminnow						
River Mile 28	**2011**	**10**	**311**	**262**	**0.726**	**± 0.102**
River Mile 20	2000	8	269	147	0.509	± 0.204
River Mile 15	**2011**	**9**	**264**	**145**	**0.327**	**± 0.066**

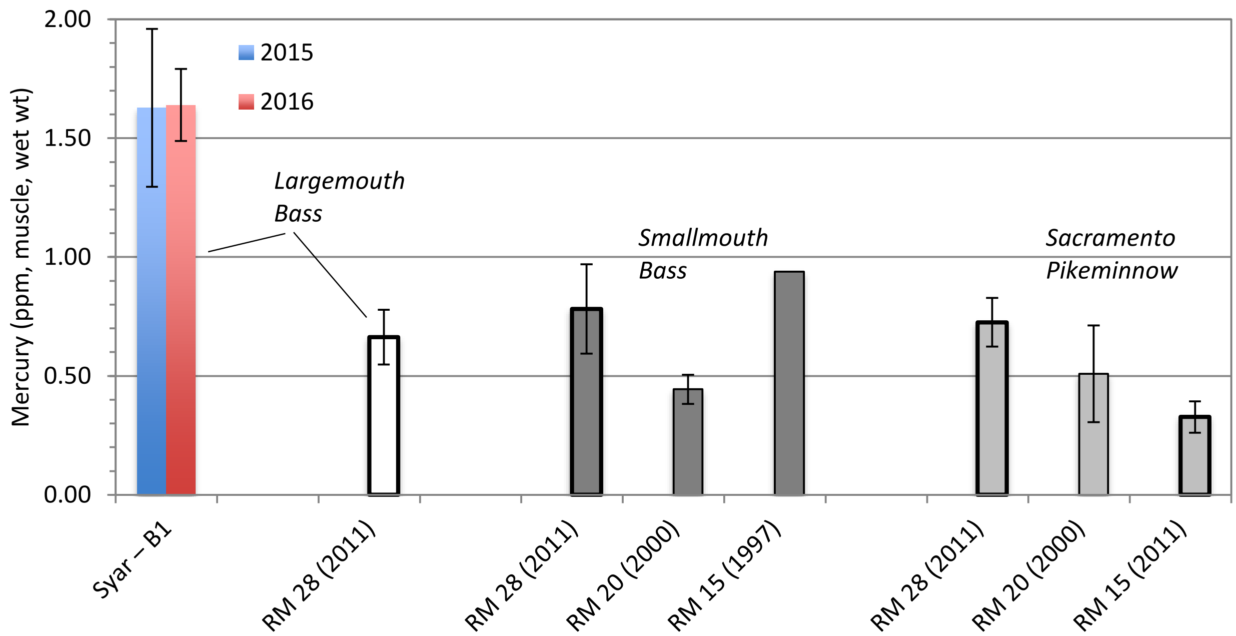


Figure 26. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 27. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	Std. Dev.
Green Sunfish						
Syar – B1 Pond	2015	**10**	118	25	**0.777**	± 0.086
Syar – B1 Pond	2016	**1**	83	12	**1.446**	
Historic/Baseline Data						
River Mile 28	**2011**	**3**	**139**	**47**	**0.540**	**± 0.124**
River Mile 20	2000	4	132	41	0.271	
River Mile 20	**2011**	**10**	**122**	**31**	**0.138**	**± 0.029**
River Mile 15	**2011**	**10**	**133**	**41**	**0.195**	**± 0.031**

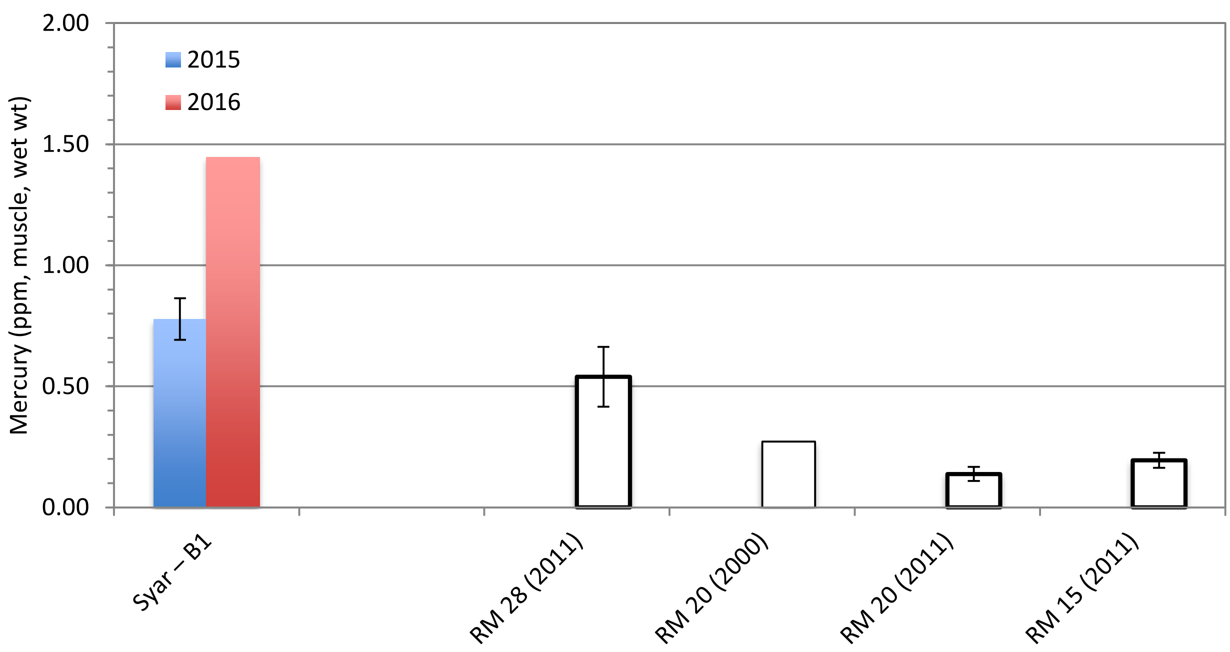


Figure 27. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Small, Young Fish Samples *(note lower concentration scales)*

Table 28. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Largemouth Bass (juveniles)							
Syar – B1 Pond	2015	**4**	7	159	44	**0.589**	± 0.030
Syar – B1 Pond	2016	**4**	10	74	5	**0.524**	± 0.119
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**3-5**	**75**	**6**	**0.142**	**± 0.026**
River Mile 15	**2011**	**3**	**1**	**93**	**10**	**0.050**	**± 0.024**

