CACHE CREEK OFF-CHANNEL AGGREGATE MINING PONDS – 2018 MERCURY MONITORING

Final Report
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Monitoring and Report by

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SUMMARY OF THE 2018 MONITORING AND ITS FINDINGS

- This Fall 2018 monitoring was the fourth year of fish mercury testing (Year 4) for four off-channel wet pit aggregate mining ponds adjacent to lower Cache Creek between Capay and Woodland: Cemex–Phase 1, Cemex–Phase 3-4, Teichert–Reiff, and Syar–B1 ponds. The monitoring was initiated in 2015. Three other ponds were added to the monitoring program in 2017: Teichert–Mast, Teichert–Storz, and Syar–'West' ponds. For these ponds, 2018 was Year 2 of mercury monitoring. 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.

- With regard to environmental mercury, fish represent the direct potential exposure to human and wildlife fish-consumers. They also provide an ideal measure of relative mercury exposure over time, and for comparison between ponds and Cache Creek. Consequently, the mercury monitoring program for Yolo County aggregate mining ponds focuses on fish.

- A variety of collecting techniques were used to obtain samples of the fish present in each of these ponds, including seines, gill nets, baited setlines, dip nets, and angling. 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 seven identified ponds. A total of 118 adult, angling-sized fish were sampled individually for fillet muscle mercury analysis in this 2018 monitoring. Additionally, a total of 451 small, young, biosentinel fish were split into 89 multi-individual, whole fish composite samples by site, species, and size. These were also analyzed for mercury.

- The new 2018 data were compared with results from 2015-2017, 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 prior years, the ponds sampled in Fall 2018 were found to show distinct, individual mercury signatures that were broadly consistent across the different fish types tested.

- **Some overall take-aways from the results reported here and previously are:**
  - Of the 7 ponds monitored in 2018, 4 have been identified as significantly elevated in fish mercury: Teichert–Reiff, Syar–B1, Cemex–Phase 3-4, and Teichert–Mast.
  - Mercury levels in small/young fish were down significantly in 2018 at all sites.
  - Active mining and/or slurry inflows appear to result in relatively *lower* mercury exposure for fish than undisturbed/unmixed conditions.
  - Future remediation, if needed, may involve some alternate way of mixing the water.

- The **Cemex–Phase 1 Pond** was sampled in 2018 for Largemouth Bass and small, young Green Sunfish and Mosquitofish, plus 1-3 individuals each of Channel Catfish, White Catfish, Green Sunfish, and juvenile bass. The Fall 2018 small fish samples all showed a substantial drop in mercury levels, indicating lower methylmercury exposure levels in the pond. The adult fish, on average, did not demonstrate a decline and instead showed a continuation of the increase in concentrations seen in recent years. However, the smallest/youngest individuals were notably lower in mercury. The general stepwise increase in mercury in all sample types between 2015 and 2017 corresponded to changes in pond operations that, among other things, resulted in less disturbance of the water column, less mixing, and less sediment suspension. The subsequent decline in small fish mercury in 2018 coincided with a resumption of slurry discharges to the pond. We believe that the mixing of the water column and addition of suspended sediment that come with slurry inputs reduced both the production and the bioavailability of methylmercury. Despite some relative increases in recent years, the Cemex–Phase 1 Pond remained the lowest in fish mercury, overall, of the ponds being monitored at this time. Concentrations were statistically similar to or lower than all corresponding baseline Cache Creek samples of similar size. The Phase 1 Pond was therefore *not* found to be "elevated over baseline in 2 or more consecutive years", which would trigger consideration of mercury remediation, with seasonal water column profiling as a first step. However, the overall low mercury status of this pond made it a key comparison for remediation insights for the elevated ponds. Water column profiling and testing of bottom sediments were initiated in 2018.

- The **Cemex–Phase 3-4 Pond** was sampled in 2018 for adult Largemouth Bass and small, young Green Sunfish and Mosquitofish. This was Year 4 of fish mercury monitoring. Fish mercury in the Phase 3-4 Pond, while remaining relatively high, showed a decrease in all sample types in 2018, from 2017. The changes were not statistically significant. Overall fish mercury at this pond remained elevated over comparable creek baseline samples for the majority of sample types. The adult bass, in particular, stayed at levels well above consumption guidelines. As this pond was found to be relatively "elevated over baseline in 2 or more consecutive years", it triggered consideration of mercury remediation. The first stage of remediation is to obtain additional water quality information, through seasonal water column profiling of a range of relevant constituents and collection of bottom sediments. That work was initiated in 2018.

- The **Teichert–Reiff Pond** was sampled in 2018 for Largemouth Bass and small, young Red Shiners, Mosquitofish, Largemouth Bass, and Green Sunfish. We were unable to collect White Catfish or Carp due to access problems in November. This was Year 4 of fish mercury monitoring. The Reiff Pond in 2018 remained highly elevated in mercury. All of the various fish samples were significantly higher in mercury than corresponding Cache Creek baseline samples. Largemouth Bass were up from 2017 and averaged about 2.0 ppm. However, young-of-year fish showed a decline, suggesting a possible leveling off or drop in general methylmercury exposure levels. In any case, the pond remained solidly in the "elevated over baseline" category and was recommended for collection of additional information to help guide remediation. Water column profiling and collection of bottom sediment samples began in May 2018. All of the Reiff Pond fish mercury trends were consistent with a rising trend in general methylmercury exposure (to the fish) between 2015 and 2017, with indication of a leveling off or decline in 2018. Just as at the Cemex–Phase 1 Pond, this trajectory coincided with a very similar pattern of pond management at Reiff. Similar to Cemex–Phase 1, the Reiff Pond has been the recipient of slurry discharge from nearby active mining. As at Cemex–Phase 1, this discharge was heavy in 2015 and declined to essentially no inputs in 2017, ramping back up partially in 2018. We think it is likely that the steady increase in fish mercury seen at both ponds between 2015 and 2017, and the subsequent tailing off or decline in 2018, was related to these management changes.

- The **Teichert–Mast Pond** was sampled for the first time in 2017. 2018 was Year 2 of fish mercury monitoring. Mast Pond continued to have a single fish species present, Mosquitofish. Samples in 2018 within the standard size ranges all showed a large drop in mercury levels, relative to 2017. However, in comparison to baseline Cache Creek Mosquitofish samples, the 2018 samples were still significantly elevated over 2 of the 3 creek data sets available and statistically similar to one. The Mast record was therefore elevated, on average, "over baseline in 2 or more consecutive years" (2017, 2018) and triggers remediation considerations at this time. It is recommended that water column profiling and sediment sampling be done at Mast to obtain more information. Due to an absence of predatory large fish at Mast, the Mosquitofish were able to attain some much larger sizes than at the other monitored ponds. Samples were taken; they were higher in mercury than the standard sizes, as expected. Interestingly, beyond 45 mm (1.8"), they all had nearly identical concentrations.

- The **Teichert–Storz Pond** was sampled for the first time in 2016, with a partial small fish collection made without the use of a boat. 2018 was Year 2 of full fish mercury monitoring. The fish community consisted of Largemouth Bass and Mosquitofish. We collected good samples of each. The primary, large fish sample of bass had mercury similar to 2017 and within the historic range of comparable baseline creek fish. Storz was second lowest in bass mercury of the 6 monitored ponds that contained bass. The Mosquitofish small fish composite samples showed a large drop from 2017, to levels at or below all baseline creek comparisons. This indicates a 2018 reduction in general methylmercury exposure levels in the water. That may result in a decline in large fish mercury next year. This pond continues to rank as "not elevated over baseline".

- The **Syar–B1 Pond** was sampled in 2018 for adult Largemouth Bass and small, young Largemouth Bass, Green Sunfish, and Mosquitofish. This was Year 4 of fish mercury monitoring. Fish mercury remained lower than in 2015-2016, after a substantial decline in 2017. Largemouth Bass remained down from previous (very high) levels, by more than 40%. Juvenile bass and Green Sunfish also remained at reduced levels similar to 2017. Mosquitofish showed a significant decline over 2017. In comparison to corresponding baseline/historic samples from Cache Creek, the B1 Pond juvenile bass were still significantly higher in mercury, despite recent declines. Juvenile Green Sunfish remained significantly higher than 4 of 5 comparisons. Mosquitofish, however, dropped to a range statistically similar to all 3 baseline creek comparisons. Adult bass, which had previously been significantly higher than all available baseline creek comparisons, were at a level statistically similar to 4 of 7 comparison sets. They remained significantly higher than 3 of the 7. On average, the site remained elevated over baseline. Because of the overall status as "elevated over baseline in 2 or more consecutive years", water column profiling and collection of bottom sediments was started here in 2018.

- The **Syar–West Pond** was sampled for the first time in 2017. 2018 was Year 2 of fish mercury monitoring, as per the ordinance. Collections in 2018 included Largemouth Bass and small, young Largemouth Bass, Green Sunfish, and Mosquitofish. The 3 small fish indicator species all showed a large, statistically significant drop in mercury levels between 2017 and 2018, indicating reduced methylmercury exposure levels in the water in 2018. The adult bass also dropped in average concentrations, though the change was not statistically significant. In comparison to corresponding baseline/historic samples from Cache Creek, the West Pond small fish in 2018 were statistically similar to or significantly lower in mercury for 11 of 12 comparisons. The juvenile bass were significantly higher than one baseline comparison. The adult Largemouth Bass were statistically similar to 5 of the 7 baseline comparison data sets and remained significantly higher than 2 of 7. The main cohort of 2018 bass at or below about 350 mm (14") were not significantly higher in mercury than any of the corresponding creek samples. Therefore, despite an "elevated above baseline" status in 2017, the Syar–West Pond fish were not "elevated over baseline for 2 or more consecutive years" and do not trigger remediation considerations at this time.

- For ponds found to have higher fish mercury, in general, than corresponding samples from Cache Creek for 2 or more consecutive 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 three identified elevated mercury ponds (Syar–B1 and Teichert–Reiff), as well as the identified lower mercury Cemex–Phase 1 Pond, are not currently being mined, so mining suspension there is not a current issue. Active mining at the Cemex Phase 3-4 Pond was also suspended previously but we believe it resumed sometime in 2018.

- Findings of this monitoring program indicate that active mining and/or slurry inflows within ponds apparently *lowers* methylmercury levels for fish. We recommended that cessation of mining not be used as a mitigation response.

- As a first phase of mitigation, it was recommended that additional information first be collected, to guide potential strategies. This includes testing bottom sediments and initiating a water column profiling program. After initial fish monitoring identified some of the ponds as elevated in fish mercury relative to the creek in 2 or more years, it was recommended that this work be started at the 3 identified higher mercury ponds, as well as at the identified lower mercury Cemex–Phase 1 pond. Specialized sampling equipment was obtained and water column profiling was conducted throughout May-Oct 2018, together with bottom sediment testing, to investigate what may be driving the high fish mercury levels at some locations and lower levels at others. If these factors can be better understood, it will help in the development of realistic mercury reduction strategies for the elevated mercury sites. Water and sediment results will be presented in accompanying, separate reports.

INTRODUCTION

This monitoring was conducted for Yolo County in the fall of 2018, 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, as in the previous years, we will first 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. Note that in December 2019 the County adopted a comprehensive update to the CCAP, which includes a revision of this code section. Future mercury monitoring and reporting will comply with the updated ordinance requirements. The 2018 monitoring work, though, was governed by the existing 1996 code. Below, 1996 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). In 2015 and 2016, we were unable to access Teichert–Mast or Teichert-Storz. Monitoring at these ponds, together with a 7th pond, Syar–West, commenced in 2017. Locations of the 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 recommended by this research team that lake profiling of relevant water column parameters should be conducted *if* significantly elevated fish mercury was found in subject ponds in repeated years.

(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 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 at four ponds: Cemex–Phase 1, Cemex–Phase 3-4, Teichert–Reiff, and Syar–B1. Results and discussion of the first-year work can be found in Slotton and Ayers (2017). Since that time, monitoring has continued at the original 4 ponds and, beginning in 2017, the program was extended to include 3 additional ponds: Teichert–Mast, Teichert–Storz, and Syar–West. Results can be found in annual reports for 2016 and 2017. The most recent work, reported here, was conducted in Fall 2018.

(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 was advised to initiate this action, based on the 2 years of fish monitoring data available after 2016, and posting was done.

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)

Two of the three identified elevated mercury ponds (Syar–B1 and Teichert–Reiff) as well as the identified lower mercury Cemex–Phase 1 Pond are not being mined, so mining suspension at these locations is not a current issue. In any case, the Ordinance guidance to immediately discontinue mining if elevated fish mercury is found appears to not be protective as intended. Results from the fish monitoring to-date indicate that cessation of mining and/or slurry inputs leads to *increased* concentrations. We recommended, therefore, that mining cessation not be used as an immediate response.

As a first phase of developing a mitigation plan, it was recommended that additional information first be collected, to guide potential remediation strategies. This includes testing bottom sediments and initiating a water column profiling program, as noted above. After initial fish monitoring identified some of the ponds as elevated in fish mercury relative to the creek in 2 or more years, it was recommended that this work be started at the 3 identified higher mercury ponds, as well as at the identified lower mercury Cemex–Phase 1 Pond. Specialized sampling equipment was obtained and water column profiling was conducted throughout May-Oct 2018, together with bottom sediment testing, to investigate what may be driving the high fish mercury levels at some locations and lower levels at others. If these factors can be better understood, it will help in the development of realistic mercury reduction strategies for the elevated mercury sites. Water and sediment results will be presented in accompanying, separate reports.

As fish constitute the most straightforward, clear measure of methylmercury exposure and bioaccumulation in aquatic systems, this monitoring focuses on fish. All seven of the currently identified ponds (Table A, Figure A) were monitored for fish mercury in 2018. Four of the ponds have been monitored since 2015 and, for them, this was Year 4 of sampling: Cemex–Phase 1, Cemex–Phase 3-4, Teichert–Reiff, and Syar–B1. Three additional ponds were added to the monitoring in 2017; for these, 2018 was Year 2: Teichert–Mast, Teichert–Storz, and Syar–West. In 2018, all seven ponds were successfully sampled for fish. Both large and small fish samples of multiple species, as available, were collected and analyzed from 6 of the 7 ponds. At the Mast Pond, large species were again absent, but we were able to collect good samples of Mosquitofish.

The purpose of this report is to present the new 2018 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 found in adjacent Cache Creek. This will help guide pond management, future reclamation and, if necessary, remediation.

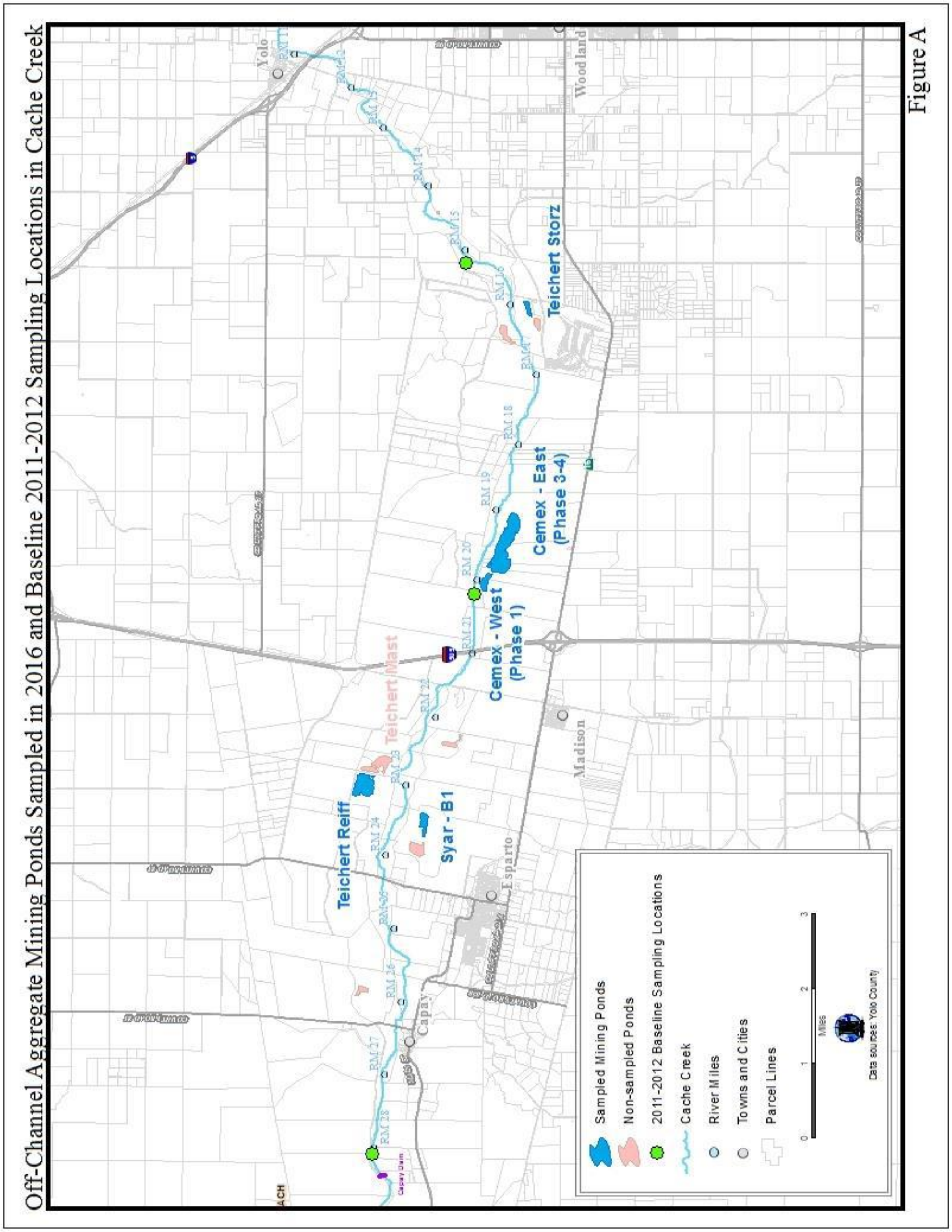
The factors that influence the production of methylmercury and its uptake by fish are complex and can change from one year to the next, often leading to a range of fish mercury levels over time rather than some absolute value. Because of this, the Ordinance states that multiple years of data are needed to make assessments. So, another objective is to compare this year's data (2018) with monitoring results found at the same sites in the previous monitoring years (2015-2017).

Following, below, are the methods we used and a presentation of the 2018 fish mercury data, by individual pond site. Each data table is accompanied by a matching figure with the same number that graphically shows the information. For each site, we first present the analytical results from each individual large fish sample and each small fish composite sample. Then we show the new data in reduced form (means, error bars, etc.) for each sample type and compare to 2015-2017 same-site 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 River Mile 15 (RM15), RM20, and RM28, which were conducted specifically to provide comparable samples for the pond monitoring, as possible. In the data tables and figures, the 2011 Baseline comparison data are highlighted with bold text and outlines. 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 Cache Creek watershed that included some fish collections in the study zone.

After individual reporting sections for each pond, a final data section consolidates summary results for each fish type, from all the sites and baseline comparisons. 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 1996 Ordinance text is attached, without commentary, as Appendix A. Appendix B includes photos of the Fall 2018 fish mercury 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	Year Monitoring Began	Monitoring Year in Fall 2018
Cemex	Madison	**Phase 1**	< 1996	Lake and habitat	2015	Year 4
Cemex	Madison	**Phase 3-4**	≤ 2002	Lake and habitat	2015	Year 4
Teichert	Esparto	**Reiff**	≤ 2002	Lake and habitat	2015	Year 4
Teichert	Esparto	**Mast**	2007-2008	Lake and habitat	2017	Year 2
Teichert	Woodland	**Storz**	2010-2011	Lake and habitat	2016 (partial)	Year 2
Syar	Madison	**B1**	≤ 2002	Lake and habitat	2015	Year 4
Syar	Madison	**West**	≤ 2002	Lake and habitat	2017	Year 2


Off-Channel Aggregate Mining Ponds Sampled in 2016 and Baseline 2011-2012 Sampling Locations in Cache Creek
Figure A
Yolo
Woodland
Madison
Esparto
Capay
Teichert Storz
Cemex - East (Phase 3-4)
Cemex - West (Phase 1)
Teichert Mast
Teichert Reiff
Syar - B1
Sampled Mining Ponds
Non-sampled Ponds
2011-2012 Baseline Sampling Locations
Cache Creek
River Miles
Towns and Cities
Parcel Lines
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.

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 2018 RESULTS

1. CEMEX–PHASE 1 (West) POND

1. CEMEX–PHASE I (West) POND *(Tables 1-8, Figures 1-8)*

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 bowl that is app. 400 m long and 150 m wide. In 2018, depths ranged between 6 and 7 m (20-23 feet). This pond went through some changes over the recent years of monitoring. Active mining was still underway in 2015, the first monitoring year. In 2016 there was little or no mining in the pond itself, but it continued to receive the silt and clay slurry effluent of the general plant operations, so the water was very turbid. In 2017, our understanding was that active mining was on hold at both Cemex ponds, so there was less slurry effluent to the Phase 1 Pond. During 2018, active mining resumed at other locations (Phase 3-4 Pond etc), with process effluent discharging to the Phase 1 Pond. This (2018) was Year 4 of monitoring at this site.