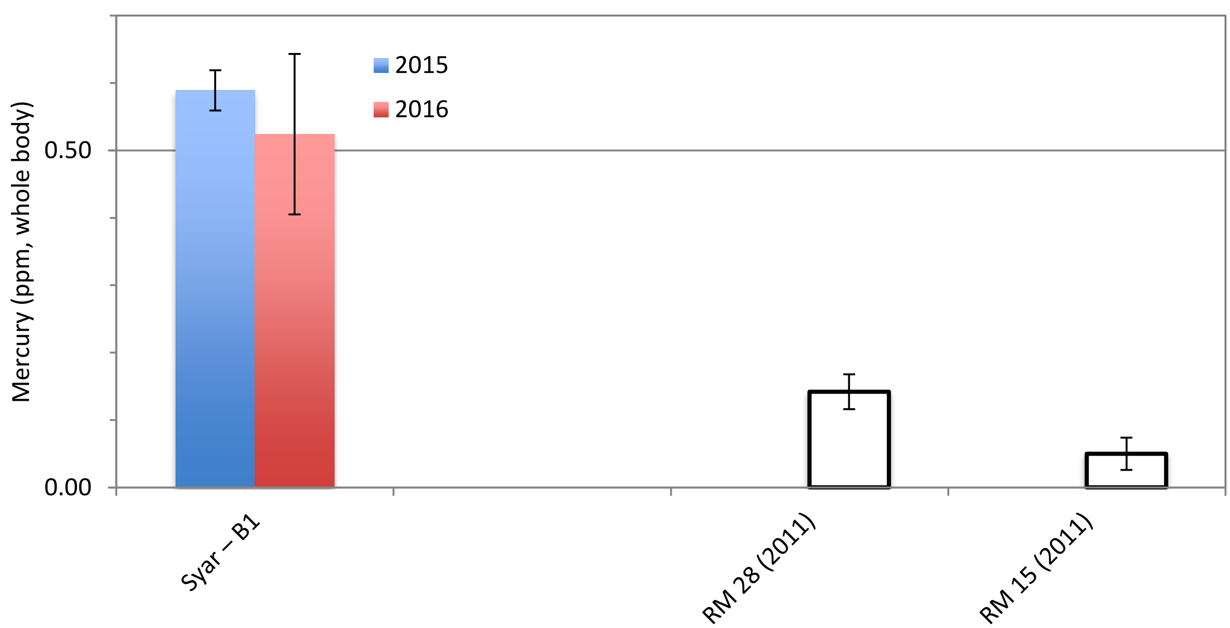


Figure 28. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 29. Juvenile Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Green Sunfish (juveniles)							
Syar – B1 Pond	2015	**4**	8-9	47	1.7	**0.325**	± 0.097
Syar – B1 Pond	2016	**4**	4	50	1.9	**0.414**	± 0.076
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**4**	**53**	**2.8**	**0.139**	**± 0.014**
River Mile 20	**2011**	**4**	**4**	**58**	**3.4**	**0.084**	**± 0.004**
River Mile 17	2000-2002	8	5-10	41-90	1-6	0.169	± 0.045
River Mile 15	2000-2002	8	4-8	40-87	1-6	0.117	± 0.028
River Mile 15	**2011**	**4**	**4-5**	**56**	**3.1**	**0.086**	**± 0.018**

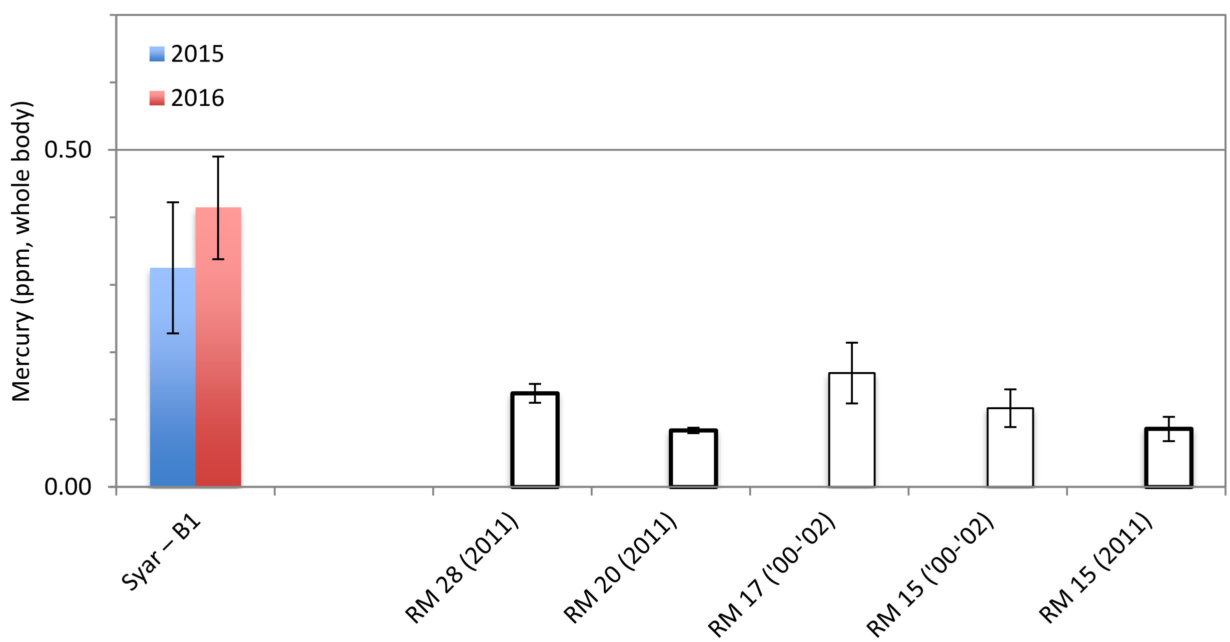


Figure 29. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 30. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	**Year**	**n** (comps)	**n** (inds/ (comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Mosquitofish							
Syar – B1 Pond	2015	**4**	5-10	31	0.3	**0.268**	± 0.043
Syar – B1 Pond	2016	**–**	–	–	–	**–**	
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

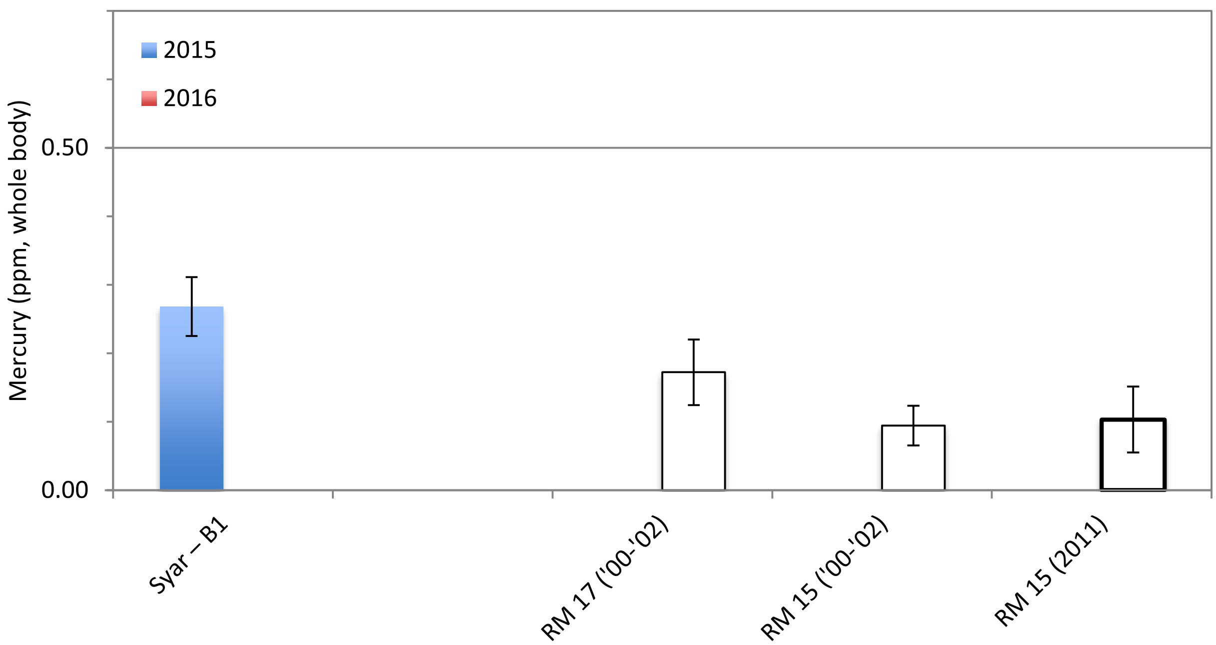


Figure 30. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

6. COMPARISON OF ALL THE MONITORED SITES AND HISTORICAL DATA, BY FISH SPECIES

6. COMPARISON OF ALL THE MONITORED SITES AND HISTORICAL DATA, BY FISH SPECIES

This section is presented to consolidate the monitoring data and place the various averages into relative context. For each sample type, data are presented numerically and graphically, together on the same page (except for adult Largemouth Bass, below, which don't quite fit on one page).

Table 31. Largemouth Bass summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Largemouth Bass						
Cemex – Phase 1 Pond	2015	**18**	305	393	**0.278**	± 0.055
Cemex – Phase 1 Pond	2016	**20**	313	383	**0.350**	± 0.066
Cemex – Phase 3-4 Pond	2015	**20**	344	526	**0.840**	± 0.113
Cemex – Phase 3-4 Pond	2016	**20**	344	557	**0.858**	± 0.139
Syar – B1 Pond	2015	**18**	281	355	**1.628**	± 0.332
Syar – B1 Pond	2016	**20**	318	489	**1.640**	± 0.152
Historic/Baseline Data (comparable predatory species)						
Largemouth Bass						
River Mile 28	**2011**	**9**	**199**	**137**	**0.663**	**± 0.116**
Smallmouth Bass						
River Mile 28	**2011**	**7**	**265**	**326**	**0.782**	**± 0.188**
River Mile 20	2000	7	234	183	0.444	± 0.061
River Mile 15	1997	2	383	780	0.939	
Sacramento Pikeminnow						
River Mile 28	**2011**	**10**	**311**	**262**	**0.726**	**± 0.102**
River Mile 20	2000	8	269	147	0.509	± 0.204
River Mile 15	**2011**	**9**	**264**	**145**	**0.327**	**± 0.066**

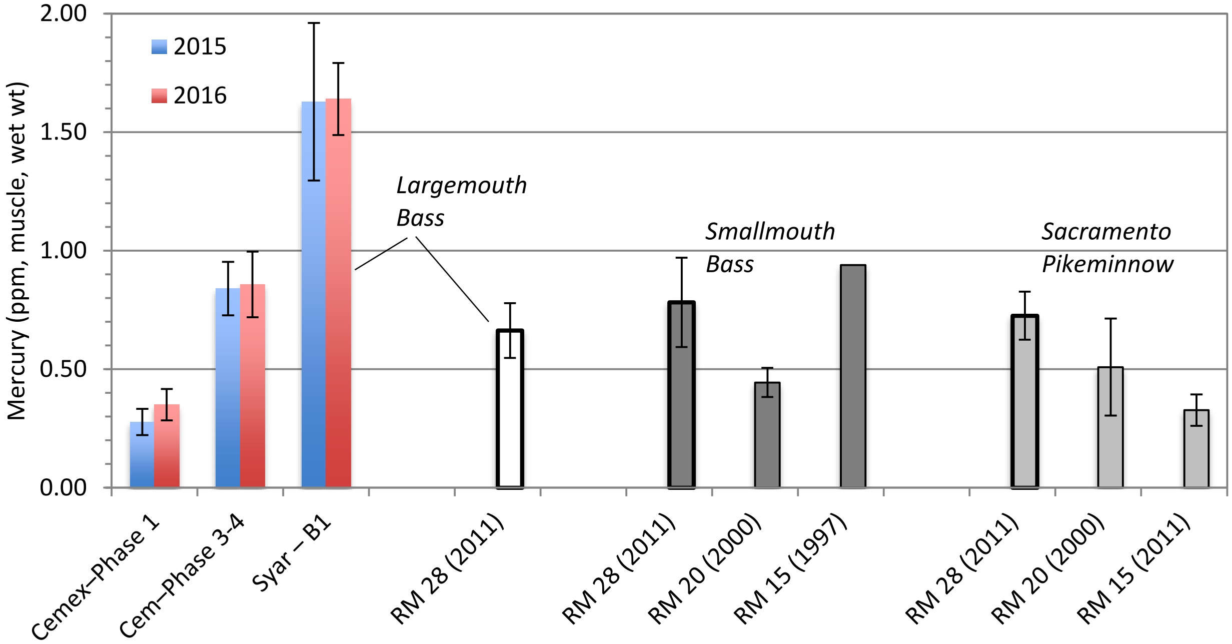


Figure 31. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 32. Catfish summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Channel Catfish						
Cemex – Phase 1 Pond	2015	**2**	595	2,130	**0.198**	
Cemex – Phase 1 Pond	2016	**2**	412	1,150	**0.100**	
White Catfish						
Cemex – Phase 1 Pond	2016	**3**	661	2,900	**0.372**	
Teichert – Reiff Pond	2015	**20**	347	658	**0.737**	± 0.156
Teichert – Reiff Pond	2016	**20**	297	341	**0.996**	± 0.153
Historic/Baseline Data						
Channel Catfish						
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	