We sampled the pond during day, twilight, and night conditions with a full range of techniques, and were able to obtain samples of the fish species available. Large, angling-sized fish taken included: 20 Largemouth Bass (*Micropterus salmoides*), 3 Channel Catfish (*Ictalurus punctatus*), 1 White Catfish (*Ameiurus catus*), and 1 Green Sunfish (*Lepomis cyanellus*). The small fish present were Mosquitofish (1-2", *Gambusia affinis*), and juvenile Green Sunfish (1-3"). Four multi-individual composite samples were analyzed for each of these small fish species, plus a single sample of juvenile Largemouth Bass (3").

In total, this added up to 25 large fish muscle samples and 9 composite small fish samples, 34 separate fish mercury samples, analyzed from the Cemex–Phase 1 Pond in the Fall 2018 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 2015-2017 results and the most closely comparable historic creek data (Tables 3-8, Figures 3-8).

Large, Angling-sized Fish

Largemouth Bass

The Phase 1 Pond adult Bass samples had fillet muscle mercury ranging from 0.202-1.071 ppm, averaging 0.481 ppm. This was up from 2017 (0.393 ppm). Though generally low overall, bass at this pond have shown a steady, stepwise increase in mercury since 2015 (0.278 ppm). These year-to-year changes were not statistically significant at the 95% level of confidence, but they indicate an incremental rise in bass mercury in the Phase 1 Pond in recent years that, in total, has been significant. Concentrations generally increased with fish size, as is typical. Similar to the previous annual collections, the 2018 bass samples ranged in size between 250 and 380 mm (about 10-15"). Adult Bass represent the top predator fish in this region and will typically have the highest mercury levels at any given site. Even with the general increase over the past several years, the Phase 1 Pond bass remained lower in mercury than 4 of 7 similar baseline/historic samples from Cache Creek (and statistically lower than the River Mile 28 site). As noted in the previous reports, the Phase 1 (West) Pond bass were among the lower mercury top predator fish samples we have collected in California across many studies. Although the overall concentrations remained relatively low, the gradual increases seen between 2015 and 2018 may provide evidence of some of the factors influencing fish mercury exposure in the aggregate mining ponds. The gradual increases in bass mercury uptake corresponded to changes in mining practices at this site: from active mining plus slurry inputs, to slurry only, to no mining or slurry and, recently, back to slurry inputs.

Channel Catfish

Three Channel Catfish were taken. Two large fish (24-25", 6.0-6.2 pounds) had fillet muscle mercury of 0.376 and 0.551 ppm. A much smaller individual (14", 0.9 pound) was considerably lower at 0.083 ppm. Together, the three samples averaged 0.337 ppm. This was higher than in previous years (0.100-0.236 ppm) though with only 2-3 samples in each year, the difference could not be assessed statistically. Across the four years of monitoring to date, Channel Catfish mercury was within a range similar to the baseline comparison catfish taken at River Mile 28 and River Mile 20. Note that the Phase 1 Pond Channel Catfish, averaging 1,673 g (3.7 pounds) across the 4 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

A single White Catfish was taken, 398 mm (16") in length and 1,115 g (2.5 pounds) in weight. Fillet muscle mercury was 0.571 ppm. This was higher than the average from prior years and higher than the creek comparisons, though the difference cannot be assessed statistically with a single sample. As noted above for Channel Catfish, the Phase 1 Pond White Catfish was 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.

Green Sunfish

A single adult Green Sunfish was taken, 200 mm (8") in length and 165 g (0.4 pounds) in weight. Fillet muscle mercury was 0.227 ppm, similar to the average of last year's fish (0.273 ppm). This range was also similar to most of the creek samples and lower than the River Mile 28 comparison fish, though, with a single sample, statistical comparisons cannot be made.

Small, Young Fish

Juvenile Largemouth Bass

The single juvenile bass sample had whole-body mercury 0.068 ppm. In contrast with the adult fish, this was markedly lower than the 2017 average (0.146 ppm). With a single sample, statistical comparisons cannot be made.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.054-0.127 ppm, averaging 0.083 ppm. As seen in the above juvenile bass, this was a substantial, and statistically significant, decrease from 2017 (0.135 ppm). The 2018 Mosquitofish average was lower than comparable Cache Creek samples from River Miles 15 and 17 (0.094-0.172 ppm), significantly lower than the River Mile 17 samples.

Juvenile Green Sunfish

The juvenile Green Sunfish composites had whole-body mercury ranging from 0.023-0.043 ppm, averaging 0.035 ppm. This represented a large, and statistically significant, decline in concentrations from 2017 (0.118 ppm). It was also significantly lower than all of the baseline juvenile Green Sunfish comparison numbers from Cache Creek (0.084-0.169 ppm).

Summary

The Cemex–Phase 1 Pond fish mercury results provide a fascinating example of apparent change in exposure levels, and the resulting same-year effects on small, young fish versus large, older adults. Mercury levels in the bodies of large, adult fish are an average, a mixture of the mercury taken in throughout the multiple years of their lives. If mercury exposure conditions for the fish change, even radically, the overall change in the fish will be averaged into the levels already accumulated. It will take several years at the changed exposure level for any change to become obvious. In contrast, small, young-of-year fish are direct indicators of mercury exposure conditions in the year sampled, because that is the only time they have accumulated their mercury. If exposure levels are high one year, that year's young will be high. If exposure is low the next year, that year's young will be low. There is no averaging with previous conditions, because the fish were not present before the recent time. Each year's new cohort can show changes, if they occur, much more distinctly than the large fish. The Fall 2018 small fish samples all showed a substantial drop in mercury levels relative to 2017, clearly indicating lower methylmercury exposure levels in the pond, at least during the preceding several summer months.

The adult bass and catfish samples, on average, did *not* demonstrate a decline and instead showed a continuation of the general increase in concentrations over recent years. We suspect that if the current apparent lower exposure conditions hold, we will see a leveling off and/or the beginning of a decline in large fish mercury levels next year as well, as the apparent lower mercury conditions are averaged in. It is notable that, of the large fish sampled in 2018, the smallest/youngest individuals were much lower in mercury (Figure 1). It can be seen that the bass under 300 mm (12") clustered under 0.500 ppm and the smaller Channel Catfish was much lower in mercury than the larger pair. These younger fish were influenced proportionally more by recent conditions (the recent year was a larger proportion of their lives than for older fish).

The general increase in mercury in all sample types between 2015 and 2017 corresponded to changes in pond operations that, among other things, resulted in less disturbance of the water column, less mixing, and less sediment suspension. The subsequent decline in small fish mercury in 2018 coincided with a resumption of slurry discharges to the pond. We believe that these were related and that the mixing of the water column and addition of suspended sediment that come with slurry inputs reduced both the production and the bioavailability of methylmercury for fish. A very similar trend was seen at the Teichert Reiff Pond.

Despite some relative ups and downs in recent years, the Cemex–Phase 1 Pond remained the lowest in fish mercury, overall, of the ponds being monitored at this time. Concentrations were statistically similar to or lower than all corresponding baseline Cache Creek samples of similar size. The Phase 1 Pond was therefore not found to be "elevated for two or more consecutive years", which therefore did not result in a triggering of seasonal water column profiling and consideration of mercury remediation. However, the overall low mercury status of this pond, and the interesting changes over the years monitored, made it a key comparison for remediation insights for the elevated ponds. Water column profiling and testing of bottom sediments were initiated in 2018 to provide additional information (and will be separately presented in accompanying reports).

Table 1. Cemex–Phase 1 (West) Pond: Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	253	10.0	200	0.4	**0.227**
Largemouth Bass	257	10.1	225	0.5	**0.219**
Largemouth Bass	260	10.2	230	0.5	**0.226**
Largemouth Bass	263	10.4	255	0.6	**0.202**
Largemouth Bass	264	10.4	235	0.5	**0.309**
Largemouth Bass	269	10.6	235	0.5	**0.257**
Largemouth Bass	273	10.7	248	0.5	**0.306**
Largemouth Bass	276	10.9	255	0.6	**0.326**
Largemouth Bass	278	10.9	255	0.6	**0.369**
Largemouth Bass	282	11.1	265	0.6	**0.306**
Largemouth Bass	284	11.2	260	0.6	**0.432**
Largemouth Bass	287	11.3	275	0.6	**0.262**
Largemouth Bass	288	11.3	305	0.7	**0.377**
Largemouth Bass	325	12.8	360	0.8	**0.828**
Largemouth Bass	328	12.9	420	0.9	**0.650**
Largemouth Bass	334	13.1	430	0.9	**0.756**
Largemouth Bass	341	13.4	530	1.2	**0.720**
Largemouth Bass	342	13.5	435	1.0	**0.940**
Largemouth Bass	366	14.4	600	1.3	**0.836**
Largemouth Bass	380	15.0	605	1.3	**1.071**
Green Sunfish	200	7.9	165	0.4	**0.227**
White Catfish	398	15.7	1,115	2.5	**0.571**
Channel Catfish	354	13.9	420	0.9	**0.083**
Channel Catfish	610	24.0	2,800	6.2	**0.551**
Channel Catfish	635	25.0	2,700	6.0	**0.376**

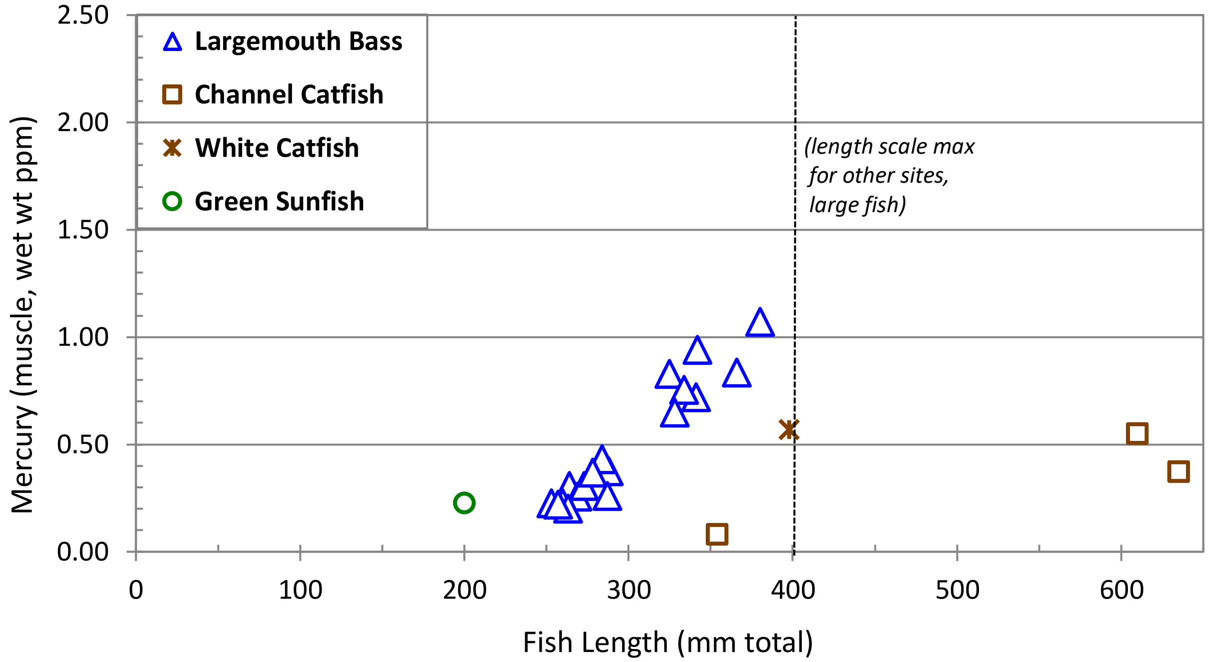


Figure 1. **Cemex–Phase 1 (West) Pond: Large fish sampled, Fall 2018**
(fillet muscle mercury in individual fish)

Table 2. Cemex–Phase 1 (West) Pond: Small Fish Sampled, Fall 2018
(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)	**1**	78	3.1	6.09	0.21	**0.068**
Green Sunfish (juv)	**1**	40	1.6	1.02	0.04	**0.033**
Green Sunfish (juv)	**2**	48	1.9	0.45	0.02	**0.041**
Green Sunfish (juv)	**2**	51	2.0	1.99	0.07	**0.023**
Green Sunfish (juv)	**2**	67	2.6	4.95	0.17	**0.043**
Mosquitofish	**10**	28	1.1	0.20	0.01	**0.054**
Mosquitofish	**10**	32	1.3	0.34	0.01	**0.069**
Mosquitofish	**10**	36	1.4	0.51	0.02	**0.082**
Mosquitofish	**6**	42	1.6	0.81	0.03	**0.127**

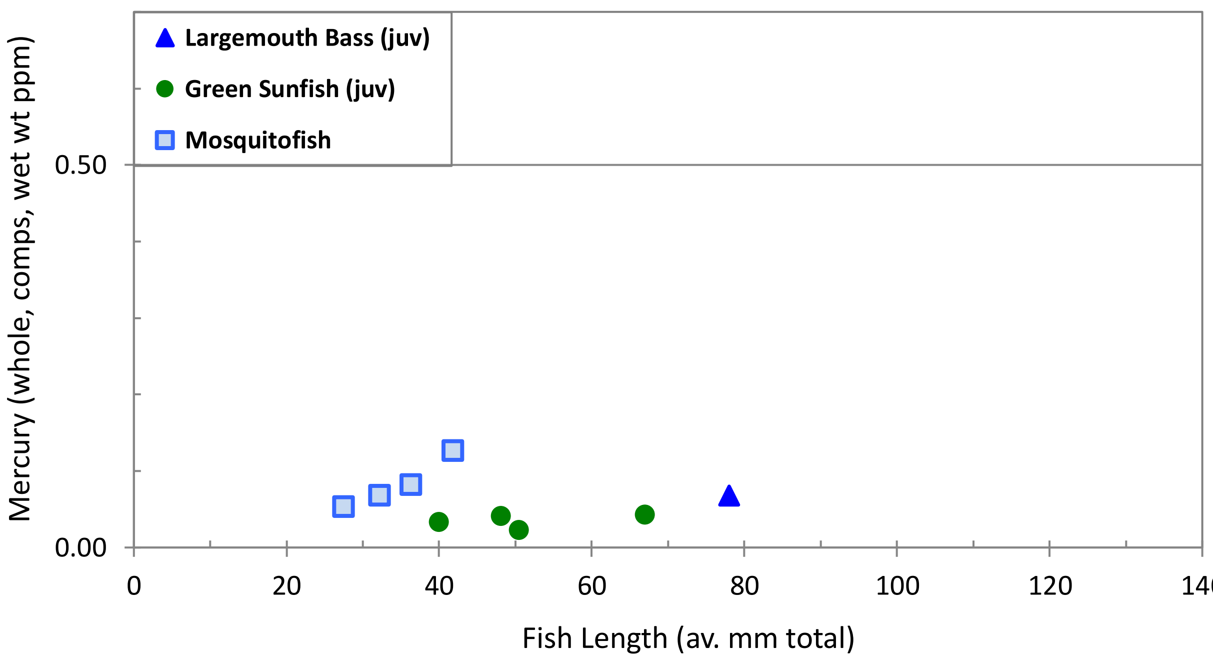


Figure 2. Cemex–Phase 1 (West) Pond: Small, young fish sampled, Fall 2018
(mercury in whole-body, multi-individual composite samples)

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 (West)	2015	**18**	305	393	**0.278**	± 0.055
Cemex – Phase 1 (West)	2016	**20**	313	383	**0.350**	± 0.066
Cemex – Phase 1 (West)	2017	**17**	299	357	**0.393**	± 0.079
Cemex – Phase 1 (West)	2018	20	298	331	**0.481**	± 0.131
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**

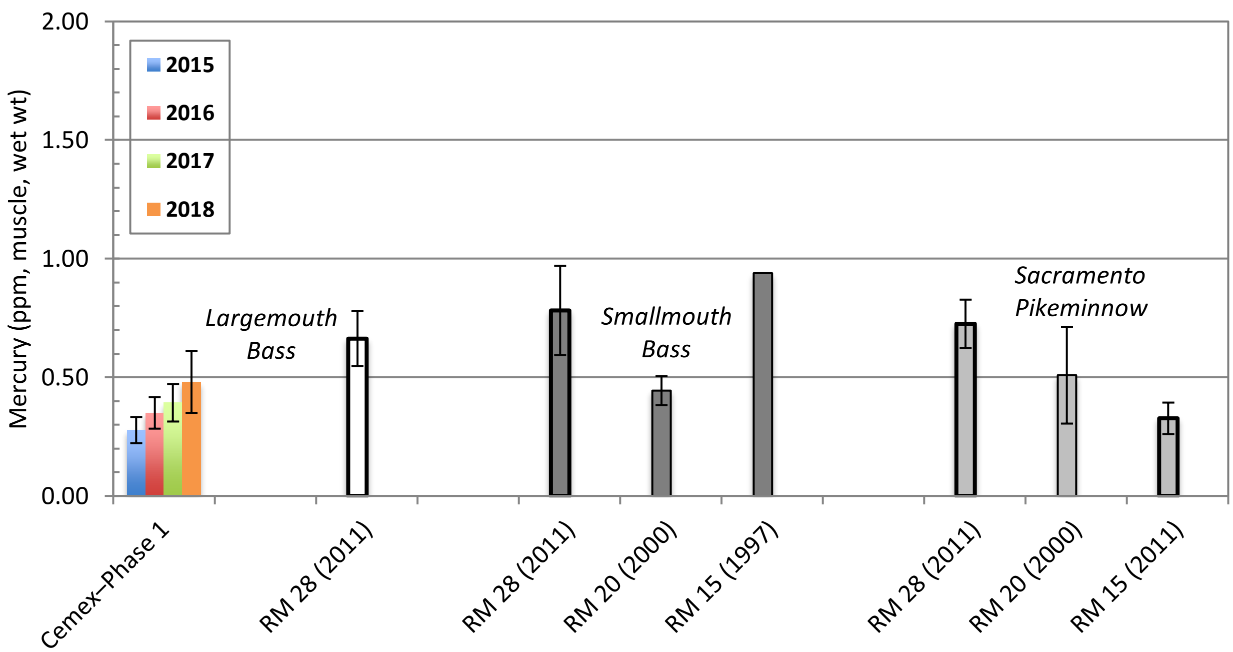


Figure 3. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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 (West)	2015	**2**	595	2,130	**0.198**	
Cemex – Phase 1 (West)	2016	**2**	412	1,150	**0.100**	
Cemex – Phase 1 (West)	2017	**2**	531	1,440	**0.236**	
Cemex – Phase 1 (West)	2018	3	533	1,973	**0.337**	± 0.587
White Catfish						
Cemex – Phase 1 (West)	2016	**3**	661	2,900	**0.372**	
Cemex – Phase 1 (West)	2017	**6**	615	2,120	**0.448**	± 0.134
Cemex – Phase 1 (West)	2018	1	398	1,115	**0.571**	
Historic/Baseline Data						
Channel Catfish						
Rumsey	2000	1	411	565	0.225	
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	

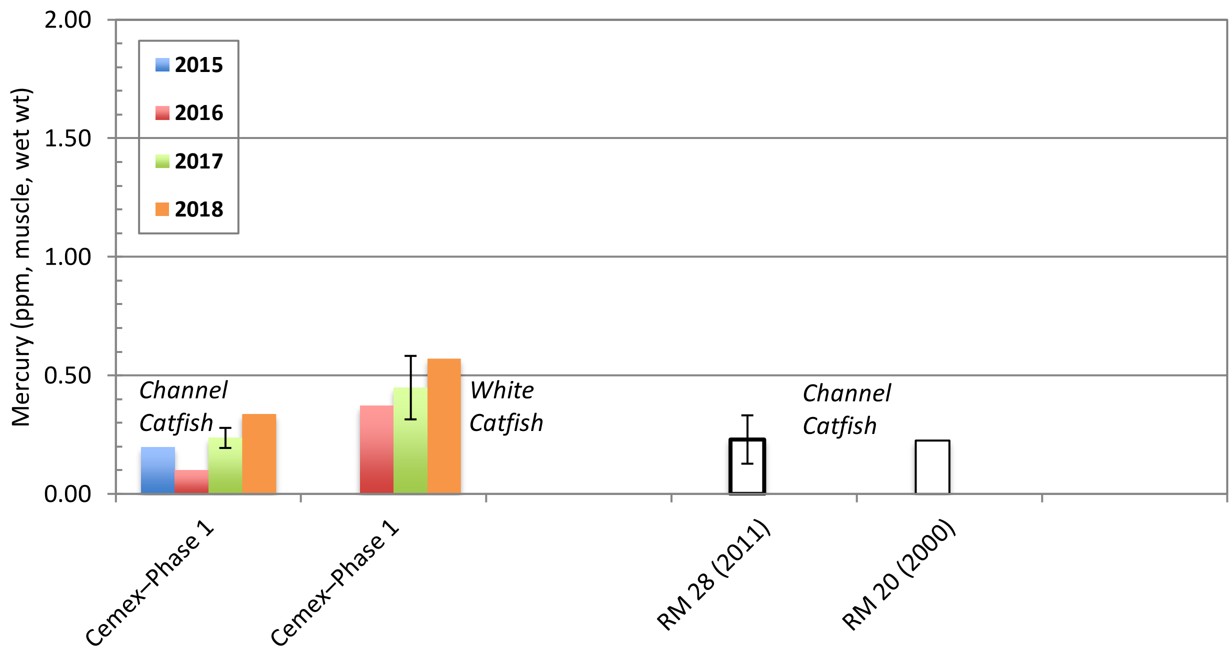


Figure 4. Channel and White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 5. 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 1 (West)	2016	–				
Cemex – Phase 1 (West)	2017	**5**	105	35	**0.273**	± 0.094
Cemex – Phase 1 (West)	2018	1	200	165	**0.227**	
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**

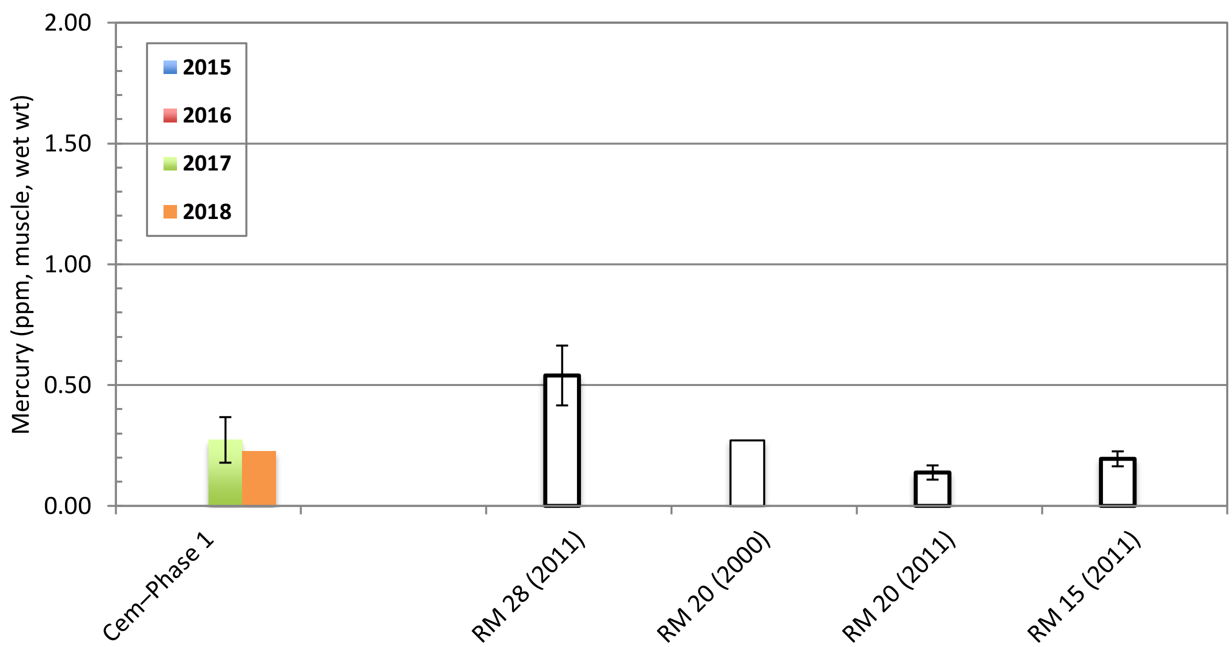


Figure 5. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 6. 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 (West)	2015	**4**	8	109	17	**0.044**	± 0.007
Cemex – Phase 1 (West)	2016	**4**	3	102	17	**0.094**	± 0.012
Cemex – Phase 1 (West)	2017	**4**	2	117	22	**0.146**	± 0.023
Cemex – Phase 1 (West)	2018	**1**	1	78	6	**0.068**	
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**

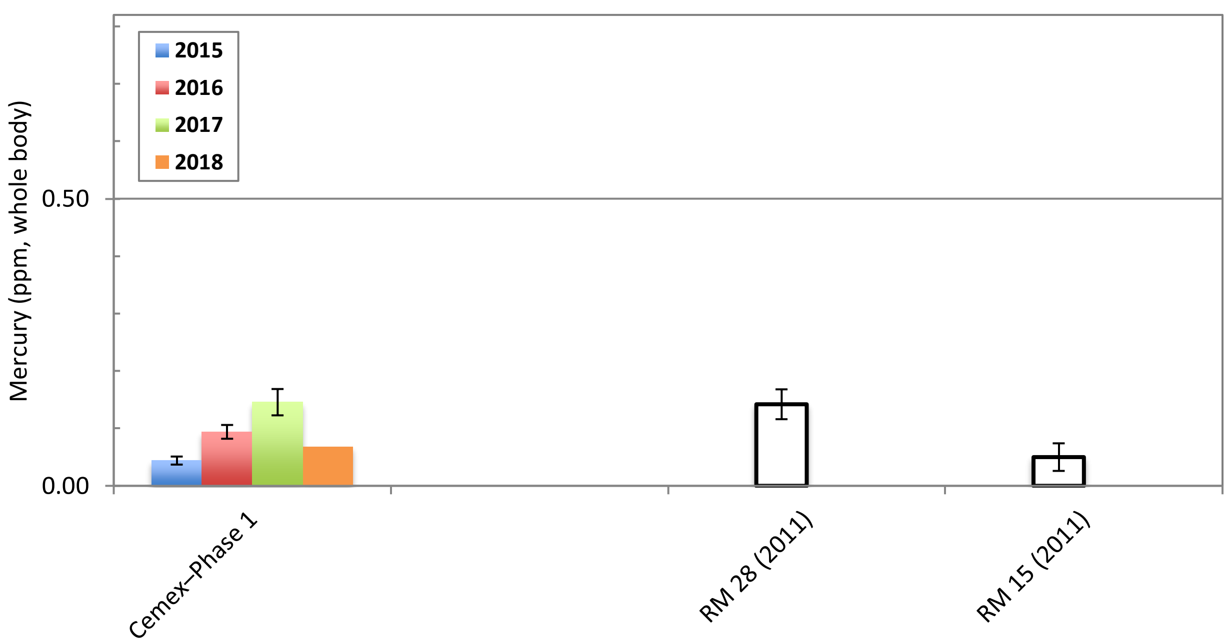


Figure 6. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 7. 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 (West)	2015	**4**	10	39	0.6	**0.075**	± 0.015
Cemex – Phase 1 (West)	2016	**4**	10	34	0.4	**0.093**	± 0.039
Cemex – Phase 1 (West)	2017	**4**	10	33	0.4	**0.135**	± 0.038
Cemex – Phase 1 (West)	2018	**4**	6-10	34	0.5	**0.083**	± 0.032
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**

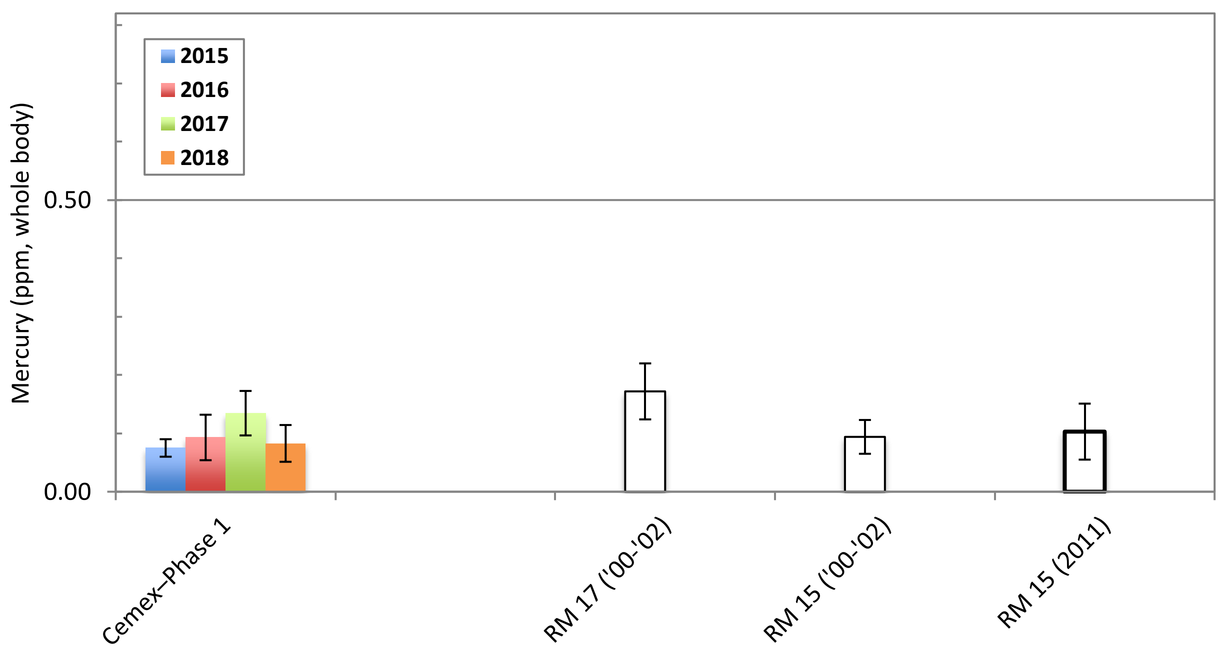


Figure 7. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 8. 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 1 (West)	2017	**4**	8-10	47	1.9	**0.118**	± 0.023
Cemex – Phase 1 (West)	2018	**4**	2	51	2.1	**0.035**	± 0.009
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**

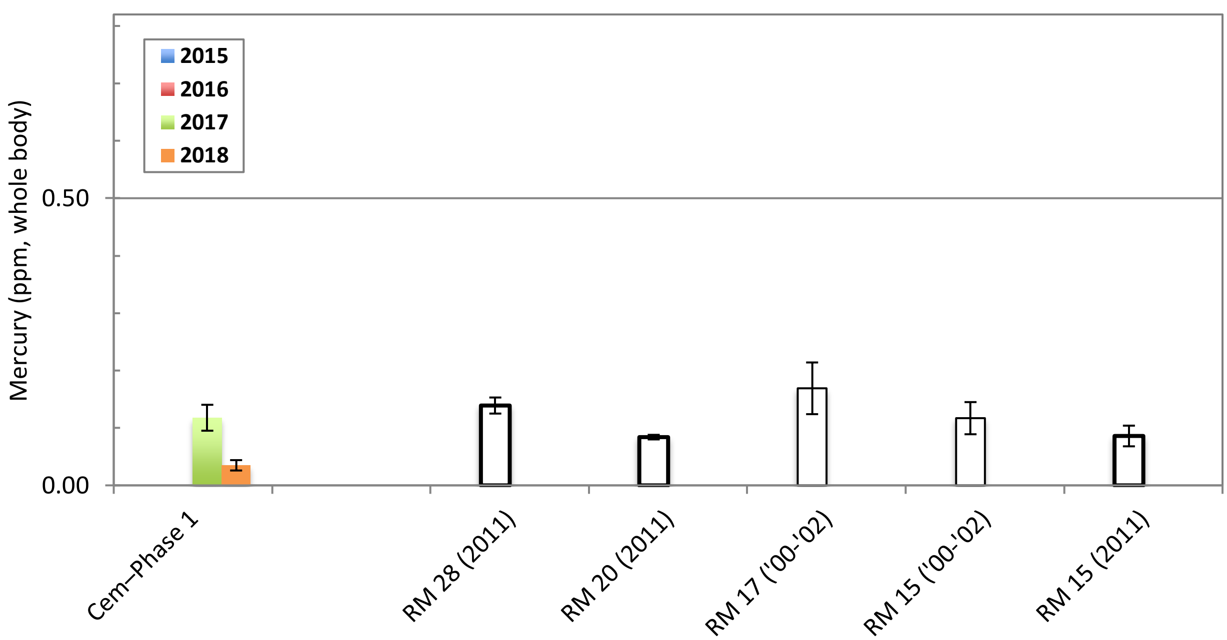


Figure 8. Juv. Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

2. CEMEX–PHASE 3-4 (East) POND

2. CEMEX–PHASE 3-4 (East) POND *(Tables 9-15, Figures 9-15)*

This pond is the more recent (approx. 2002), and more recently active, of the two Cemex ponds. It is also located just south of Cache Creek and east of Highway 505. It is 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. Maximum depth was app. 10-11 m (32-37 feet) in 2018. Active mining was halted here in 2017, and apparently resumed during 2018. This (2018) was Year 4 of monitoring.

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*) across the range of sizes present. The small fish available were juvenile Green Sunfish (*Lepomis cyanellus*, 1-2"), and Mosquitofish (*Gambusia affinis*, 1-2"), each sampled with 4 composites. We were unable to collect juvenile bass. Predation pressure at this site is very high.

In total, 20 large fish muscle samples and 8 small fish composite samples, 28 separate mercury samples, were analyzed from the Cemex–Phase 3-4 Pond in the Fall 2018 monitoring. The analytical results from each individual large fish muscle sample and each small, young fish composite sample can be seen in Tables 9 and 10 and, graphically, in Figures 9 and 10. Then, for each sample type, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015-2017 results and the most closely comparable historic creek data (Tables 11-15, Figures 11-15).

Large, Angling-sized Fish

Largemouth Bass

The Phase 3-4 Pond adult Largemouth Bass samples had fillet muscle mercury ranging from 0.390-1.290 ppm, averaging 0.918 ppm. This was down from 2017 (1.093 ppm); the within-pond difference was not statistically significant. The 2018 average was similar to 2015-2016 levels (0.840, 0.858 ppm). Concentrations increased with size in a smooth, general trend, in contrast with the Phase 1 bass which demonstrated a sharp demarcation between fish of different sizes/ages. Similar to the previous sets of bass, the 2018 samples ranged between 285 and 376 mm (about 11-15"). Adult bass represent the top predator fish in this region and will typically have the highest mercury levels at any given site. The 2018 Cemex–Phase 3-4 bass continued to have higher mercury than 6 of 7 corresponding baseline creek data sets; the difference was statistically significant for 4 of these.

Green Sunfish

We have not been able to collect this species in useful numbers since 2015, despite considerable effort. For completion, the earlier data are included in Table 12 and Figure 12.

Small, Young Fish

Juvenile Largemouth Bass

We were not been able to collect juvenile bass in 2018, even with extensive seining. For completion, the earlier data are included in Table 13 and Figure 13.

Juvenile Green Sunfish

The juvenile Green Sunfish samples had whole-body mercury ranging from 0.092-0.139 ppm, averaging 0.112 ppm. This was lower than in 2017 (0.150 ppm); the difference was not statistically significant. It was, however, significantly lower than in samples analyzed from 2016 (0.233 ppm) and 2015 (0.275 ppm). It should be noted that the fish available for collection in 2017 and 2018 were considerably smaller and younger (34-36 mm, 0.5-0.7 g) than those analyzed in 2015-2016 (47-49 mm, 1.8-2.0 g), and this may have been a factor in the apparent decline in mercury. Compared to baseline juvenile Green Sunfish mercury from Cache Creek, Phase 3-4 Pond fish in 2018 were very similar to the 5 available creek comparisons: statistically equivalent to 3 sets, statistically lower than one, and statistically higher than one.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.162-0.258 ppm, averaging 0.203 ppm. This was down from the previous year (0.286 ppm), though the difference was not statistically significant. Mercury in this species has gone up and down within a fairly narrow range, all below 0.300 ppm; the 2018 mean was statistically similar to those of all 3 of the previous monitoring years. Relative to the baseline Cache Creek comparison samples, the 2018 Cemex–Phase 3-4 Mosquitofish were statistically similar in mercury to the River Mile 17 sample sets (0.172 ppm) and higher than the two sets from River Mile 15 and 17 (0.094-0.103 ppm).

Summary

In summary, fish mercury in the Cemex–Phase 3-4 Pond, while remaining relatively high, showed a decrease in all sample types in 2018, from 2017. The changes were not statistically significant. Overall fish mercury at this pond remained elevated over comparable creek baseline samples for the majority of sample types. The adult bass, in particular, stayed at levels well above consumption guidelines. As this pond was found to be relatively "elevated for two or more consecutive years", that triggered consideration of mercury remediation. The first stage of remediation is to obtain additional water quality information, through seasonal water column profiling of a range of relevant constituents and collection of bottom sediments. That work was initiated in 2018 and will be presented in accompanying reports.

Table 9. Cemex–Phase 3-4 Pond (East): Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	285	11.2	275	0.6	**0.574**
Largemouth Bass	294	11.6	295	0.7	**0.390**
Largemouth Bass	295	11.6	325	0.7	**0.605**
Largemouth Bass	300	11.8	340	0.7	**0.704**
Largemouth Bass	302	11.9	325	0.7	**0.613**
Largemouth Bass	310	12.2	365	0.8	**0.917**
Largemouth Bass	314	12.4	385	0.8	**0.747**
Largemouth Bass	320	12.6	355	0.8	**0.807**
Largemouth Bass	325	12.8	445	1.0	**0.929**
Largemouth Bass	328	12.9	450	1.0	**0.875**
Largemouth Bass	330	13.0	440	1.0	**1.154**
Largemouth Bass	343	13.5	515	1.1	**0.996**
Largemouth Bass	343	13.5	525	1.2	**0.906**
Largemouth Bass	354	13.9	570	1.3	**1.057**
Largemouth Bass	355	14.0	585	1.3	**1.064**
Largemouth Bass	357	14.1	545	1.2	**1.094**
Largemouth Bass	362	14.3	605	1.3	**1.100**
Largemouth Bass	363	14.3	610	1.3	**1.290**
Largemouth Bass	369	14.5	670	1.5	**1.259**
Largemouth Bass	376	14.8	625	1.4	**1.285**

Table 10. Cemex–Phase 3-4 Pond (East): Small Fish Sampled, Fall 2018
(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)
Green Sunfish (juv)	**1**	34	1.3	0.33	0.01	**0.103**
Green Sunfish (juv)	**1**	33	1.3	0.51	0.02	**0.116**
Green Sunfish (juv)	**1**	34	1.3	0.61	0.02	**0.092**
Green Sunfish (juv)	**1**	35	1.4	0.56	0.02	**0.139**
Mosquitofish	**10**	27	1.1	0.18	0.01	**0.162**
Mosquitofish	**10**	33	1.3	0.37	0.01	**0.176**
Mosquitofish	**10**	36	1.4	0.46	0.02	**0.215**
Mosquitofish	**3**	42	1.7	0.81	0.03	**0.258**

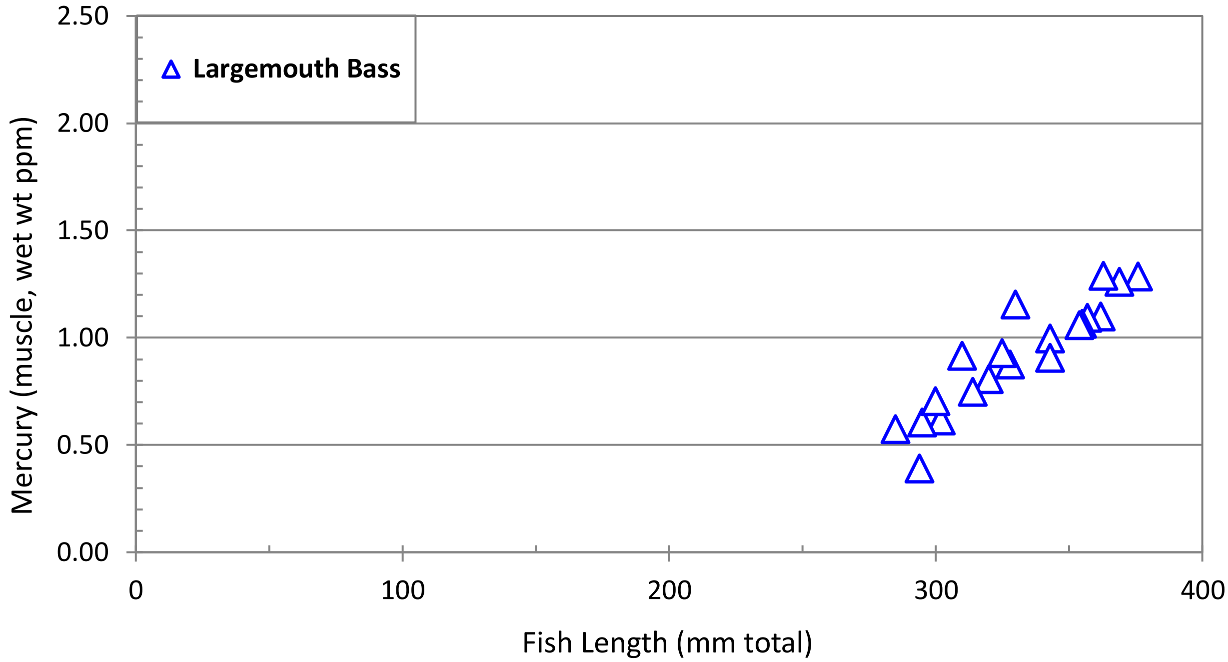


Figure 9. Cemex–Phase 3-4 Pond (East): Large fish sampled, Fall 2018
(fillet muscle mercury in individual fish)