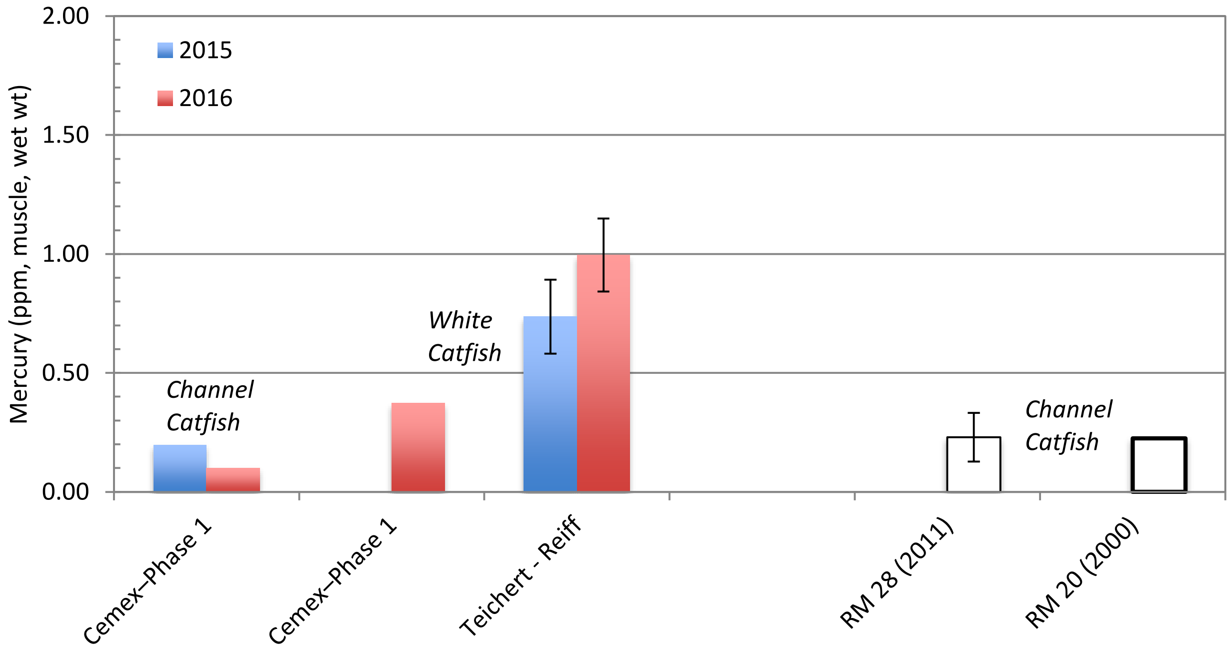


Figure 32. Catfish summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 33. Green Sunfish summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Site	Year	Number of Fish	Av Length (mm total)	Av Weight (grams)	Av Hg (µg/g = ppm, wet wt)	95% C.I.
Green Sunfish						
Cemex – Phase 3-4 Pond	2015	**10**	133	67	**0.534**	± 0.076
Cemex – Phase 3-4 Pond	2016	**1**	101	16	**0.382**	
Teichert – Reiff Pond	2015	**1**	140	40	**0.328**	
Teichert – Reiff Pond	2016	**–**				
Syar – B1 Pond	2015	**10**	118	25	**0.777**	± 0.086
Syar – B1 Pond	2016	**1**	83	12	**1.446**	
Historic/Baseline Data						
River Mile 28	**2011**	**3**	**139**	**47**	**0.540**	**± 0.124**
River Mile 20	2000	4	132	41	0.271	
River Mile 20	**2011**	**10**	**122**	**31**	**0.138**	**± 0.029**
River Mile 15	**2011**	**10**	**133**	**41**	**0.195**	**± 0.031**

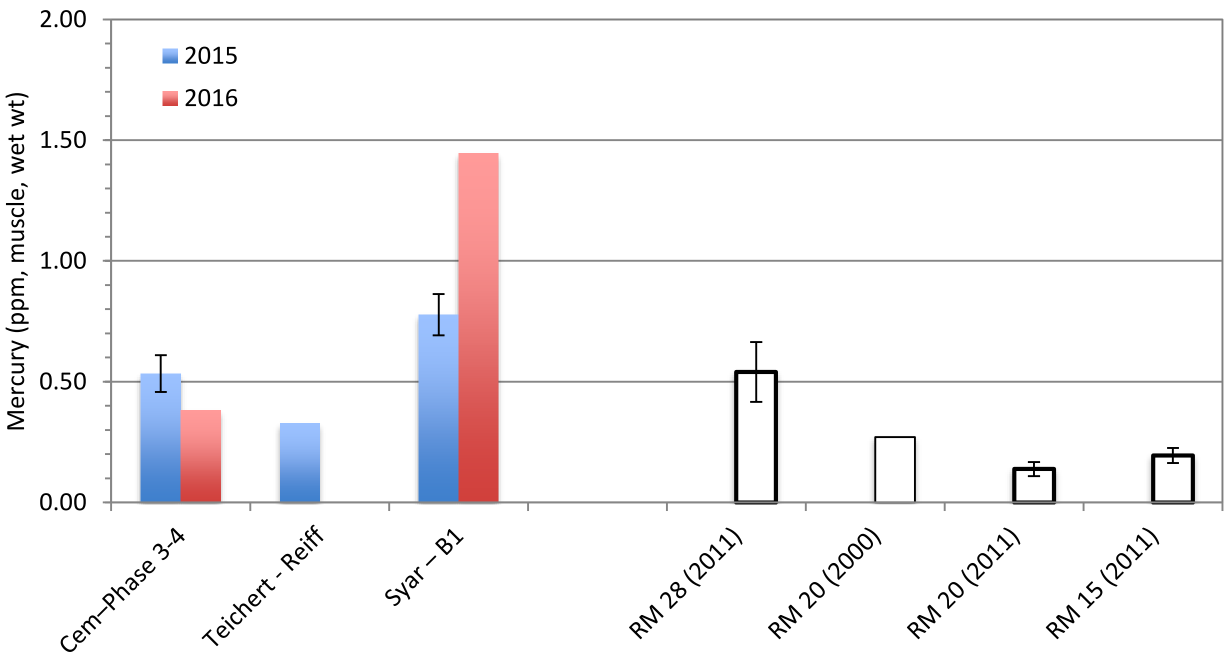


Figure 33. Green Sunfish summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Small, Young-of-Year Fish Samples *(note lower concentration scales)*

Table 34. Juvenile Bass summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	**n** (comps)	**n** (inds/ (comp)	**Av Lgth** (mm total)	**Av Wt** (grams)	**Hg** (µg/g = ppm, wet wt)	**Std. Dev.**
Largemouth Bass (juveniles)							
Cemex – Phase 1 Pond	2015	**4**	8	109	17	**0.044**	± 0.007
Cemex – Phase 1 Pond	2016	**4**	3	102	17	**0.094**	±0.012
Cemex – Phase 3-4 Pond	2015	**4**	7	108	16	**0.334**	± 0.052
Cemex – Phase 3-4 Pond	2016	**4**	2	114	18	**0.372**	±0.053
Syar – B1 Pond	2015	**4**	7	159	44	**0.589**	± 0.030
Syar – B1 Pond	2016	**4**	10	74	5	**0.524**	±0.119
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**3-5**	**75**	**6**	**0.142**	**± 0.026**
River Mile 15	**2011**	**3**	**1**	**93**	**10**	**0.050**	**± 0.024**