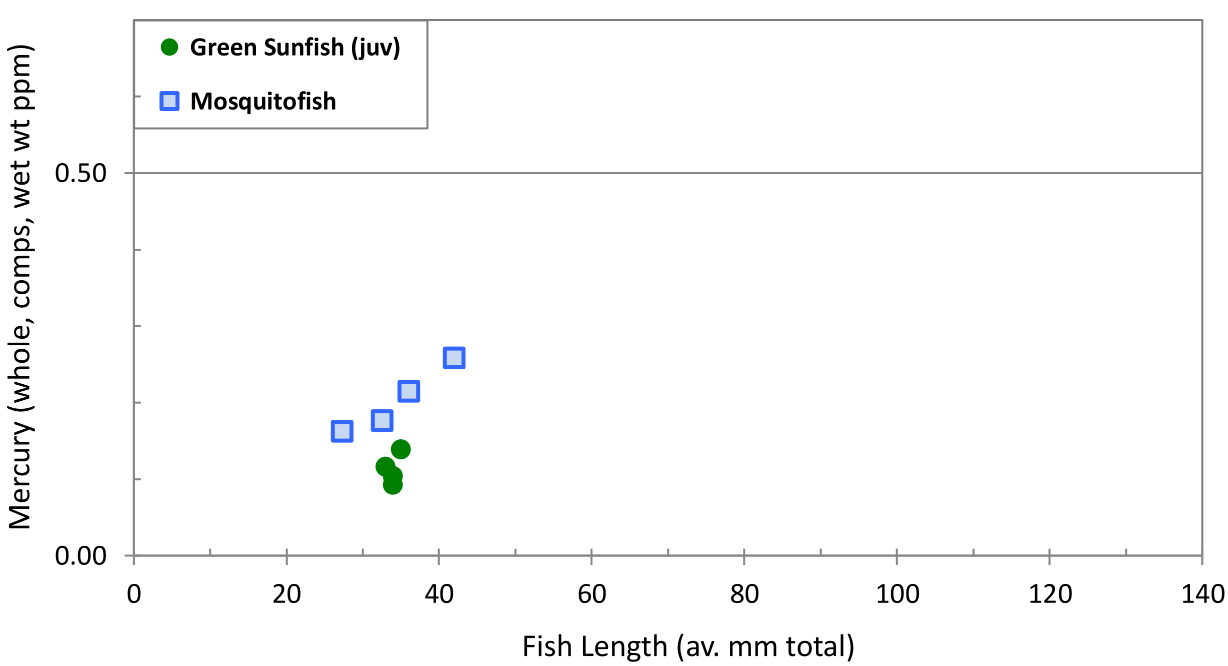


Figure 10. Cemex–Phase 3-4 Pond (East): Small, young fish sampled, Fall 2018
(mercury in whole-body, multi-individual composite samples)

Table 11. 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 (East)	2015	**20**	344	526	**0.840**	± 0.113
Cemex – Phase 3-4 (East)	2016	**20**	344	557	**0.858**	± 0.139
Cemex – Phase 3-4 (East)	2017	**20**	334	479	**1.093**	± 0.172
Cemex – Phase 3-4 (East)	2018	20	331	463	**0.918**	± 0.119
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**

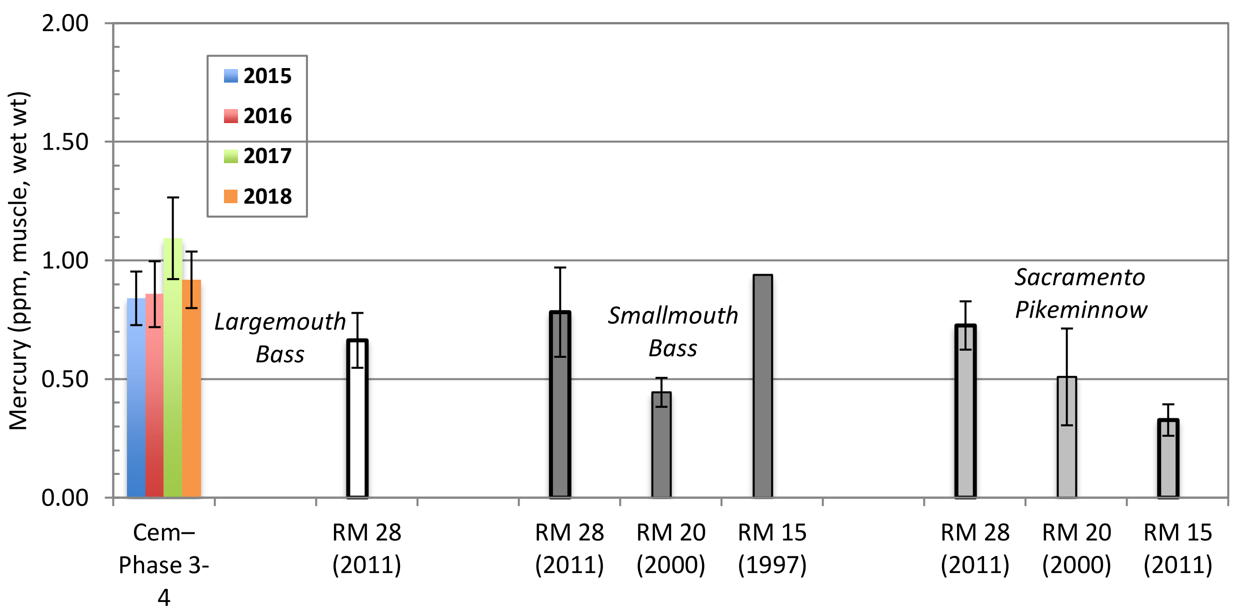


Figure 11. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 12. 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 (East)	2015	**10**	133	67	**0.534**	± 0.076
Cemex – Phase 3-4 (East)	2016	**1**	101	16	**0.382**	
Cemex – Phase 3-4 (East)	2017	**–**				
Cemex – Phase 3-4 (East)	2018	–				
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**

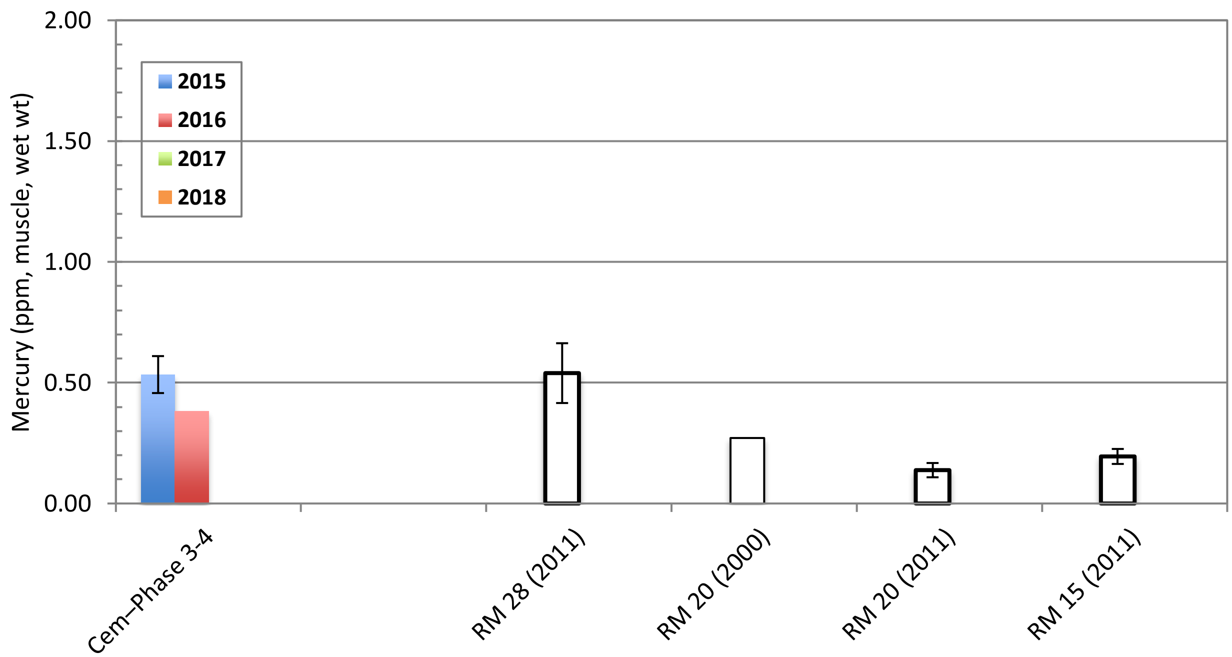


Figure 12. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 13. 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 (East)	2015	**4**	7	108	16	**0.334**	± 0.052
Cemex – Phase 3-4 (East)	2016	**4**	2	114	18	**0.372**	± 0.053
Cemex – Phase 3-4 (East)	2017	**4**	2-3	108	16	**0.249**	± 0.033
Cemex – Phase 3-4 (East)	2018	(no samples)					
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**

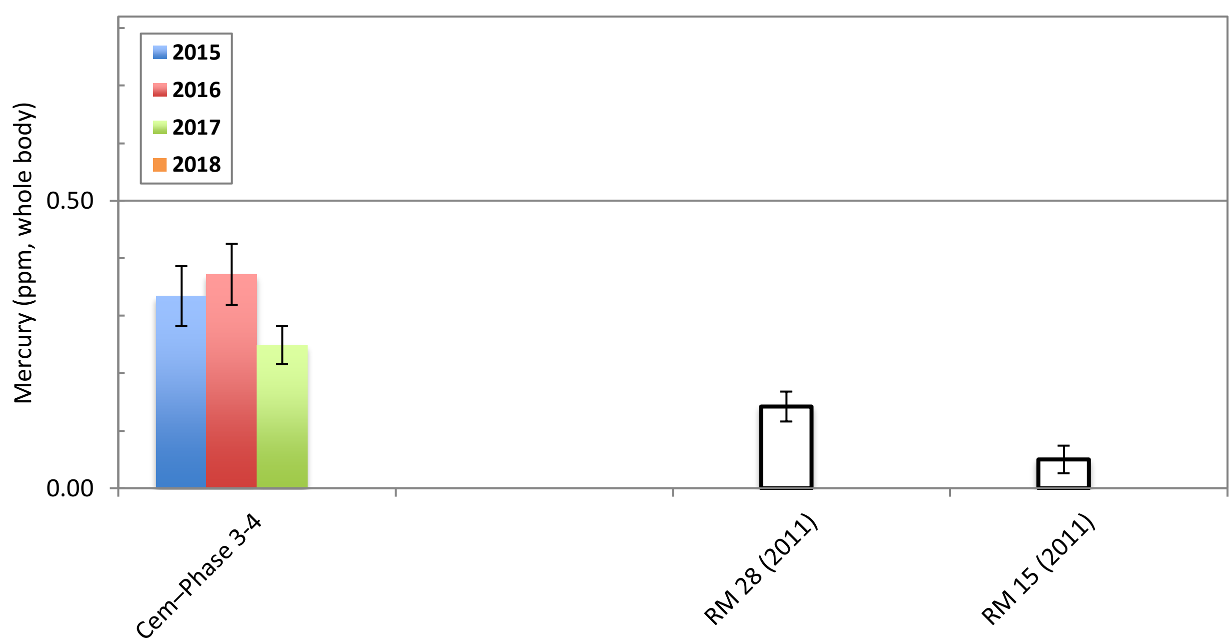


Figure 13. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 14. 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 (East)	2015	**4**	10	47	1.8	**0.275**	± 0.022
Cemex – Phase 3-4 (East)	2016	**4**	4-5	49	2.0	**0.233**	± 0.026
Cemex – Phase 3-4 (East)	2017	**4**	2-6	36	0.7	**0.150**	± 0.051
Cemex – Phase 3-4 (East)	2018	**4**	1	34	0.5	0.112	± 0.020
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**

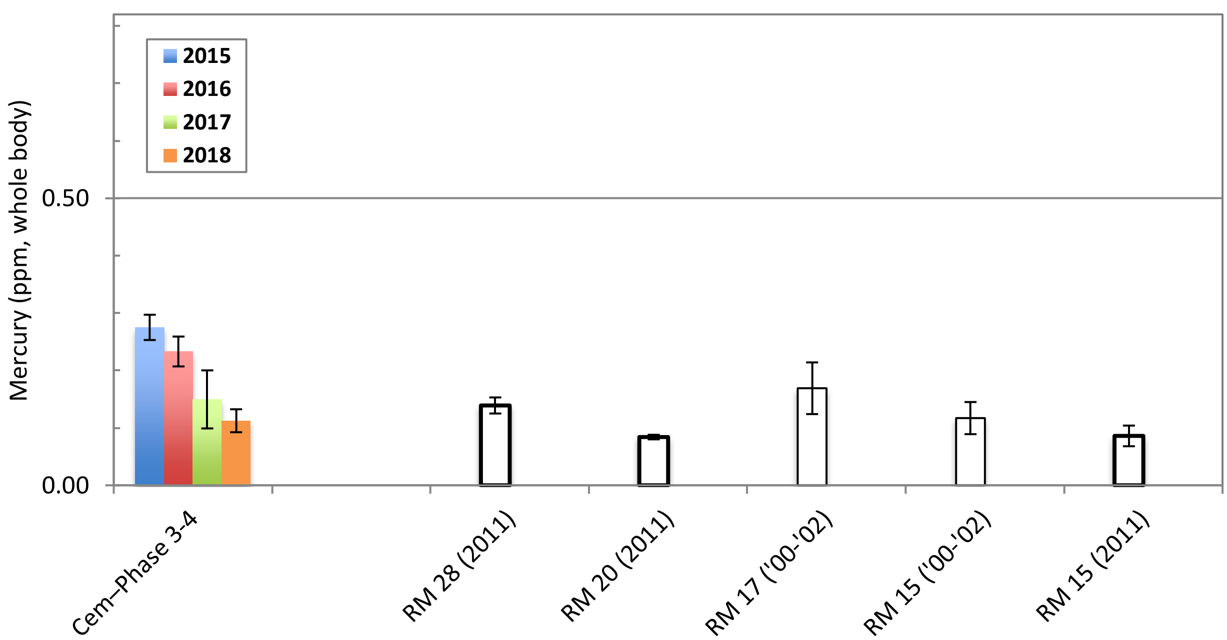


Figure 14. Juv. Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 15. 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 (East)	2015	**4**	10	37	0.6	**0.228**	± 0.059
Cemex – Phase 3-4 (East)	2016	**4**	10	37	0.6	**0.157**	± 0.037
Cemex – Phase 3-4 (East)	2017	**4**	6-10	34	0.5	**0.286**	± 0.071
Cemex – Phase 3-4 (East)	2018	**4**	3-10	34	0.5	**0.203**	± 0.043
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**

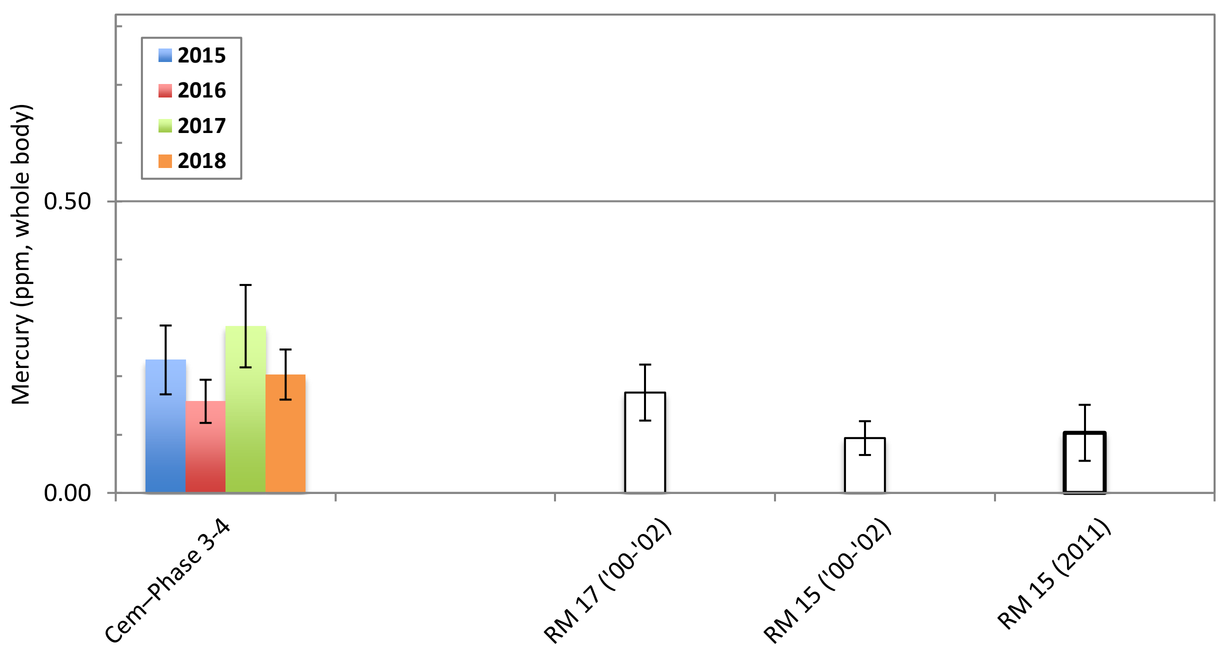


Figure 15. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

3. TEICHERT–REIFF POND

3. TEICHERT–REIFF POND *(Tables 16-24, Figures 16-24)*

This pond is the largest of the Teichert wet pits. It is located at Teichert's Esparto Facility, just north of Cache Creek and 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 the margins to a deeper central area that ranged from 5-7 m (16-23 feet) deep. 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. In 2017, active mining appeared to have been halted at the Esparto Plant in general, stopping the slurry inflows. This (2018) was Year 4 of monitoring.

We sampled the pond primarily during day and twilight conditions. The fish collected are listed in Tables 16 and 17. These included, for large, angling-sized fish, samples of 10 Largemouth Bass (*Micropterus salmoides*). White Catfish and Carp, normally collected here at night with baited setlines and gillnets, could not be taken in 2018 due to access problems in November. However, extensive samples were collected of small fish, including juvenile Largemouth Bass (3-5"), juvenile Green Sunfish (*Lepomis cyanellus*, 1-3") Red Shiners (*Cyprinella lutrensis*, ~2") and Mosquitofish (*Gambusia affinis*, 1-2"). We collected 4 multi-individual composite samples from each of these 4 species.

In total, this added up to 10 large fish muscle samples and 16 young, small fish composites, or 26 separate mercury samples analyzed from the Reiff Pond in the Fall 2018 monitoring. The analytical results from each individual large fish muscle sample and each small fish composite sample can be seen in Tables 16 and 17 and, graphically, in Figures 16 and 17. Then, for each large and small fish species taken, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015-2018 results and the most closely comparable historic creek data (Tables 18-24, Figures 18-24).

Large, Angling-sized Fish

Largemouth Bass

We took a sample of 10 bass in 2018. The sizes (237-270 mm, 9-11") clustered in a range larger than last year (70-200 mm, 3-8"), indicating that this is a young, growing population. Average weight jumped from 78 g in 2017 to 181 g in 2018, more than doubling. As found last year, the 2018 samples had extremely high mercury levels for bass of these relatively small sizes (or any size), ranging between 1.656 and 2.478 ppm, averaging 1.997 ppm. This was significantly higher than all the baseline/historic comparative creek levels. It was also significantly elevated over 2017, though this may be a function of the fish growing larger and older.

White Catfish

Carp

We were unable to access the pond in November to sample for these species, but expect to resume collections at Reiff in 2019. For this report, we are including 2015-2017 catfish and carp data.

Small, Young Fish

Mosquitofish

Mosquitofish could not be located or collected from Reiff Pond in 2017, but they were again present in 2018, allowing a complete sampling. Sizes closely matched previous collections here and at other sites, averaging 28-42 mm and 0.2-0.8 g. Mercury in the 4 composite sets ranged from 0.201-0.306 ppm, averaging 0.262 ppm. This was up somewhat from the last collection (2016, 0.212 ppm) and significantly above 2015 levels (0.094 ppm). We suspect it may have been down, however, from Year 2017 (see species below) when we could not locate Mosquitofish at Reiff. In any case, the 2018 concentrations remained higher than corresponding Cache Creek baseline samples (0.094-0.172 ppm); the difference was statistically significant.