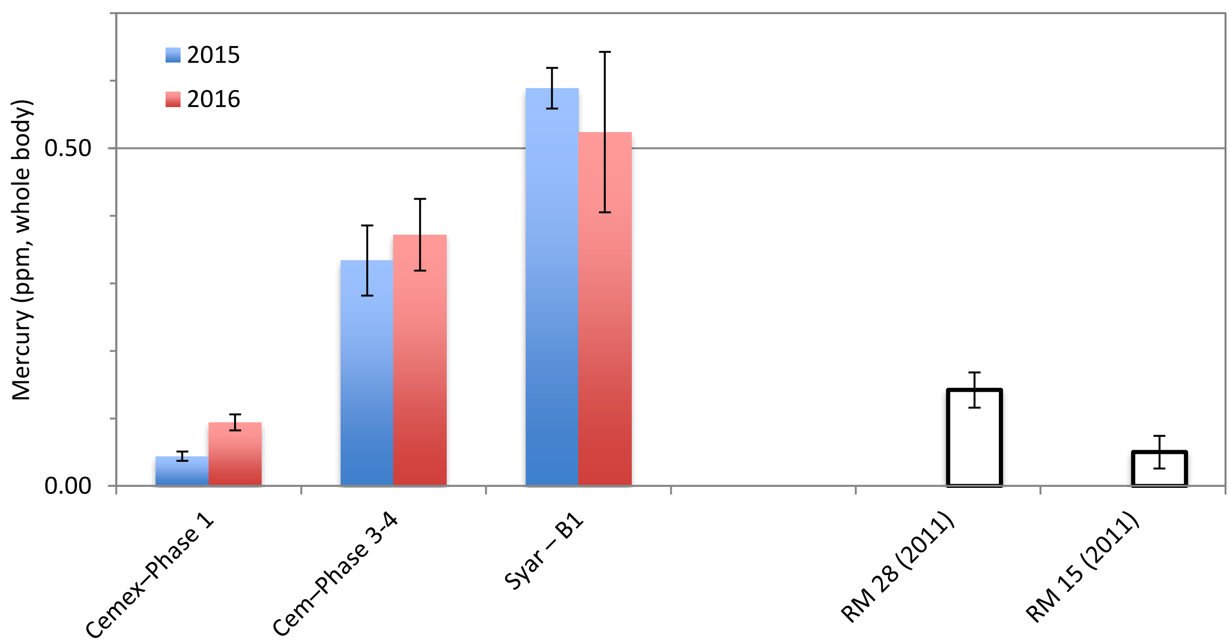


Figure 34. Juvenile Bass summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 35. Juvenile Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Green Sunfish (juveniles)							
Cemex – Phase 3-4 Pond	2015	**4**	10	47	1.8	**0.275**	± 0.022
Cemex – Phase 3-4 Pond	2016	**4**	4-5	49	2.0	**0.233**	± 0.026
Teichert – Reiff Pond		2015	**–**	1	68	2.7	**0.241**
Teichert – Reiff Pond		2016	**–**	–	–	–	**–**
Syar – B1 Pond	2015	**4**	8-9	47	1.7	**0.325**	± 0.097
Syar – B1 Pond	2016	**4**	4	50	1.9	**0.414**	± 0.076
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**4**	**53**	**2.8**	**0.139**	**± 0.014**
River Mile 20	**2011**	**4**	**4**	**58**	**3.4**	**0.084**	**± 0.004**
River Mile 17	2000-2002	8	5-10	41-90	1-6	0.169	± 0.045
River Mile 15	2000-2002	8	4-8	40-87	1-6	0.117	± 0.028
River Mile 15	**2011**	**4**	**4-5**	**56**	**3.1**	**0.086**	**± 0.018**

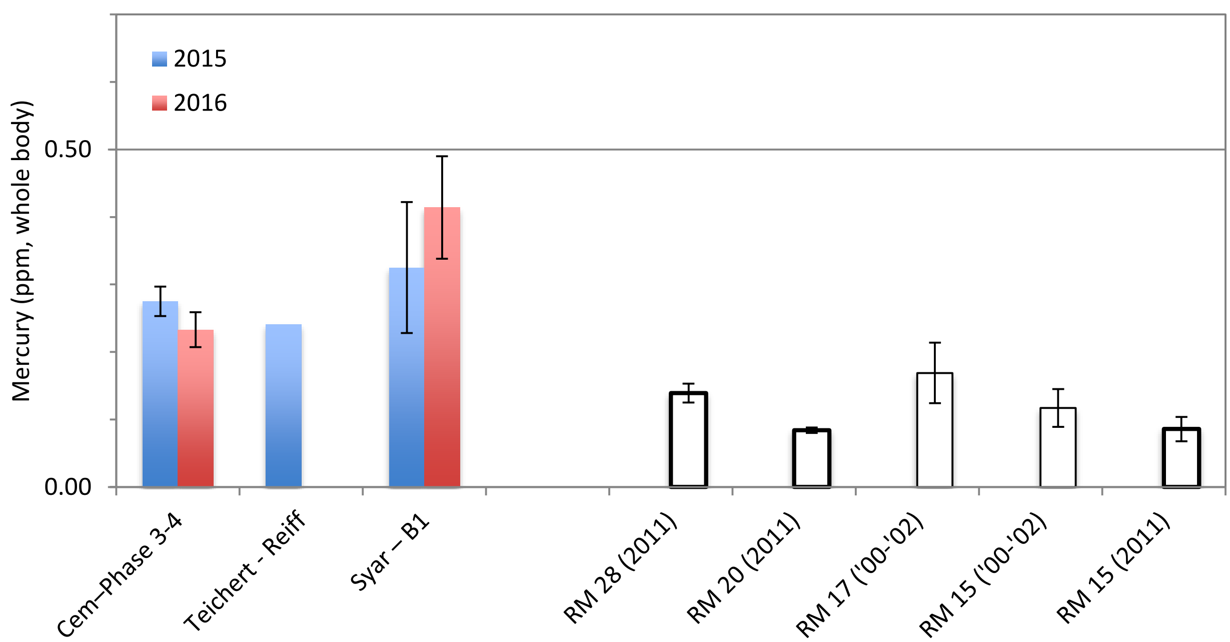


Figure 35. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 36. Mosquitofish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Cemex – Phase 1 Pond	2016	**4**	10	34	0.4	**0.093**	± 0.039
Cemex – Phase 3-4 Pond	2015	**4**	10	37	0.6	**0.228**	± 0.059
Cemex – Phase 3-4 Pond	2016	**4**	10	37	0.6	**0.157**	± 0.037
Teichert – Reiff Pond	2015	**4**	12	38	0.6	**0.094**	± 0.010
Teichert – Reiff Pond	2016	**4**	10	36	0.5	**0.212**	± 0.041
Syar – B1 Pond	2015	**4**	5-10	31	0.3	**0.268**	± 0.043
Syar – B1 Pond	2016	**–**	–	–	–	**–**	
Teichert – **Storz Pond**	2016	**4**	10	35	0.5	**0.229**	± 0.109
Historic/Baseline Data							
River Mile 17	2000-2002	13	5-30	26-47	0.2-1.1	0.172	± 0.048
River Mile 15	2000-2002	10	5-30	26-47	0.2-1.0	0.094	± 0.029
River Mile 15	**2011**	**4**	**1-10**	**37**	**0.7**	**0.103**	**± 0.048**

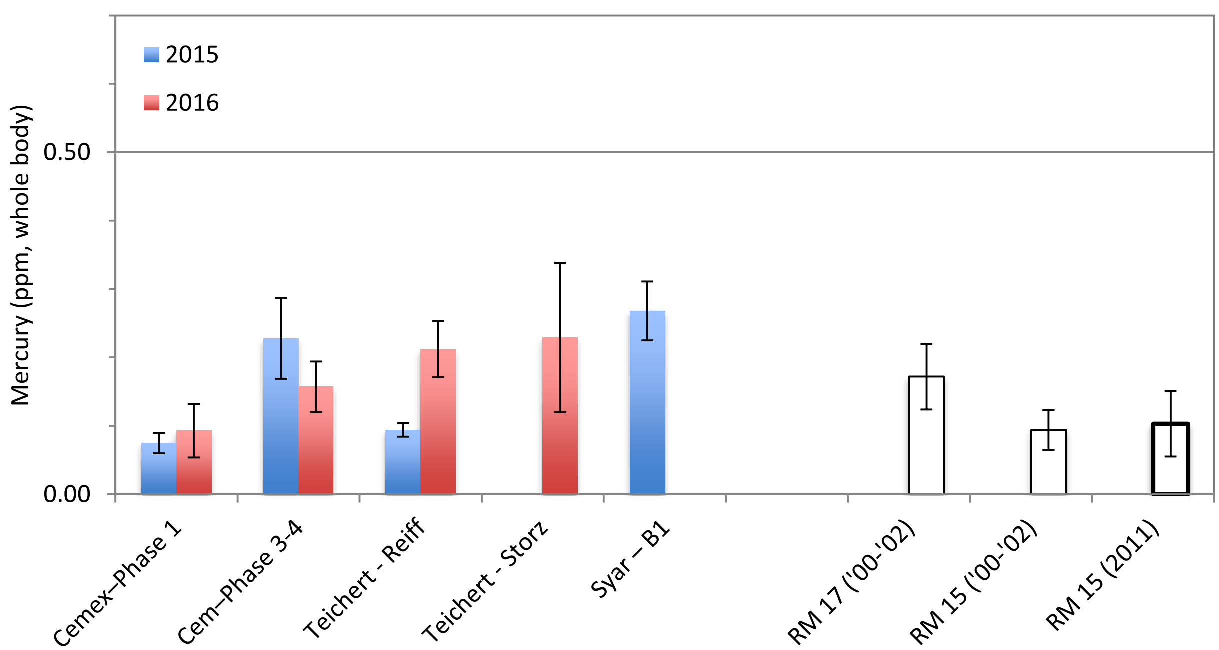


Figure 36. Mosquitofish summary data (all sites), and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 37. Red Shiner summary data (all sites), and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)
'**n**' = *number: number of composite samples; number of individual fish per composite*

Site	Year	n (comps)	n (inds/ (comp)	Av Lgth (mm total)	Av Wt (grams)	Hg (µg/g = ppm, wet wt)	Std. Dev.
Red Shiners							
Teichert – Reiff Pond	2015	**4**	10	50	1.3	**0.152**	± 0.018
Teichert – Reiff Pond	2016	**4**	10	47	1.1	**0.412**	± 0.084
Historic/Baseline Data							
River Mile 28	**2011**	**4**	**10**	**48**	**1.0**	**0.242**	**± 0.036**
River Mile 20	2000	3	9	42	0.6	0.166	± 0.003
River Mile 17	2000-2002	11	6-15	27-58	0.2-1.8	0.225	± 0.086
River Mile 15	1997	3	19	37	0.5	0.159	± 0.024
River Mile 15	2000-2002	13	6-12	30-60	0.2-2.0	0.131	± 0.033

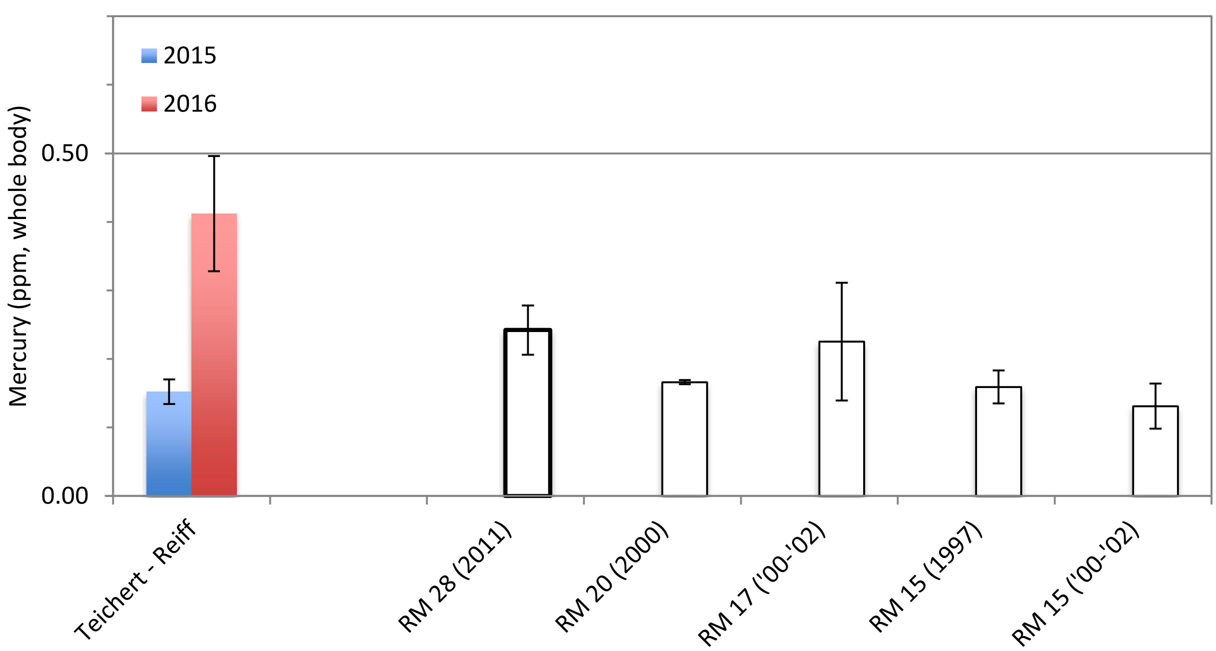


Figure 37. Red Shiner summary data (all sites), and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

DISCUSSION AND CONCLUSIONS

There are now two years of fish mercury monitoring data from 4 of the 6 aggregate mining ponds identified by the County for annual monitoring: Cemex–Phase 1, Cemex–Phase 3-4, Teichert-Reiff, and Syar-B1. The Ordinance calls for action based on two years of data, as follows:

> ***If the average fish specimen mercury content exceeds the statistically verified ambient mercury concentrations for comparable fish species (of similar size) collected within the CCRMP planning area for two (2) consecutive years, wet pit mining on property controlled by the mining operator/owner shall be suspended and the owner/operator shall either:***
>
> ***(g) Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material;***
>
> ***or***
>
> ***(h) Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible and reliable method or reducing methylmercury production or exposure to elevated mercury levels. Potential mitigation could include permanent aeration of the bottom levels of the lake, alteration of the water chemistry (increasing pH or dissolved organic carbon levels), control of anaerobic bacteria populations, or removal and replacement of affected fish populations. The mitigation plan would require review by the Regional Water Quality Control Board, California Department of Fish and Game, and the Yolo County Department of Environmental Health. (The removal and replacement of fish is not intended to be a long-term solution.)***
>
> ***The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)***

One of the 4 ponds – Cemex–Phase 1 – was clearly low in fish mercury, significantly lower than or similar to all corresponding baseline samples from Cache Creek. One pond was clearly elevated – Syar-B1, significantly higher than corresponding baseline samples from the creek.

The other two ponds, Cemex–Phase 3-4 and Teichert-Reiff, were more ambiguous, with a mixture of statistically similar and statistically higher fish mercury levels, relative to creek comparisons.