Red Shiner

The Red Shiner multiple-fish composites had whole-body mercury ranging from 0.491-0.640 ppm, averaging 0.556 ppm. This was down, though not significantly, relative to similar-sized fish collected in 2017 (0.695 ppm). Like the Mosquitofish historic trend (Fig. 21), the Reiff Pond Red

Shiner samples initially (2015, 0.152 ppm) averaged similar or lower mercury than the 6 historic/baseline sample sets from the creek (0.123-0.242 ppm), significantly lower than the River Mile 28 data set. In 2016, concentrations jumped over 3-fold to an average of 0.412 ppm, which was significantly higher than all of the comparable Cache Creek sample sets. Corresponding 2017 fish were another step higher, averaging 0.695 ppm. The relative drop in 2018 to 0.556 ppm may represent a leveling off or declining trend in methylmercury exposure levels to the Reiff food web. Even with the recent decline, though, Red Shiner mercury remained significantly higher than the historic creek comparisons.

Juvenile Largemouth Bass

The juvenile bass samples had whole-body mercury ranging from 0.536-0.977 ppm, averaging 0.445 ppm. This was significantly lower than the 2017 samples (0.798 ppm). As just discussed for Red Shiners, this suggests a possible drop in overall methylmercury exposure conditions in 2018. Relative to baseline juvenile bass comparison data from Cache Creek, despite the large decrease in 2018, they remained significantly higher in mercury than the two creek sample sets available: River Mile 28 (0.142 ppm) and River Mile 15 (0.050 ppm).

Juvenile Green Sunfish

The juvenile sunfish samples had whole-body mercury at 0.233-0.276 ppm, averaging 0.252 ppm. This was statistically unchanged from the single sample available here previously (2015, 0.241 ppm). As noted above for Mosquitofish, with no comparable samples from 2016-2017, we do not know if the 2018 levels represent a change in exposure. As compared to Cache Creek baseline comparison samples, the 2018 Reiff juvenile sunfish were significantly higher in mercury than all 5 baseline sets.

Summary

In summary, the Teichert–Reiff Pond in 2018 remained highly elevated in mercury. All of the various fish samples were significantly higher in mercury than corresponding Cache Creek baseline samples. Largemouth Bass were up from 2017 and averaged about 2.0 ppm. However, young-of-year fish that were available in both 2017 and 2018 (Red Shiners and juvenile bass) showed a decline, suggesting a possible leveling off or drop in general methylmercury exposure levels. In any case, the pond remained solidly in the 'elevated over baseline' category and was recommended for collection of additional information to help guide remediation. Water column profiling and collection of bottom sediment samples began in May 2018 and will be the subject of accompanying reports.

All of the Reiff Pond fish mercury trends during the 2015-2018 years of monitoring were consistent with a rising trend in general methylmercury exposure (to the fish) between 2015 and 2017, with indication of a leveling off or decline in 2018. As discussed for the Cemex–Phase 1 Pond, this trajectory coincided with a very similar pattern of pond management at Reiff. Similar to Cemex–Phase 1, the Reiff Pond has been the recipient of slurry discharge from nearby active mining (Mast). As at Cemex–Phase 1, this discharge was heavy in 2015 and declined to essentially no inputs in 2017, ramping back up partially in 2018. We think it is likely that the steady increase in fish mercury seen at both ponds through 2017, and the subsequent leveling off or decline in 2018, was related to these management changes.

Table 16. Teichert–Reiff Pond: Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	237	9.3	150	0.3	**2.048**
Largemouth Bass	238	9.4	145	0.3	**1.871**
Largemouth Bass	240	9.4	148	0.3	**1.757**
Largemouth Bass	248	9.8	180	0.4	**1.656**
Largemouth Bass	249	9.8	165	0.4	**1.989**
Largemouth Bass	251	9.9	190	0.4	**1.879**
Largemouth Bass	253	10.0	182	0.4	**2.478**
Largemouth Bass	257	10.1	195	0.4	**1.930**
Largemouth Bass	268	10.6	230	0.5	**2.166**
Largemouth Bass	270	10.6	225	0.5	**2.200**

(White Catfish and Carp were unobtainable in 2018 due to access problems in November)

Table 17. Teichert–Reiff Pond: Small Fish Sampled, Fall 2018

(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)	**6**	90	3.5	8.1	0.28	**0.348**
Largemouth Bass (juv)	**4**	106	4.2	14.2	0.50	**0.543**
Largemouth Bass (juv)	**4**	118	4.6	20.3	0.71	**0.553**
Largemouth Bass (juv)	**4**	130	5.1	24.8	0.87	**0.650**
Green Sunfish (juv)	**2**	39	1.5	1.0	0.03	**0.239**
Green Sunfish (juv)	**2**	41	1.6	1.1	0.04	**0.233**
Green Sunfish (juv)	**2**	43	1.7	1.3	0.04	**0.260**
Green Sunfish (juv)	**2**	71	2.8	5.8	0.20	**0.276**
Red Shiner	**10**	41	1.6	0.7	0.02	**0.491**
Red Shiner	**10**	44	1.7	0.7	0.03	**0.537**
Red Shiner	**10**	46	1.8	0.8	0.03	**0.557**
Red Shiner	**10**	50	2.0	1.1	0.04	**0.640**
Mosquitofish	**10**	28	1.1	0.2	0.01	**0.201**
Mosquitofish	**10**	32	1.3	0.3	0.01	**0.234**
Mosquitofish	**10**	37	1.4	0.6	0.02	**0.306**
Mosquitofish	**10**	42	1.6	0.8	0.03	**0.306**

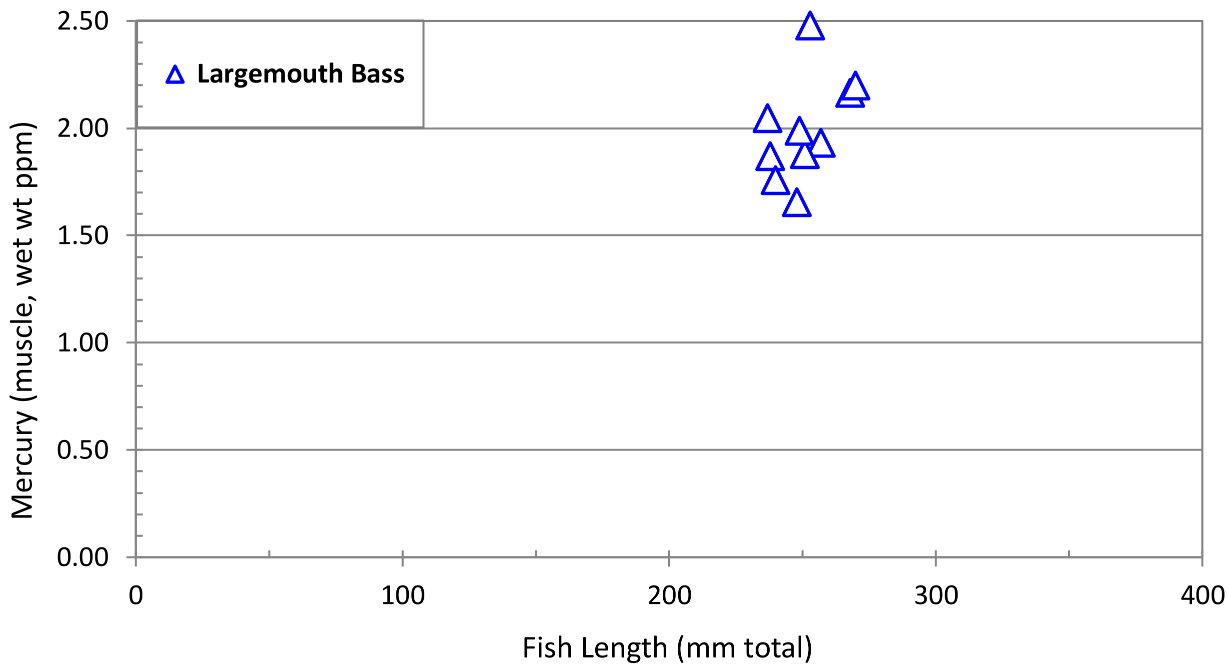


Figure 16. Teichert–Reiff Pond: large fish sampled, Fall 2018
(fillet muscle mercury in individual fish)

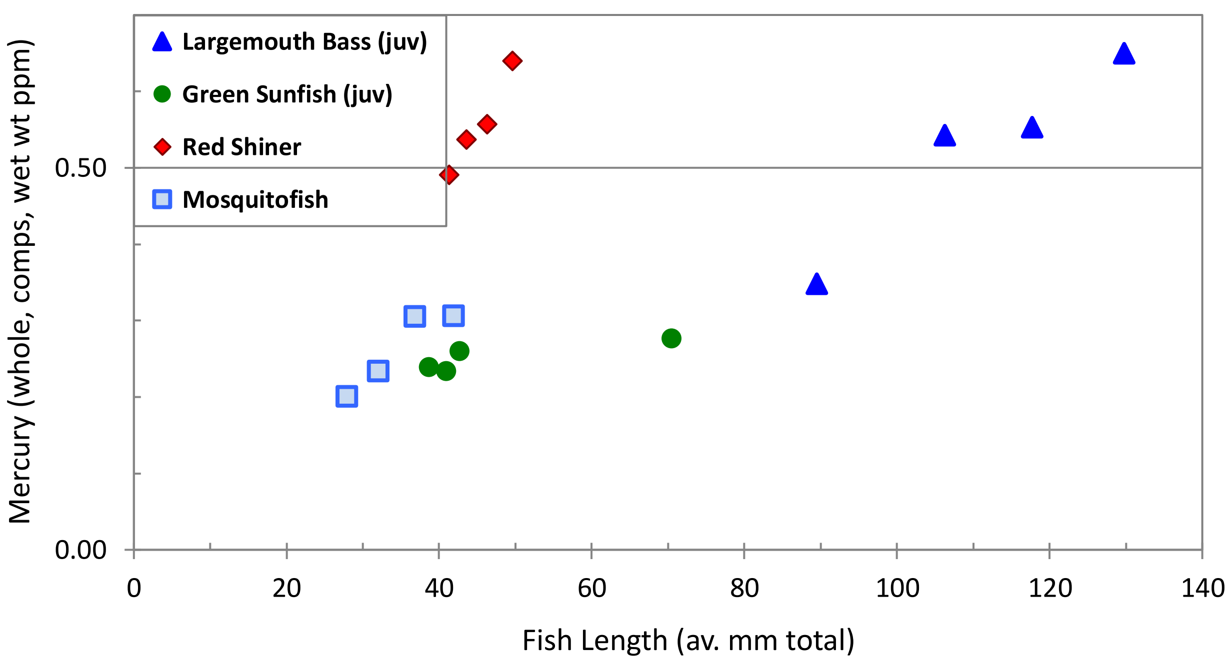


Figure 17. Teichert–Reiff Pond: small, young fish sampled, Fall 2018
(mercury in whole-body, multi-individual composite samples)

Table 18. 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.
Teichert – Reiff	2017	5	189	78	1.679	± 0.180
Teichert – Reiff	2018	10	251	181	**1.997**	± 0.170
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**

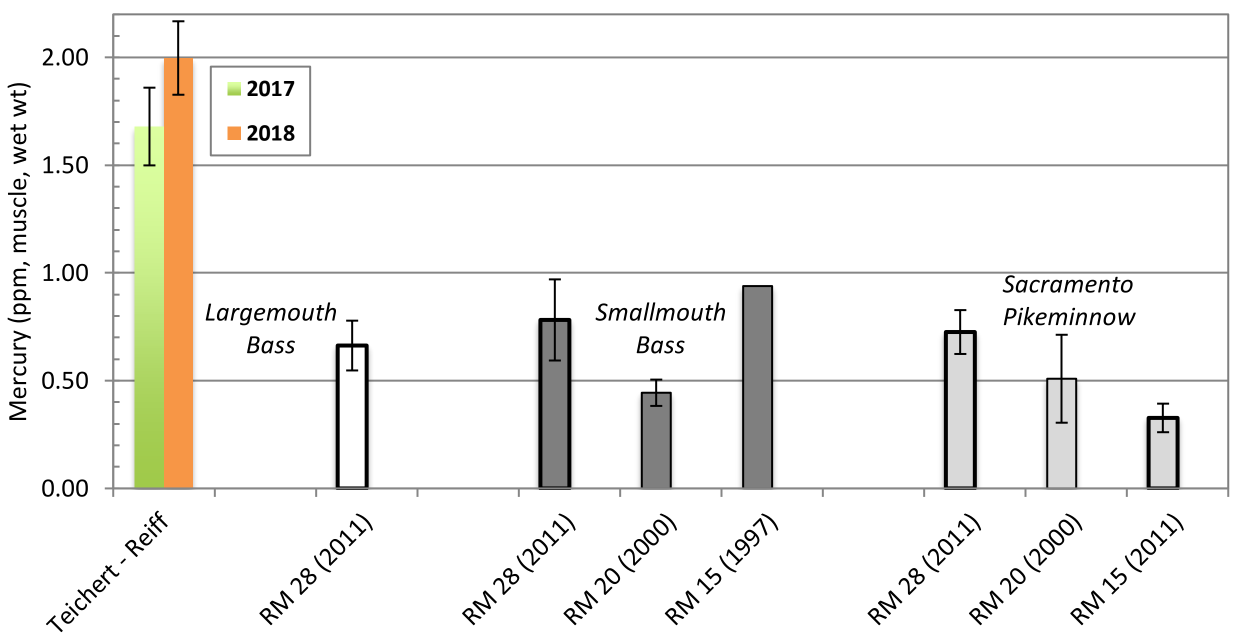


Figure 20. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 19. 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	2015	**20**	347	658	**0.737**	± 0.156
Teichert – Reiff	2016	**20**	297	341	**0.996**	± 0.153
Teichert – Reiff	2017	**16**	355	677	**1.287**	± 0.197
Teichert – Reiff	2018 (no samples)					
Historic/Baseline Data						
Channel Catfish						
Rumsey	2000	1	411	565	0.225	
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	
River Mile 03	1997	10	336	304	0.174	± 0.019

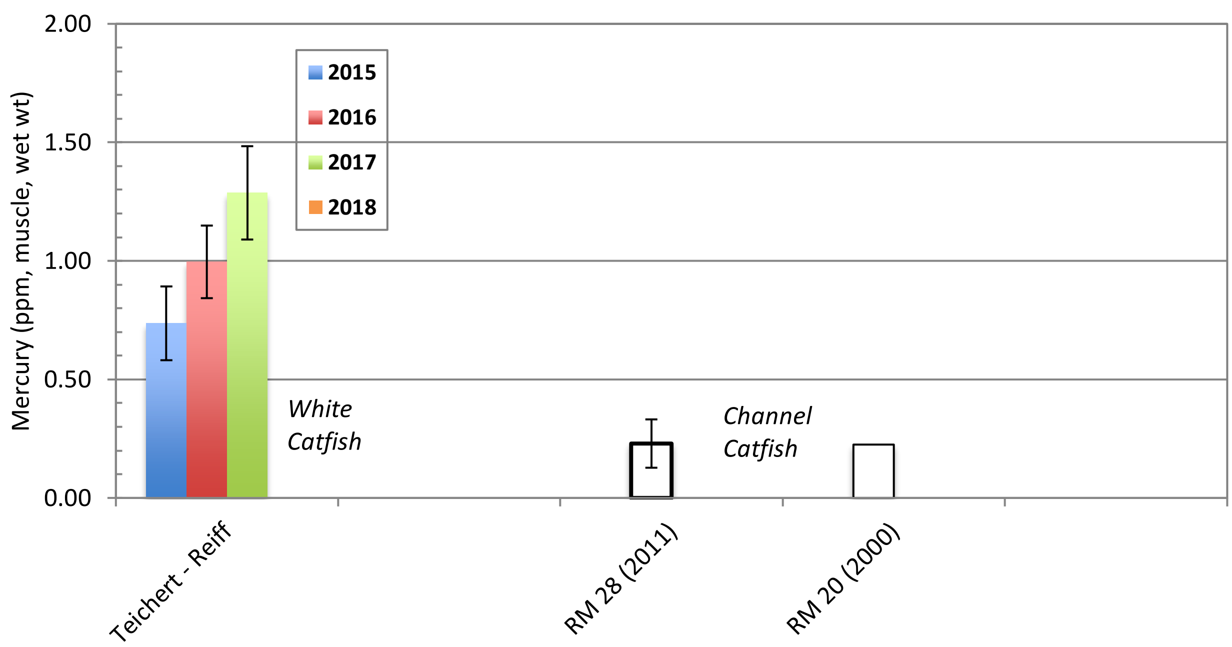


Figure 19. White Catfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 20. 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	2015	**2**	421	918	**0.351**	
Teichert – Reiff	2016	**5**	430	975	**0.854**	± 0.387
Teichert – Reiff	2017	**9**	481	1,499	**1.122**	± 0.321
Teichert – Reiff	2018 (no samples)					
Historic/Baseline Data (most comparable species available)						
Sacramento Sucker						
Rumsey	2000	6	328	396	0.198	± 0.113
River Mile 20	2000	5	253	174	0.154	± 0.034
River Mile 15	**2011**	**8**	**276**	**231**	**0.143**	**± 0.011**
River Mile 08	2000	4	319	336	0.339	
River Mile 03	1997	5	343	402	0.263	± 0.068

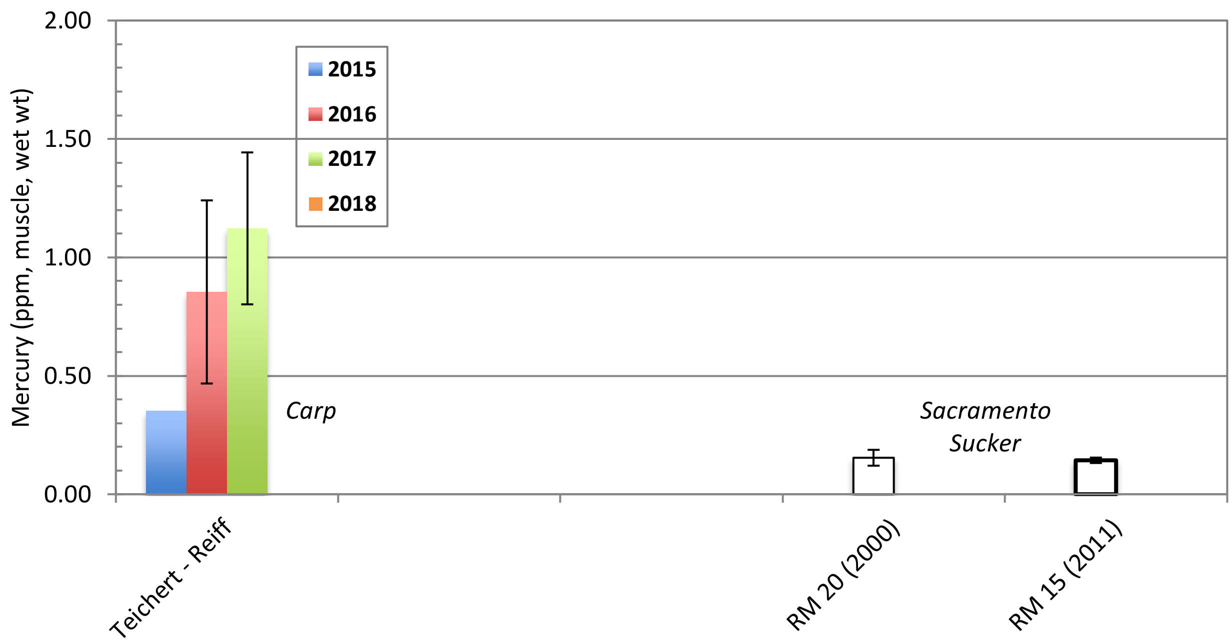


Figure 20. Carp summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 21. 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	2015	**4**	12	38	0.6	**0.094**	± 0.010
Teichert – Reiff	2016	**4**	10	36	0.5	**0.212**	± 0.041
Teichert – Reiff	2017	–	–	–	–	–	
Teichert – Reiff	2018	**4**	10	35	0.5	**0.262**	± 0.053
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**

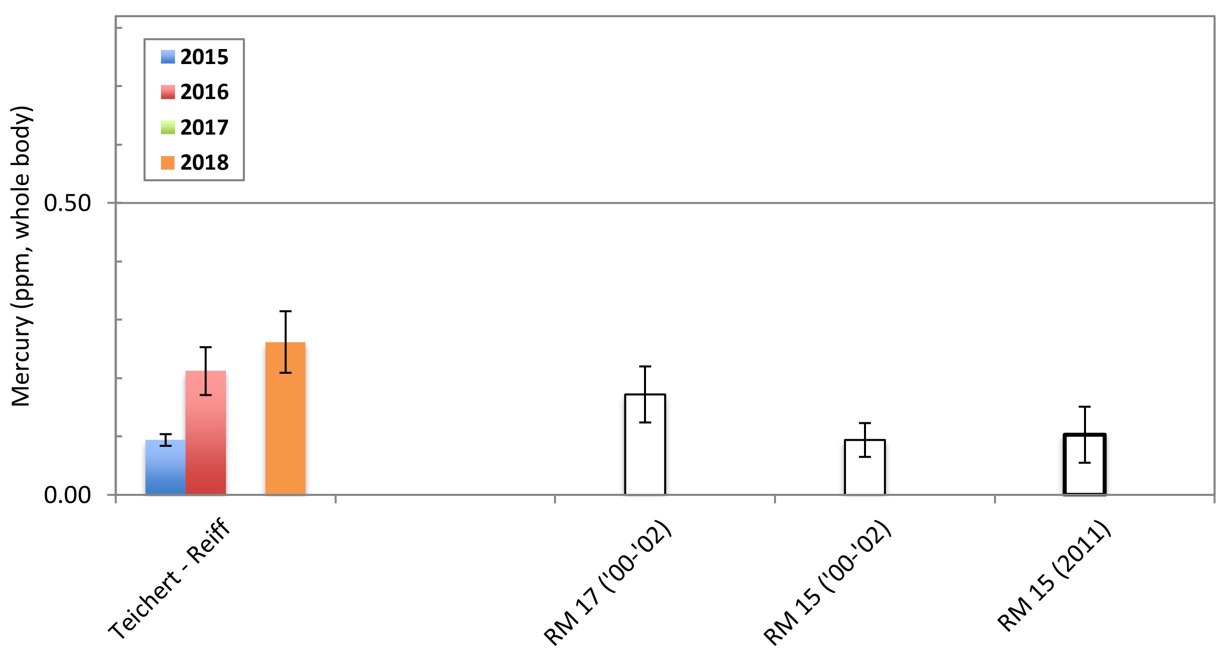


Figure 21. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 22. 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	2015	**4**	10	50	1.3	**0.152**	± 0.018
Teichert – Reiff	2016	**4**	10	47	1.1	**0.412**	± 0.084
Teichert – Reiff	2017	**4**	10	49	1.1	**0.695**	± 0.141
Teichert – Reiff	2018	**4**	10	45	0.8	**0.556**	± 0.062
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
River Mile 08	2000	4	10	42	0.7	0.123	± 0.016

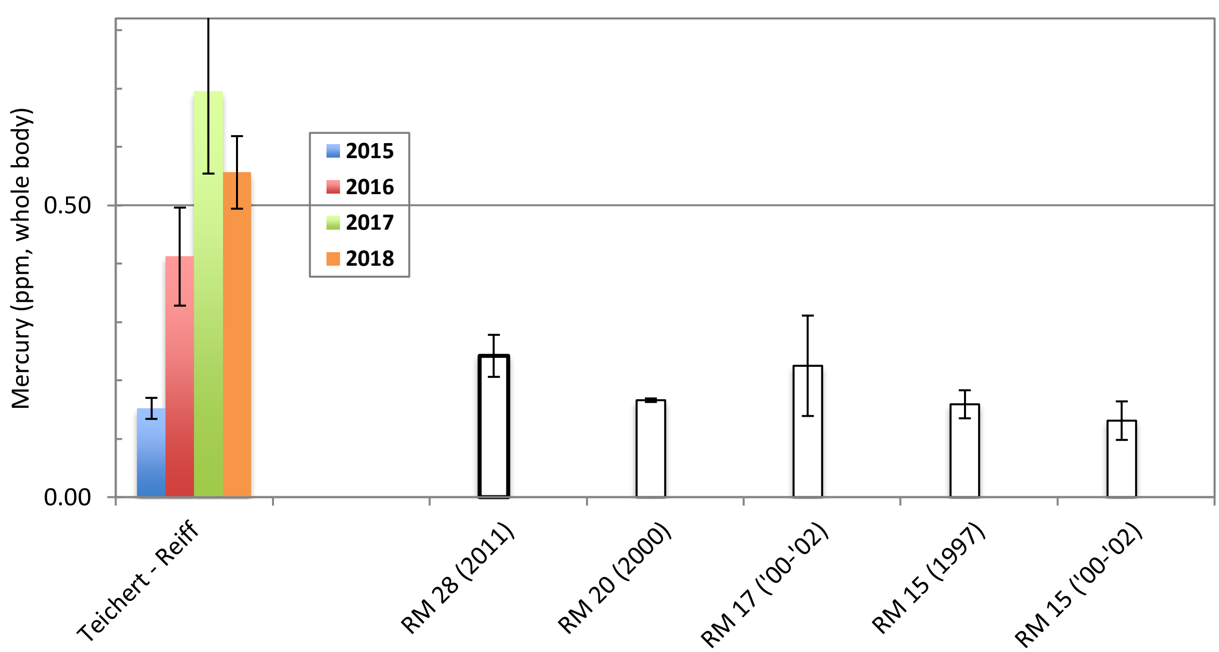


Figure 22. Red Shiner summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 23. 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)							
Teichert – Reiff	2015	–	–				
Teichert – Reiff	2016	–	–				
Teichert – Reiff	2017	**4**	1-2	137	32	**0.798**	± 0.188
Teichert – Reiff	2018	**4**	4-6	111	17	**0.445**	± 0.138
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**

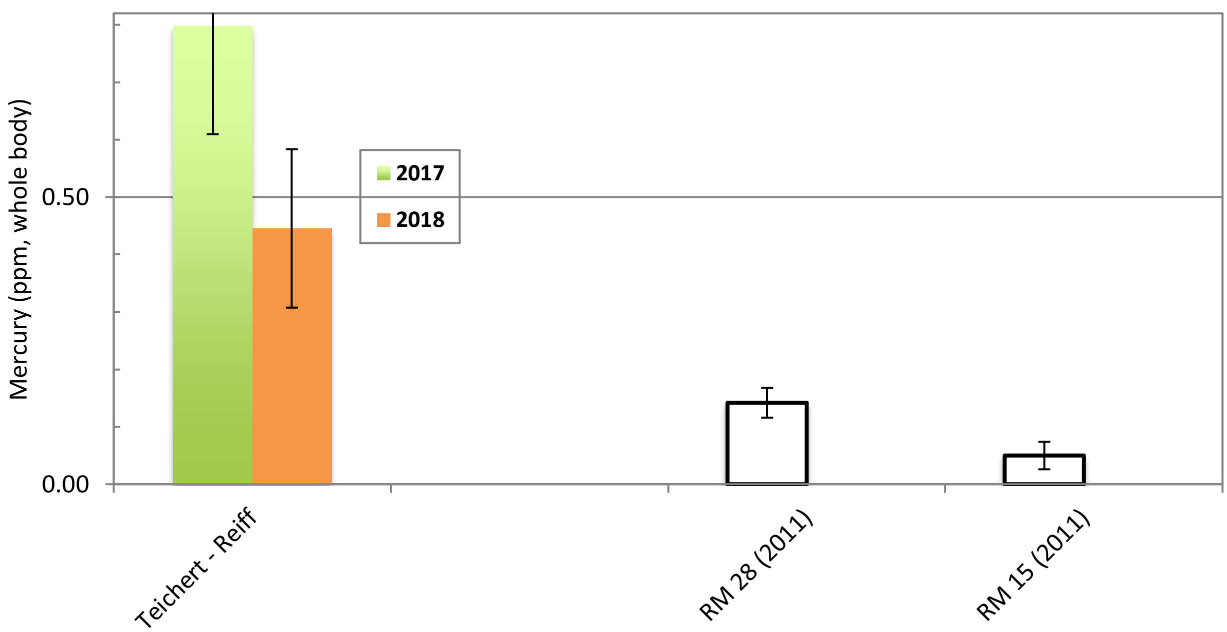


Figure 23. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 24. 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	2015	**1**	1	68	5.1	**0.241**	
Teichert – Reiff	2016	**–**	–				
Teichert – Reiff	2017	–	–				
Teichert – Reiff	2018	**4**	2	48	2.3	**0.252**	± 0.020
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**

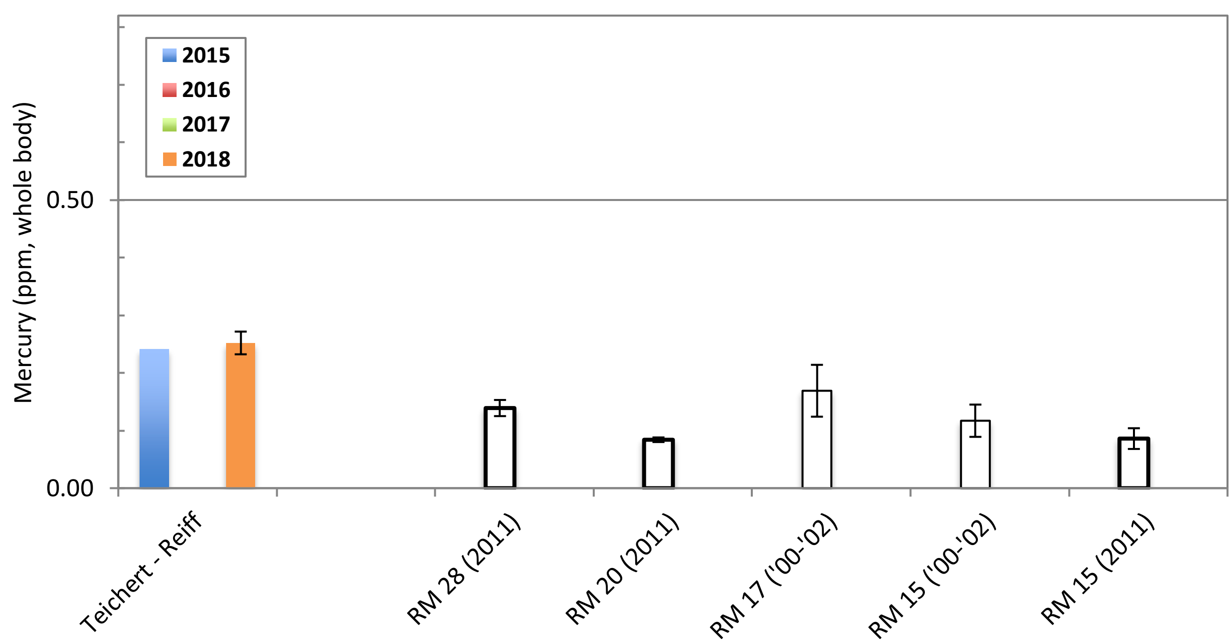


Figure 24. Juvenile Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

4. TEICHERT–MAST POND

4. TEICHERT–MAST POND *(Tables 25-26, Figures 25-26)*

The Mast Pond is located at Teichert's Esparto Facility, just north of Cache Creek and west of Highway 505 between 505 and County Road 87. It is near the Reiff pond, which is northwest of Mast. Mast Pond, at the time of sampling in Fall 2018, was separated into two basins as in 2017. The northwest basin was an elongated oval approximately 425 m long and 150 m wide. The southeast basin was an irregular shape approximately 400 m by 400 m. Depths were not measured but appeared to be similar to the Reiff Pond, to about 9 m (30 feet). This pond was first created in or before 2002, along with Reiff. It was the site of extensive active mining in 2015 and 2016, which was halted in 2017. In 2017, active mining was halted at the Esparto Plant in general, with Teichert's focus shifting to the downstream Woodland Plant area. In 2018, the Esparto Plant was gearing up for resumed mining. This (2018) was Year 2 of monitoring for the Teichert–Mast Pond.

We sampled both basins of the pond with a range of techniques, but were again unable to locate or collect large fish in 2018. They may not be present. Extensive seining, set-lines, and gill-nets continued to yield just one species of small fish, Mosquitofish (*Gambusia affinis*), present in high densities. With no predatory fish at this time, Mast Mosquitofish were able to reach significantly larger sizes than at the other ponds. While still very small fish (1.9-2.5" and 1-3 g, vs. 1.1-1.8" and 0.2-0.9 g), they represent the largest fish class present at Mast Pond. As Mosquitofish were the only species available, we collected composites within the standard, inter-comparable sizes (4 composites of 10 fish each in classes between 25-43 mm or 1.0-1.7") from each of the two basins, and also 3 composites from each basin of the larger sizes. The Mosquitofish collected are listed in Table 25.

In total this added up to 14 small fish composite mercury samples analyzed from the Mast Pond in the Fall 2018 monitoring. The analytical results from each small fish composite sample can be seen in Table 25 and, graphically, in Figure 25. Then the data are shown in reduced form (means, error bars, etc.) and compared the most closely comparable historic creek data (Table 26, Figure 26).

Small, Young Fish

Mosquitofish

Standard, Intercomparable Sizes: The standard Mosquitofish multiple-fish composites, overall across both Mast basins, had whole-body mercury ranging from 0.118-0.254 ppm, averaging 0.182 ppm. Fish from the northwest basin ranged from 0.118-0.228 ppm, averaging 0.168 ppm. Fish from the southeast basin were slightly higher, ranging from 0.175-0.254 ppm, and averaging 0.197 ppm. The difference between the two basins was not statistically significant. All of the 2018 standard-sized composites were substantially lower in mercury than corresponding samples from 2017, which averaged 0.312 ppm. The decrease was not statistically significant though, due to high variability in the 2017 samples. Also, despite the lower Mosquitofish levels in 2018, they were still statistically elevated over 2 of 3 Cache Creek baseline comparison sets.

Additional, Larger Sizes: The larger classes of Mosquitofish, ≥ 48 mm (1.9") and 0.04 g, were all very similar to each other in their mercury content, ranging narrowly between 0.283-0.307 ppm, with an overall mean of 0.295 ppm. It is interesting that the concentrations leveled off beyond app. 45 mm, rather than continuing to increase. Mercury in these larger fish was significantly higher than in the smaller, standard-sized fish from the same ponds. They are a measure for Mast of the maximum exposure to fish-eating herons and egrets, which preferentially target the larger fish.

Summary

Mast Pond continued to have a single fish species present, Mosquitofish. Samples in 2018 within the standard size ranges all showed a large drop in mercury levels, relative to 2017. However, in comparison to baseline Cache Creek Mosquitofish samples, the 2018 standard samples remained statistically elevated over 2 of the 3 creek data sets available and significantly similar to one. The Mast record was therefore elevated in two consecutive years, on average, over baseline and triggers remediation considerations at this time. It is recommended that water column profiling and sediment sampling be done at Mast to obtain more information.

Table 25. Teichert–Mast Pond: Small Fish Sampled, Fall 2018
(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)
Northwest Basin						
Standard, inter-comparable sizes						
Mosquitofish	**10**	28	1.1	0.2	0.01	**0.118**
Mosquitofish	**10**	33	1.3	0.4	0.01	**0.142**
Mosquitofish	**10**	37	1.5	0.6	0.02	**0.183**
Mosquitofish	**10**	43	1.7	0.9	0.03	**0.228**
Additional, larger sizes						
Mosquitofish	**8**	48	1.9	1.3	0.05	**0.293**
Mosquitofish	**6**	54	2.1	1.8	0.07	**0.294**
Mosquitofish	**5**	58	2.3	2.8	0.10	**0.302**
Southeast Basin						
Standard, inter-comparable sizes						
Mosquitofish	**10**	28	1.1	0.2	0.01	**0.181**
Mosquitofish	**10**	33	1.3	0.4	0.01	**0.177**
Mosquitofish	**10**	36	1.4	0.5	0.02	**0.175**
Mosquitofish	**10**	39	1.5	0.6	0.02	**0.254**
Additional, larger sizes						
Mosquitofish	**2**	49	1.9	1.1	0.04	**0.291**
Mosquitofish	**2**	53	2.1	1.5	0.05	**0.283**
Mosquitofish	**2**	63	2.5	3.1	0.11	**0.307**

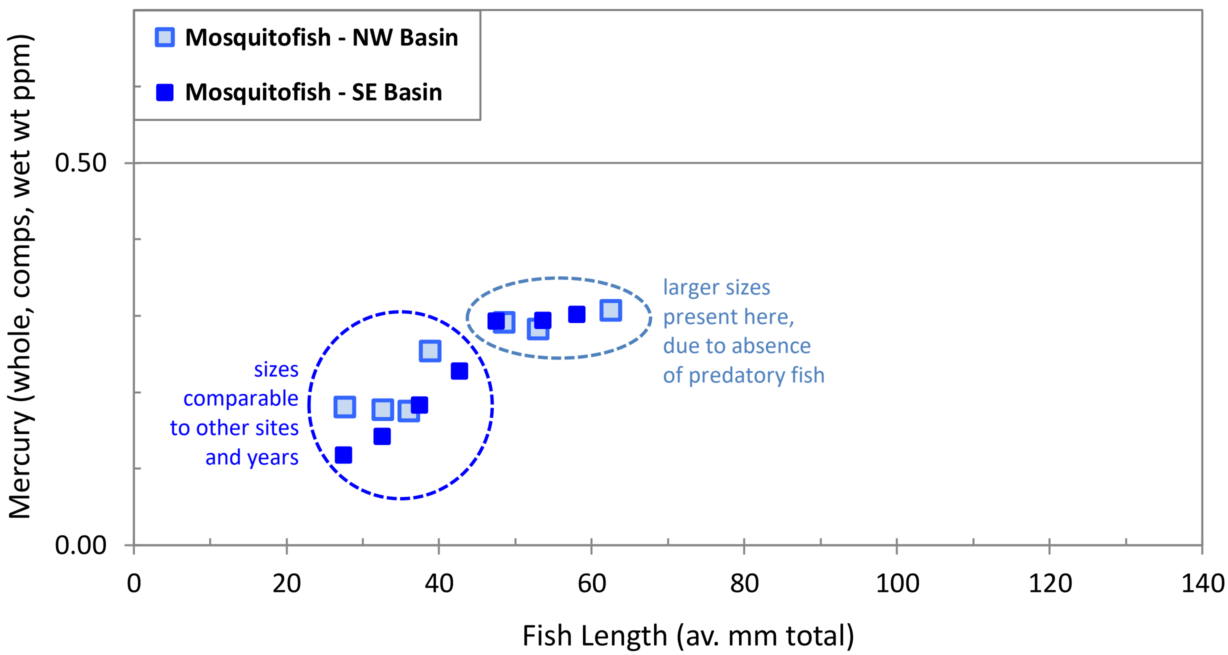


Figure 25. **Teichert–Mast Pond: Small Fish Sampled, Fall 2018**
(mercury in whole-body, multi-individual composite samples)

Table 26. 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 *(standard sizes comparable to other sites and dates)*							
Teichert – Mast (NW)	2017	4	10	35	0.5	0.351	± 0.154
Teichert – Mast (SE)	2017	4	10	35	0.5	0.273	± 0.111
Teichert – Mast (ALL)	2017	8	10	35	0.5	0.312	± 0.231
Teichert – Mast (NW)	2018	**4**	10	34	0.4	**0.197**	± 0.038
Teichert – Mast (SE)	2018	**4**	10	35	0.5	**0.168**	± 0.048
Teichert – Mast (All)	2018	**8**	10	34	0.5	**0.182**	± 0.043
(larger sizes present at Mast – due to absence of large, predatory fish; not comparable to other sites)							
Teichert – Mast 'giants'	2018	**6**	2-8	54	2.0	**0.295**	± 0.009
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**

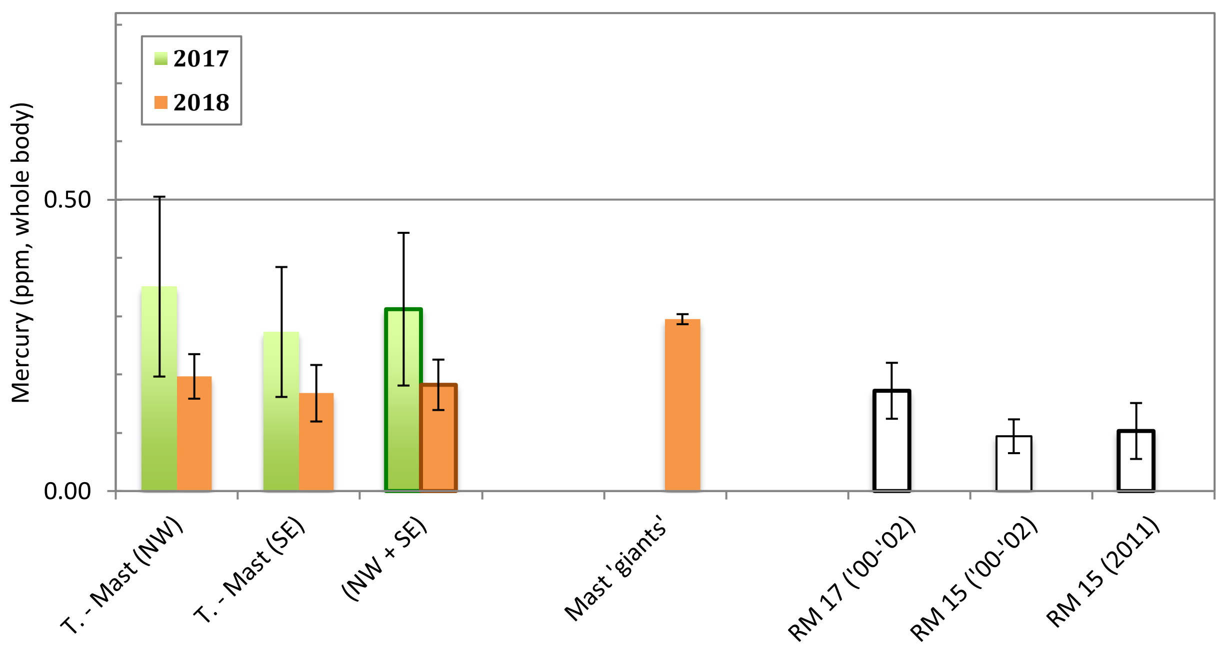


Figure 26. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

5. TEICHERT–STORZ POND

5. TEICHERT–STORZ POND *(Tables 27-31, Figures 27-31)*

This pond is part of the Teichert–Woodland operations, located approximately 7 river miles downstream from the Reiff and Mast Ponds and Teichert–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. Depths in 2018 were shallow, ranging to approximately 6 m (20'). Storz consists of 2 sub-basins that alternate between being connected and split, depending on runoff inputs. In Fall 2018, they were separated. Together, they are approximately 150 m x 800 m in size.