Taken together for each pond, we interpret these mixed results as averaging to an elevation relative to the creek. We recognize that this is a consequential designation that might be argued differently. Part of the calculation is the fact that the primary large fish in these ponds, Largemouth Bass in Cemex Phase 3-4 and White Catfish in Teichert-Reiff, had average mercury levels of 0.737-0.996 ppm across both sampling years, with individual fish ranging as high as 1.996 ppm. These are very high concentrations, in general and as compared to the 0.500 ppm level indicated as an initial threshold in the Ordinance.

Here are recommendations for moving forward:

1. At this point, maintain mining activities as planned

At two of the identified higher mercury ponds, Syar-B1 and Teichert-Reiff, mining has been discontinued for a number of years, so suspension of activities is probably not an issue. At the third, Cemex Phase 3-4, there has been and continues to be active mining. Initial disturbance of mercury-containing submerged sediments has been linked to temporary increases in methylmercury production and bioaccumulation (e.g. Eggleton and Thomas 2004, Mailman *et al.* 2006). However, in these Yolo County mining ponds, evidence suggests that suspension of mining may not lower the production and bioaccumulation of methylmercury, and could actually increase the problem. It is notable that the highest mercury site, Syar-B1, was idle since 2011 and had the clearest water of the ponds monitored. In contrast, the lowest mercury site, Cemex–Phase 1, received the plant silt and clay slurry from active mining and had the most turbid water. At least two factors linked to methylmercury production and bioavailability may be at play in these systems. First, active mining and slurry inflows likely disrupt warm season water column stratification, keeping active ponds relatively more mixed. This could slow or stop the seasonal development of anoxic bottom water zones and the production and movement of methylmercury into the water column (e.g. Perron *et al.* 2014, Hsu-Kim *et al.* 2018). Second, active mining and slurry inflows put a large amount of silt and clay into the water, resulting in the cloudy appearance. These suspended particles contain surface charges that operate as binding sites for dissolved substances, including mercury. This can remove a fraction of inorganic and methyl mercury from the dissolved state, slowing both production and bioaccumulation (e.g. Rudd and Turner 1983). Water column profiling will help to better understand these processes, and others. In the meantime, observations to-date suggest that suspension of mining may not be helpful and could be counter-productive.

2. Initiate water column profiling

The Ordinance called for water column profiling in each pond, beginning in Year 1 of monitoring. It was decided that this was premature until and unless a problem was identified. At this point, profiling is clearly warranted to help identify factors linked to elevated fish mercury in some ponds and lower mercury in others. We recommend that this work be started at:

– the 1 very elevated mercury pond (Syar-B1),
– the 2 other identified elevated mercury ponds (Teichert-Reiff and Cemex–Phase 3-4),
– the lower mercury Cemex–Phase 1 Pond (for comparison purposes).

This will provide a range of fish mercury conditions to compare water quality results to.

Water column profiling should include a determination of pond bottom depth and sequential water quality data collection at approximately every meter from surface to bottom. A time period of May through October is recommended, in order to follow lake condition across the typical warm season cycle for this region (this is longer than the June-September period listed in the Ordinance). This period could be well characterized with 5 water column profiling events per year, distributed approximately every 6 weeks between early May and late October.

Two key parameters to profile from surface to bottom are temperature and dissolved oxygen, because one of the most important potential mercury issues in ponds and lakes is the phenomenon of warm season thermal stratification (annual physical separation, like oil and water, of sun-warmed upper waters from cool deep waters). This can lead to the depletion of oxygen in the isolated bottom water through normal microbial metabolism, and the production and movement of methylmercury into that anoxic water, and then into the food web. Other important water quality parameters to profile include:

– Conductivity, a measure of dissolved ions
– pH, a measure of how acidic or basic the water is
– ORP, oxidation-reduction potential, which effects chemical reactions
– Suspended Solids and/or Turbidity, measuring particle density in the water

– DOM, Dissolved Organic Matter, closely linked to methylmercury

– Algal density: chlorophyll and/or phycocyanin (blue-green algae)

Nutrient ions like nitrate would also be useful. Results of the profiling may indicate additional water parameters that could be useful to test in the future to help determine appropriate mitigation approaches.

3. Characterize pond bottom sediment

At the ponds being tested for water column parameters, some basic information about the bottom sediments will be essential, to see if there are any large differences between the ponds that could help account for the mercury bioaccumulation patterns. It is recommended, for each pond, that 6 independent bottom samples be taken from locations distributed across the pond, specifically of fine-grained surficial sediments (top 2 cm). These should be analyzed for total mercury and organic matter content, on a dry weight basis. Additional sediment analyses may be warranted in the future to help determine appropriate mitigation approaches.

The Ordinance states that operators of identified elevated-mercury ponds:

(g) Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material; or

(h) Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible and reliable method or reducing methylmercury production or exposure to elevated mercury levels.

A realistic mitigation approach cannot be developed without site-specific information. The above recommended steps should be considered the first phase of mitigation.

The last line of the Ordinance states:

The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)

We now understand that each aquatic system has its own unique mercury dynamics. It is not reasonable to apply one mitigation, like a deep lake thermal destratification technique, to other lakes that have no anoxic bottom waters, etc. Similar water bodies may benefit from the same mitigation approach, but each should be assessed, and mitigated, individually.

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Yolo County Code, Title 10. Chapter 5 (Surface Mining Reclamation), Section 10.5.517. 1996. Mercury Bioaccumulation in Wildlife.

APPENDIX A

Yolo County, CA Code of Ordinances

Sec. 10-5.517. Mercury Bioaccumulation in Wildlife

Yolo County, CA Code of Ordinances.
Sec. 10-5.517. Mercury Bioaccumulation in Wildlife.

Prior to the approval of reclamation of aggregate mining areas to permanent lakes, the County shall commission a sampling and analysis program, to be implemented in one existing wet pit mining area within the OCMP planning area, to evaluate the potential for increased methylmercury production associated with wet pit mining and reclamation of mining areas to permanent lakes. The program shall include the sampling of water and sediments from the bottom of the existing pit and analysis of the samples for organic content; pH; dissolved oxygen content; dissolved carbon content; and total mercury. In addition, samples of predatory fish (preferably largemouth bass) shall be collected and analyzed for mercury and methylmercury content.

If the initial sampling indicates either of the following conditions, the County shall perform verification sampling:

(a) Average concentrations of total mercury in excess of 0.000012 milligrams per liter (mg/l) in the water; and

(b) Average mercury levels in fish samples in excess of 0.5 milligrams per kilogram (mg/kg).

If verification sampling indicates exceedance of these mercury criteria, the County shall approve the reclamation of mining areas to permanent lakes only if the average level of mercury in fish collected from the existing mining pits is shown to be equal to or less than ambient (background) mercury levels determined from a representative sample of similar species of fish (of similar size) collected in the Cache Creek channel within the planning area.

The determination of the ambient mercury level shall be performed by the County prior to the excavation of any new wet pit mine and at years ten (10), twenty (20) and thirty (30) in the permit time period, and shall be paid for by the mining permit operators on a fair-share basis. The County shall evaluate available data to determine any significant change in ambient concentrations of mercury in fish within the Cache Creek channel.