We began sampling this pond in 2016, but were unable to get our boat in at that time. By shore seining, we collected a good sample of Mosquitofish, (*Gambusia affinis,* 1-2") in 2016, but no additional species. In 2017, we were able to get our boat into the pond and sample more completely, making 2017 Year 1 of full sampling here. Since 2017, we have been able to collect Largemouth Bass (*Micropterus salmoides*) in addition to Mosquitofish. Bass were present in the 230-280 mm (9-11") size range. Twenty fish were sampled for fillet muscle mercury. Mosquitofish were again sampled with 4 size-class composites of 10 fish each. We were not able to collect juvenile bass, despite extensive seining.

In total, 20 large fish muscle samples and 4 small fish composite samples, or 24 separate mercury samples, were analyzed from the Teichert–Storz Pond in the Fall 2018 monitoring. The fish metrics and analytical results from each of the bass muscle and small fish composite samples are shown in Tables 27-28 and, graphically, in Figures 27-28. The data are shown in reduced form (means, error bars) and compared to the most closely comparable historic creek data in Tables 29-31 and Figures 29-31.

Large, Angling-sized Fish

Largemouth Bass

Twenty fish were sampled across the fairly narrow size range present at that time (237-280 mm or 9-11"). Fillet muscle mercury ranged between 0.330 and 0.960 ppm, averaging 0.611 ppm.

Levels were down slightly from 2017 (0.657 ppm); the difference was not statistically significant. Compared to other aggregate mining ponds being monitored at this time, Storz was the second lowest in bass mercury of the 6 ponds that contained bass. Relative to historic baseline creek comparison samples, they were lower than or similar to 5 of 7 sets and significantly higher than 2.

Small, Young Fish

Mosquitofish

The Mosquitofish composite samples had whole-body mercury ranging from 0.061-0.136 ppm, averaging 0.087 ppm. This was significantly lower than the 2016 and 2017 samples, which averaged 0.229 and 0.282 ppm respectively. This indicates a decline in general methylmercury exposure in the Storz Pond water in 2018. As compared to baseline creek samples, the 2018 Storz Pond Mosquitofish dropped to mercury levels lower than all 3 of the creek data sets, which averaged 0.094-0.172 ppm. The Storz 2018 level was significantly lower than the River Mile 17 average and statistically similar to the two River Mile 15 sets.

Juvenile Largemouth Bass

Juvenile bass were apparently a food item of choice for the larger bass, judging by their absence in many extensive seining attempts. Data from 2017 are included in the table and figure.

Summary

The primary, large fish sample of bass had mercury similar to 2017 and within the historic range of comparable baseline creek fish. Storz was second lowest in bass mercury of the 6 monitored ponds that contained bass. The Mosquitofish small fish composite samples showed a large drop from 2017, to levels at or below all baseline creek comparisons. This indicates a 2018 reduction in general methylmercury exposure levels in the water. That may result in a decline in large fish mercury next year. This pond continues to rank as "not elevated over baseline".

Table 27. Teichert–Storz Pond: Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	237	9.3	140	0.3	**0.437**
Largemouth Bass	240	9.4	160	0.4	**0.674**
Largemouth Bass	242	9.5	158	0.3	**0.423**
Largemouth Bass	243	9.6	187	0.4	**0.330**
Largemouth Bass	247	9.7	168	0.4	**0.538**
Largemouth Bass	247	9.7	193	0.4	**0.376**
Largemouth Bass	248	9.8	202	0.4	**0.568**
Largemouth Bass	249	9.8	192	0.4	**0.567**
Largemouth Bass	251	9.9	199	0.4	**0.388**
Largemouth Bass	254	10.0	210	0.5	**0.676**
Largemouth Bass	256	10.1	203	0.4	**0.747**
Largemouth Bass	256	10.1	185	0.4	**0.509**
Largemouth Bass	257	10.1	200	0.4	**0.646**
Largemouth Bass	259	10.2	225	0.5	**0.807**
Largemouth Bass	264	10.4	215	0.5	**0.844**
Largemouth Bass	266	10.5	210	0.5	**0.504**
Largemouth Bass	268	10.6	222	0.5	**0.722**
Largemouth Bass	269	10.6	190	0.4	**0.829**
Largemouth Bass	270	10.6	223	0.5	**0.960**
Largemouth Bass	280	11.0	260	0.6	**0.680**

Table 28. Teichert–Storz Pond: Small Fish Sampled, Fall 2018
(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**	26	1.0	0.2	0.01	**0.061**
Mosquitofish	**10**	29	1.1	0.2	0.01	**0.076**
Mosquitofish	**10**	31	1.2	0.3	0.01	**0.074**
Mosquitofish	**10**	34	1.3	0.4	0.01	**0.136**

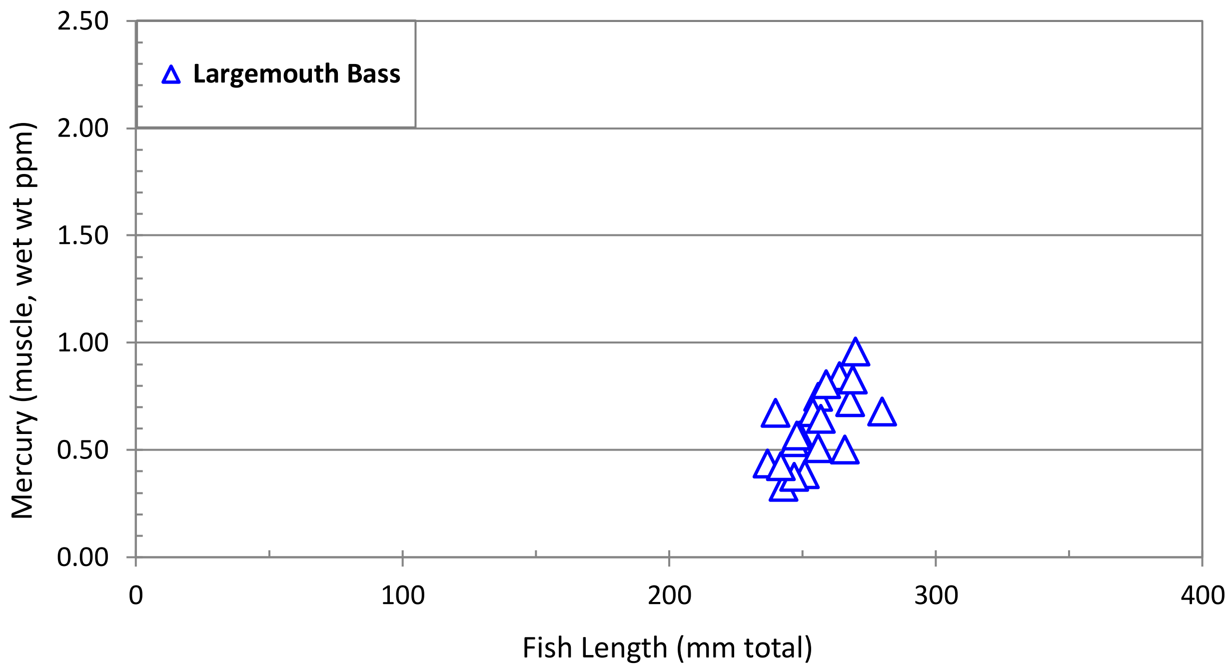


Figure 27. Teichert–Storz Pond: Large Fish Sampled, Fall 2018
(mean fillet muscle mercury, with 95% confidence intervals)

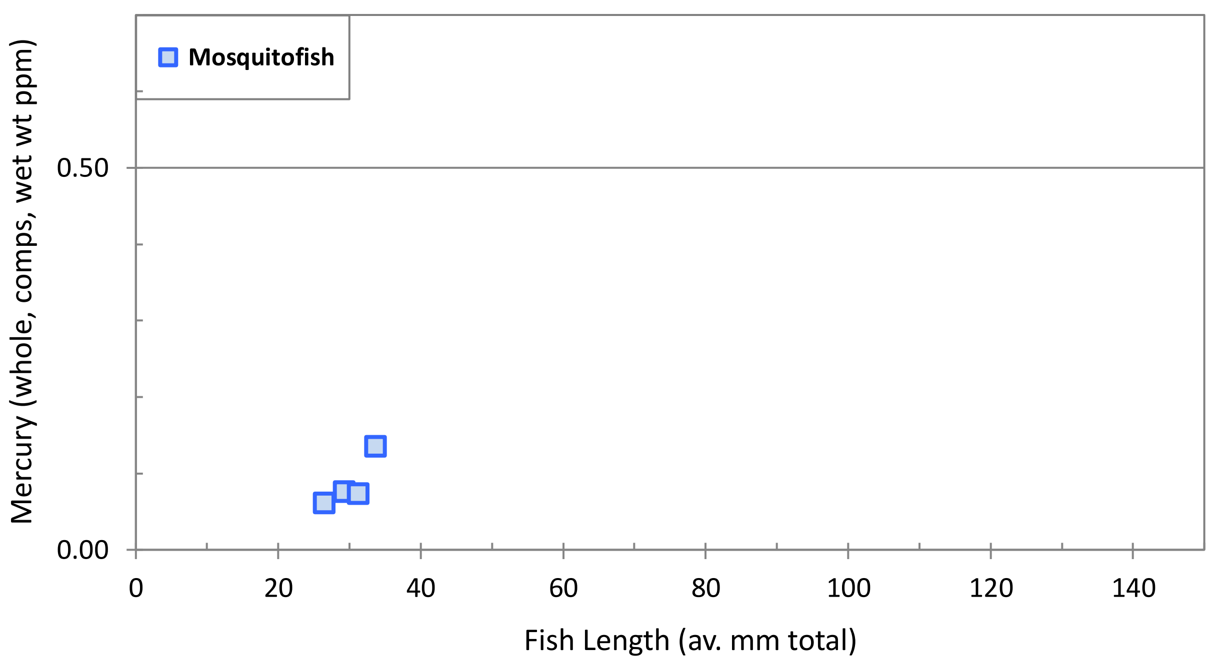


Figure 28. Teichert–Storz Pond: Small Fish Sampled, Fall 2018
(mercury in whole-body, multi-individual composite samples)

Table 29. 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.
Teichert – Storz	2017	**20**	245	203	**0.657**	± 0.038
Teichert – Storz	2018	20	255	197	**0.611**	± 0.082
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**

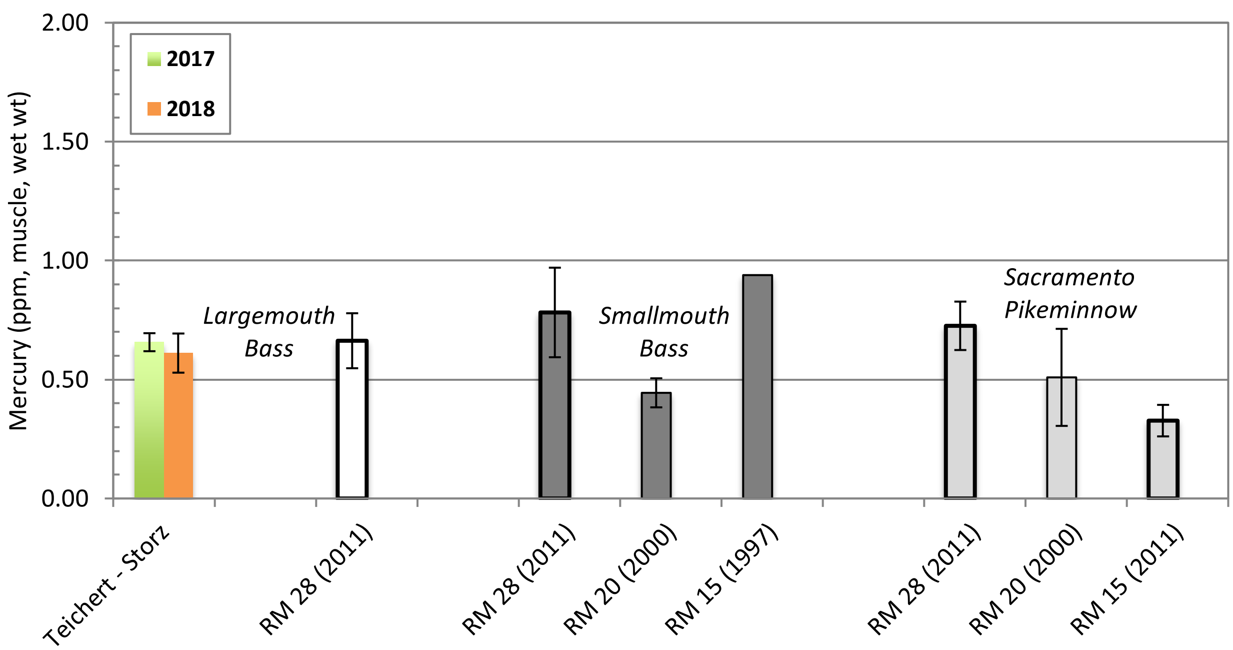


Figure 29. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

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							
Teichert – Storz	2016	**4**	10	35	0.5	**0.229**	± 0.109
Teichert – Storz	2017	**4**	8-10	29	0.2	**0.282**	± 0.022
Teichert – Storz	2018	**4**	10	30	0.3	**0.087**	± 0.033
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**

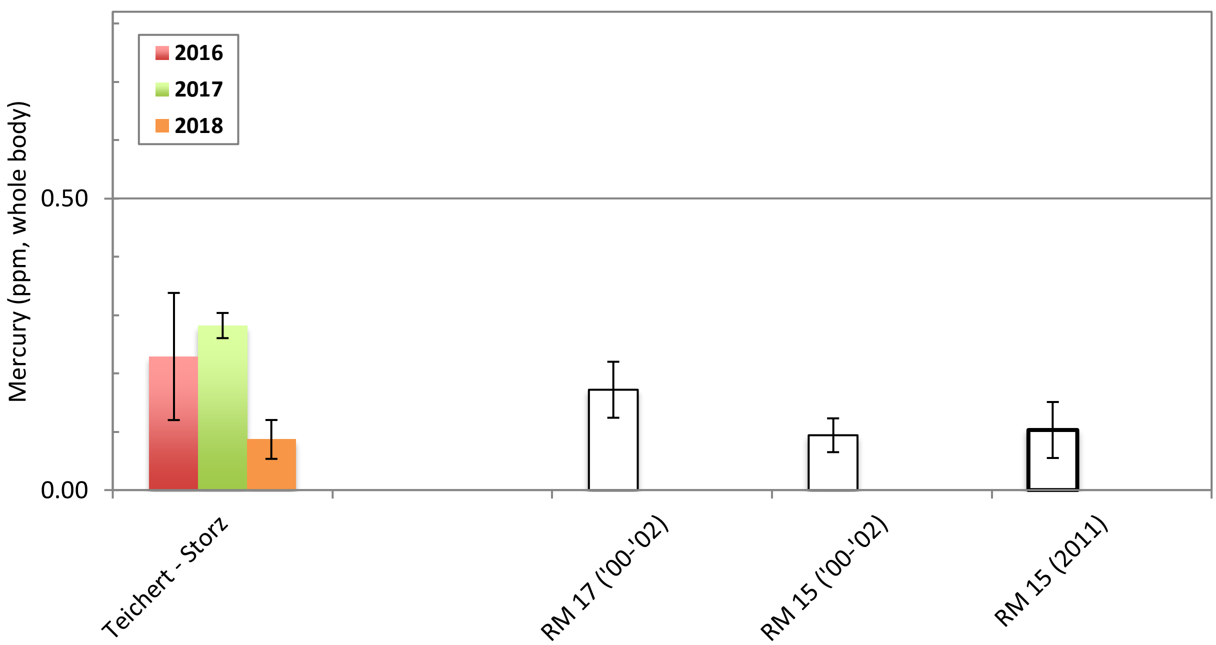


Figure 30. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 31. 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)							
Teichert – Storz	2017	**4**	1	143	35	**0.337**	± 0.059
Teichert – Storz	2018	–	–				
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**

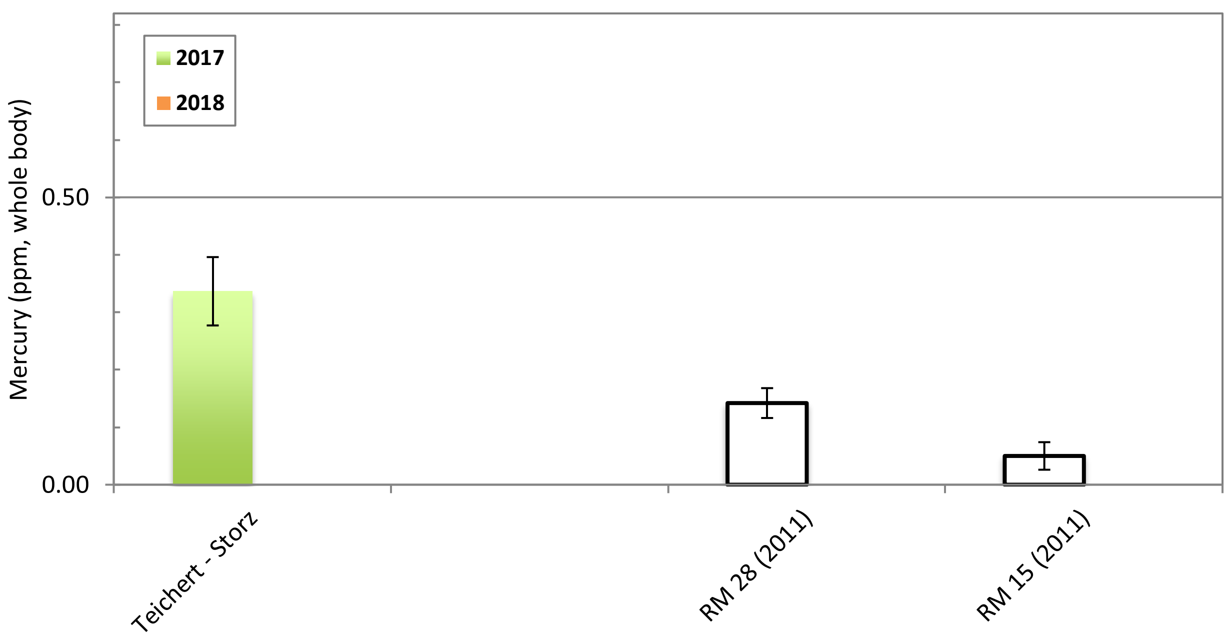


Figure 31. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

6. SYAR–B1 POND

6. SYAR–B1 POND *(Tables 32-38, Figures 32-38)*

The Syar Cache Creek mining operation, begun before 2002, has been idle since 2011 and remained inactive throughout the 4 years it has been monitored (2015-2018). The site is located south of Cache Creek and west of Highway 505, between 505 and County Road 87. There are two mid-sized ponds at the site. One has an irregular shape about 500 m long x 75-200 m wide. The other, located to the west, is approximately 300 m x 400 m in size. 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 since 2015, and refer to that as the Syar–B1 Pond. Beginning in 2017, we also sampled the western pond (Syar–West Pond), discussed in the next section. This (2018) was Year 4 of monitoring for the Syar – B1 Pond.

The B1 Pond is located in a steep-sided surrounding depression. Following years of drought conditions, the heavier rainfall inputs of 2017 and 2018 raised the water level by at least 10 feet. Maximum depth throughout the 2018 sampling year ranged between 7.6 and 10.1 m (25-33 feet).

As at the other sites, we sampled the B1 Pond during day, twilight, and night conditions on multiple days and with a range of techniques. We were able to obtain good samples of most of the fish species present. Fishing pressure has been heavy and obvious at this pond, mostly from Esparto teenagers. At this point, we have talked to enough of them that the word has spread to not take and eat the fish; there is now a lot of mostly catch and release fishing. That does, however, train the fish to be wary, making our collections more difficult, but we were still able to get a good cross section of bass. The 2018 collections included a full set of 20 Largemouth Bass (*Micropterus salmoides*) fillet muscle samples. The small, young fish present were juvenile Largemouth Bass (3-4"), juvenile Green Sunfish (1-2") and Mosquitofish (*Gambusia affinis*, 1-2"). Each of these were sampled with 4 multi-individual composites.