In the event of approval of reclamation of mined areas to permanent lakes, each mining area to be reclaimed to a permanent lake as part of each approved long-range mining plan shall be evaluated annually by the operator for five (5) years after creation of the lake for conditions that could result in significant methylmercury production.

An additional ten (10) years of biennial monitoring shall be performed after reclamation of each lake has been completed.

The evaluations shall be conducted by a qualified aquatic biologist or limnologist acceptable to the County and shall include the following analyses:

(c) Lake condition profiling during the period of June through September, including

measurements of pH; eH (or redox potential); temperature; dissolved oxygen; and total dissolved carbon.

(d) Collection of a representative sample of fish specimens (including a minimum of five (5) predator fish if available) and analysis of the specimens for mercury content. Sampling and analysis shall be conducted using methodologies which are consistent with the California State Water Resources Control Board Toxic Substances Monitoring Program procedures, or more stringent procedures.

(e) The results of the evaluation shall be summarized in a report and submitted to the County. The report shall include a comparison of the site-specific data to available data on the background concentrations of mercury in fish within the Cache Creek watershed. The County shall be responsible for submitting the data on mercury levels in fish to the California Department of Fish and Game and the Office of Environmental Health Hazard Assessment for a determination of whether a fish advisory should be issued.

(f) If a fish advisory is issued, the owner/operator shall be required to post warnings on fences surrounding the mining pit lakes which prohibit fishing in the lakes and describe the fish advisory.

If the average fish specimen mercury content exceeds the statistically verified ambient mercury concentrations for comparable fish species (of similar size) collected within the CCRMP planning area for two (2) consecutive years, wet pit mining on property controlled by the mining operator/owner shall be suspended and the owner/operator shall either:

(g) Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material; or

(h) Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible and reliable method or reducing methylmercury production or exposure to elevated mercury levels. Potential mitigation could include permanent aeration of the bottom levels of the lake, alteration of the water chemistry (increasing pH or dissolved organic carbon levels), control of anaerobic bacteria populations, or removal and replacement of affected fish populations. The mitigation plan would require review by the Regional Water Quality Control Board, California Department of Fish and Game, and the Yolo County Department of Environmental Health. (The removal and replacement of fish is not intended to be a long-term solution.)

The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)

APPENDIX B

Representative Photos of the 2016 Monitoring

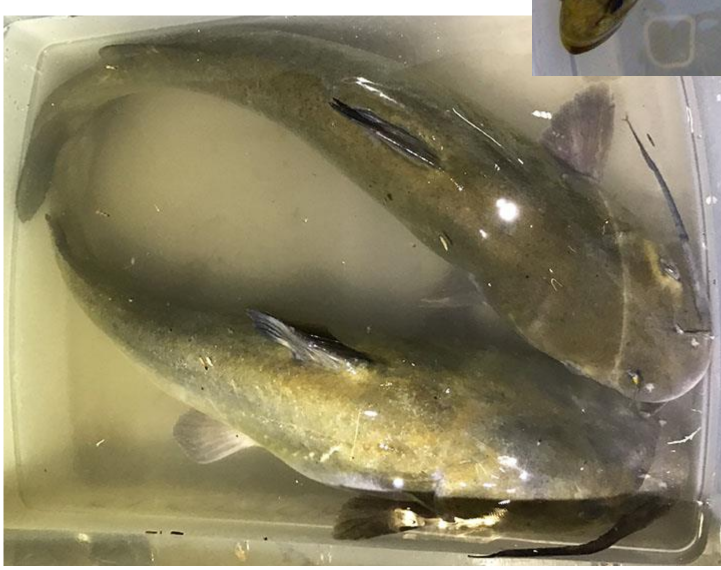
CEMEX – PHASE 1 POND (West)

A1. Seining for small fish

A2. Mosquitofish and juvenile bass

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

A4. Some of the bass samples



A5. Some of the catfish samples

CEMEX – PHASE 3-4 POND (East)

A6. View of pond

A7. Largemouth Bass samples

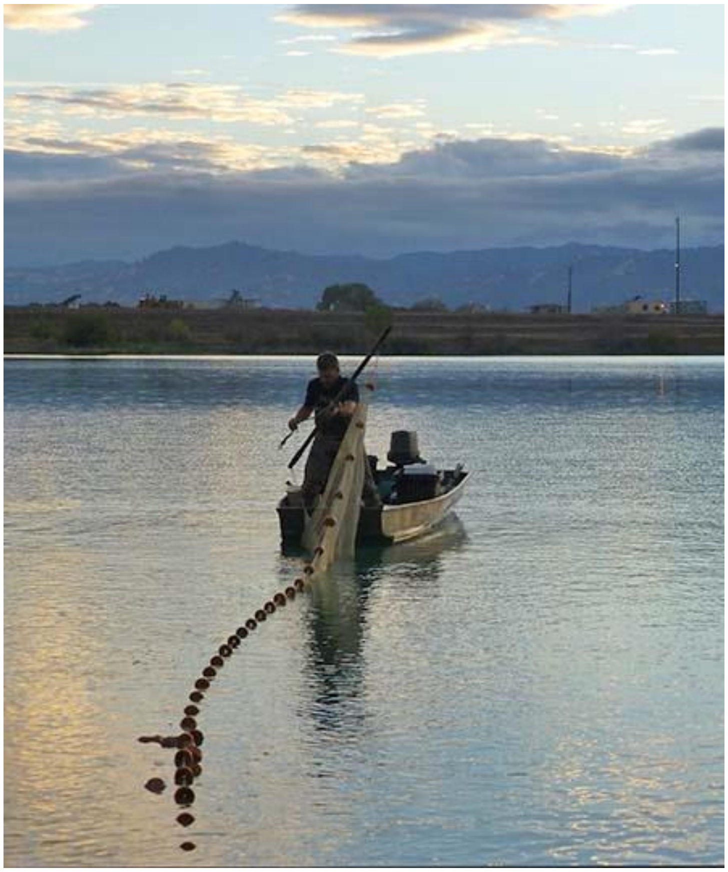
CEMEX – PHASE 3-4 POND (East) *(continued)*

A8. Juvenile Largemouth Bass and Green Sunfish samples

A9. Mosquitofish samples

TEICHERT – REIFF POND

A10. View of pond



A11. Seining

TEICHERT – REIFF POND *(continued)*

A12. White Catfish samples

A13. Mosquitofish and Red Shiner samples

TEICHERT – STORZ POND

A14. View of pond

A15. Mosquitofish

A16. Mosquitofish samples

SYAR – B1 POND

A17. View of pond

A18. Largemouth Bass samples

A19. Small fish samples

SYAR – B1 POND *(continued)*

A20. Juvenile Largemouth Bass samples

A21. Juvenile Green Sunfish samples

FIELD METHODS PHOTOS, etc.

A22. Weighing fish

A23. Measuring fish length

A24. Field dissecting muscle sample

A25. Sampled fish, ready for live return

A26. Analytical muscle samples

A27. Analytical muscle samples

A28. Muscle samples in laboratory

A29. Re-weighing pre-weighed tubes to get exact sample weights

A30-31. Example of 'The Food Chain' in action: Large fish eating a small fish – that was in the process of eating a smaller fish... Cemex Phase 3-4 bass, October 2016