In total, 20 large fish muscle samples and 12 young, small fish composite samples, or 32 separate mercury samples, were analyzed from the Syar–B1 Pond in the Fall 2018 monitoring. The fish metrics and analytical results from each individual large fish muscle sample and each small, young fish composite sample can be seen in Tables 32 and 33 and, graphically, in Figures 32 and 33. Then, for each sample type, the new data are shown in reduced form (means, error bars, etc.) and compared to 2015-2017 results and the most closely comparable historic creek data (Tables 34-38, Figures 34-38).

Large, Angling-sized Fish

Largemouth Bass

The B1 Pond adult Largemouth Bass samples had fillet muscle mercury ranging from 0.552-1.973 ppm, averaging 0.977 ppm. This was statistically unchanged from 2017 (0.904 ppm) and remained significantly down, by approximately 40%, from the levels found in 2015-2016 when they averaged 1.628 and 1.640 ppm, which were extremely high fish mercury levels. After previously being significantly higher than all 7 comparable baseline/historic samples from Cache Creek, the 2017-2018 decline in bass mercury concentrations brought the B1 Pond fish into a range statistically similar to 4 of 7 baseline comparisons. It can be seen in Figure 32 that the bulk of the 2018 fish clustered in a narrower and lower range of mercury concentrations (0.552-1.146 ppm, mean = 0.815 ± 0.164 ppm, n=17). In contrast, three of the largest and oldest individuals contained much higher levels at 1.804-1.973 ppm (mean = 1.895 ± 0.085, n=3). Relative to the creek baseline comparison data sets, the 2018 Syar–B1 Pond bass were statistically similar to 4 of 7 and statistically higher than 3, whether the larger/older 3 fish are included or not.

Green Sunfish

Adult Green Sunfish could not be found for collection in 2018. We are including data from previous years in Table 35 and Fig. 35 for completion.

Small, Young Fish

Juvenile Largemouth Bass

The juvenile bass composite samples had whole-body mercury ranging from 0.329-0.425 ppm, averaging 0.368 ppm. This was down somewhat, relative to samples analyzed in 2017 (0.461 ppm). The juvenile bass have come down in mercury each year since 2015 (0.589 ppm). The

2018 samples were significantly lower than corresponding samples from 2015 and 2016, and statistically similar to the 2017 fish. Relative to baseline juvenile bass comparison data from Cache Creek, they still 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 0.169-0.273 ppm, averaging 0.231 ppm. This was essentially identical to corresponding collections from 2017 (0.225 ppm). This was down, relative to fish analyzed in 2015 (0.325 ppm) and significantly lower than the 2016 sample (0.414 ppm). Relative to baseline juvenile Green Sunfish comparison numbers from Cache Creek, they remained higher despite the decline of the last two years. The difference was statistically significant for 4 of the 5 comparisons.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.127-0.245 ppm, averaging 0.163 ppm. This was significantly lower than previous corresponding collections in 2015 (0.268 ppm) and 2017 (0.309 ppm). Mosquitofish could not be found at the B1 Pond in 2016. The 2018 Mosquitofish mercury levels dropped into a range statistically similar to all 3 comparable Cache Creek sample sets from River Miles 15 and 17 (0.094-0.172 ppm).

Summary

In summary, fish mercury in the Syar–B1 Pond remained lower than in 2015-2016, after a substantial decline in 2017. In particular, available samples of adult Largemouth Bass remained down from previous (very high) levels, by more than 40%. Juvenile bass and Green Sunfish also remained at reduced levels similar to 2017. Mosquitofish showed a significant decline over 2017. In comparison to corresponding baseline/historic samples from Cache Creek, the B1 Pond juvenile bass were still significantly higher in mercury, despite recent declines. Juvenile Green Sunfish remained significantly higher than 4 of 5 comparisons. Mosquitofish, however, dropped to a range statistically similar to all 3 baseline creek comparisons. Adult bass, which had previously been significantly higher than all available baseline creek comparisons, were at a level statistically similar to 4 of 7 comparison sets. They remained significantly higher than 3 of the 7.

Because of the overall status of the B1 Pond as "elevated over baseline in 2 or more consecutive years", water column profiling and collection of bottom sediments was started here in 2018.

Table 32. Syar–B1 Pond: Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	242	9.5	150	0.3	**1.095**
Largemouth Bass	243	9.6	150	0.3	**0.809**
Largemouth Bass	253	10.0	185	0.4	**0.751**
Largemouth Bass	258	10.2	195	0.4	**0.614**
Largemouth Bass	259	10.2	210	0.5	**0.573**
Largemouth Bass	267	10.5	230	0.5	**0.724**
Largemouth Bass	267	10.5	215	0.5	**0.882**
Largemouth Bass	277	10.9	280	0.6	**0.792**
Largemouth Bass	278	10.9	245	0.5	**0.552**
Largemouth Bass	281	11.1	290	0.6	**0.805**
Largemouth Bass	283	11.1	270	0.6	**0.904**
Largemouth Bass	284	11.2	265	0.6	**0.904**
Largemouth Bass	297	11.7	335	0.7	**0.847**
Largemouth Bass	330	13.0	460	1.0	**0.978**
Largemouth Bass	339	13.3	555	1.2	**0.738**
Largemouth Bass	341	13.4	525	1.2	**1.146**
Largemouth Bass	344	13.5	500	1.1	**1.907**
Largemouth Bass	346	13.6	495	1.1	**0.738**
Largemouth Bass	354	13.9	515	1.1	**1.973**
Largemouth Bass	360	14.2	625	1.4	**1.804**

Table 33. Syar–B1 Pond: Small Fish Sampled, Fall 2018
(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**	79	3.1	6.0	0.21	**0.354**
Largemouth Bass (juv)	**2**	84	3.3	7.3	0.26	**0.329**
Largemouth Bass (juv)	**2**	88	3.4	8.4	0.29	**0.365**
Largemouth Bass (juv)	**2**	101	4.0	12.7	0.45	**0.425**
Green Sunfish (juv)	**10**	31	1.2	0.4	0.02	**0.169**
Green Sunfish (juv)	**10**	36	1.4	0.7	0.03	**0.239**
Green Sunfish (juv)	**10**	39	1.5	0.9	0.03	**0.245**
Green Sunfish (juv)	**10**	43	1.7	1.3	0.04	**0.273**
Mosquitofish	**9**	24	0.9	0.1	0.00	**0.127**
Mosquitofish	**7**	27	1.1	0.2	0.01	**0.135**
Mosquitofish	**6**	33	1.3	0.4	0.01	**0.143**
Mosquitofish	**6**	38	1.5	0.7	0.02	**0.245**

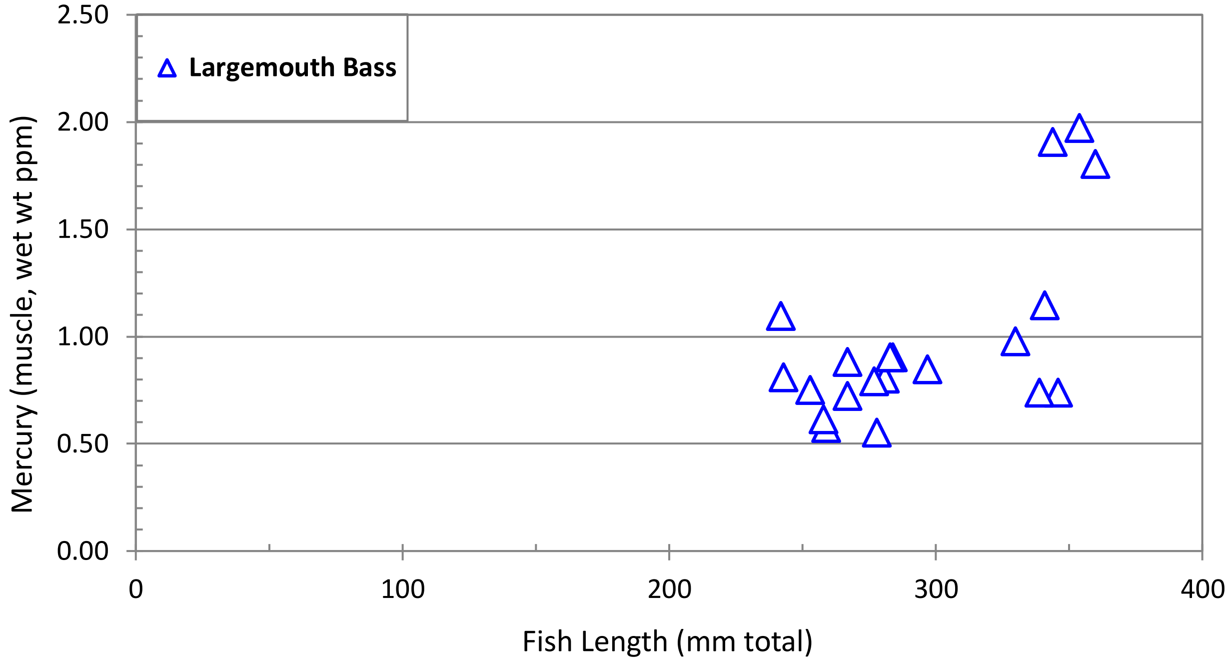


Figure 32. **Syar–B1 Pond: large fish sampled, Fall 2018**
(fillet muscle mercury in individual fish)

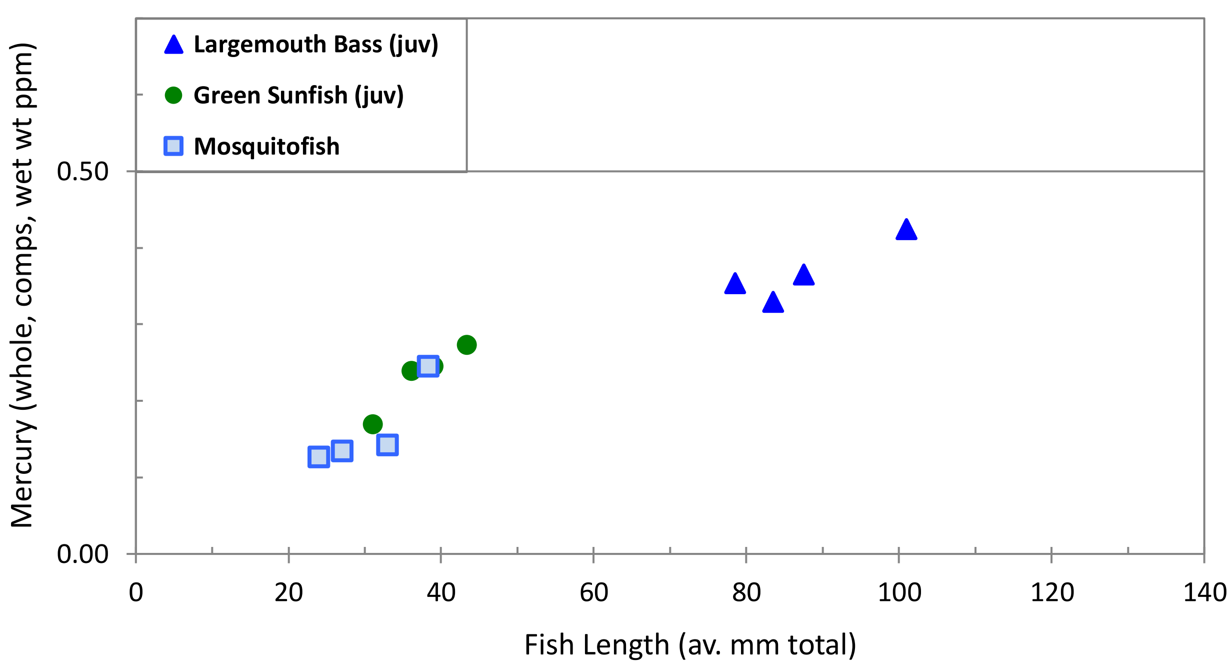


Figure 33. **Syar–B1 Pond: small, young fish sampled, Fall 2018**
(mercury in whole-body, multi-individual composite samples)

Table 34. 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	2015	**18**	281	355	**1.628**	± 0.332
Syar – B1	2016	**20**	318	489	**1.640**	± 0.152
Syar – B1	2017	**16**	260	265	**0.904**	± 0.239
Syar – B1	2018	20	295	335	**0.977**	± 0.198
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**

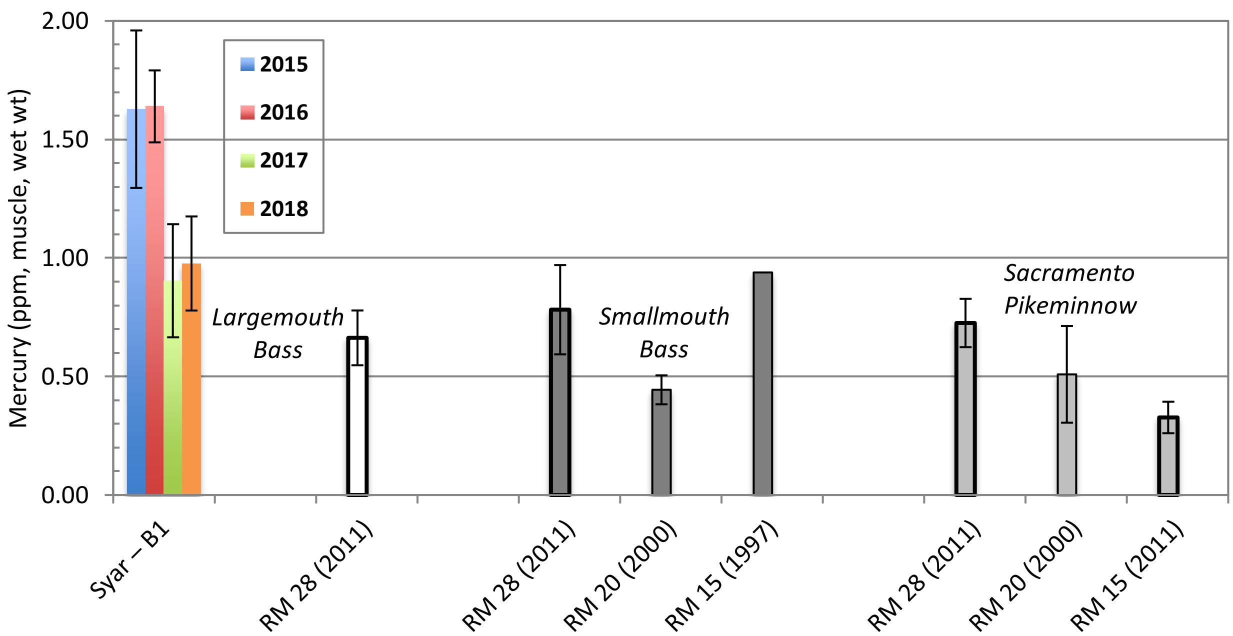


Figure 34. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 35. 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	2015	**10**	118	25	**0.777**	± 0.086
Syar – B1	2016	**1**	83	12	**1.446**	
Syar – B1	2017	**–**				
Syar – B1	2018	–				
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**

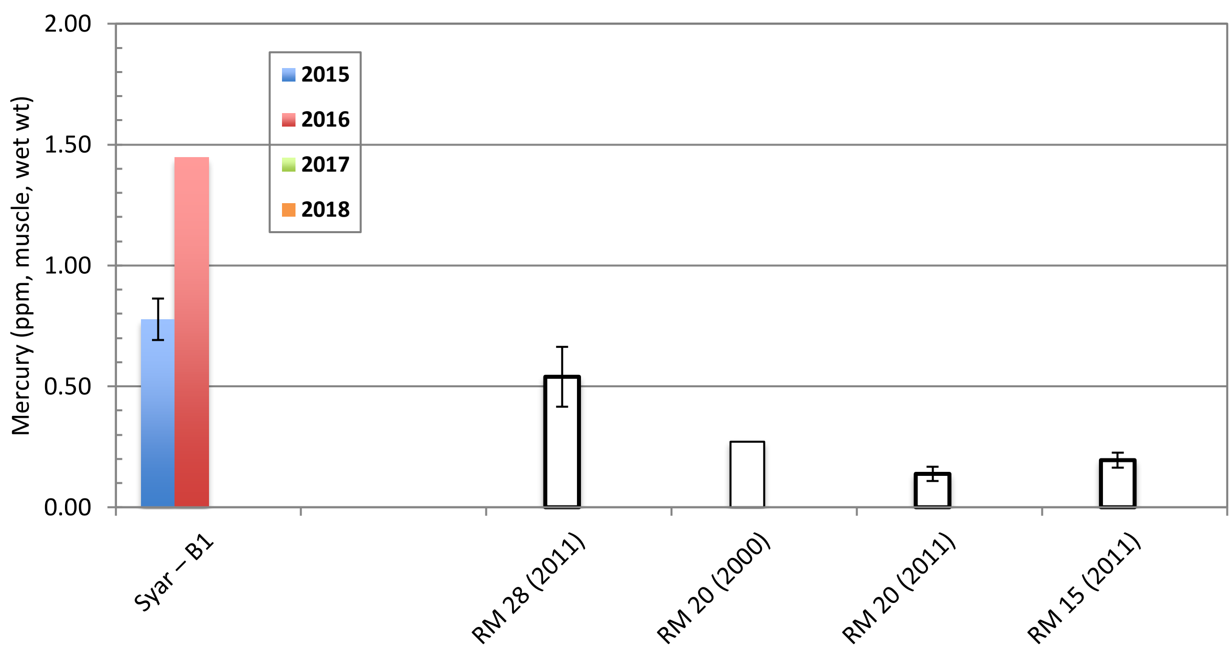


Figure 35. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 36. 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	2015	**4**	7	159	44	**0.589**	± 0.030
Syar – B1	2016	**4**	10	74	5	**0.524**	± 0.119
Syar – B1	2017	**4**	1-2	102	18	**0.461**	± 0.175
Syar – B1	2018	**4**	2	88	9	**0.368**	± 0.040
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**

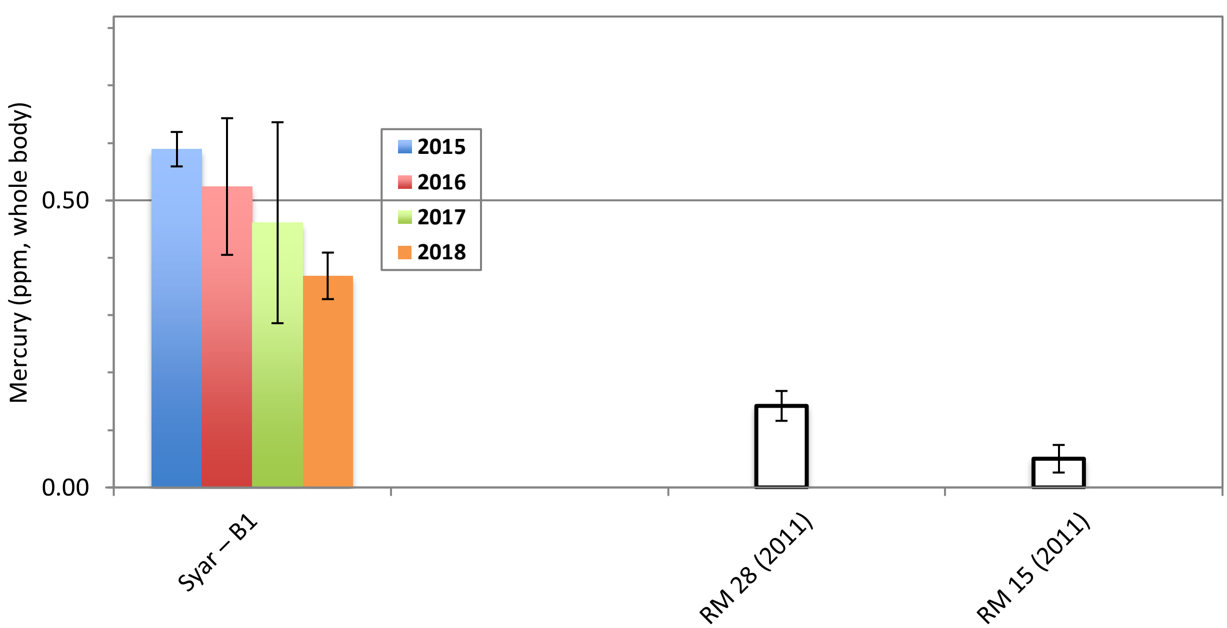


Figure 36. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 37. 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	2015	**4**	8-9	47	1.7	**0.325**	± 0.097
Syar – B1	2016	**4**	4	50	1.9	**0.414**	± 0.076
Syar – B1	2017	**4**	6-7	40	1.0	**0.225**	± 0.069
Syar – B1	2018	**4**	10	37	0.8	**0.231**	± 0.044
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**

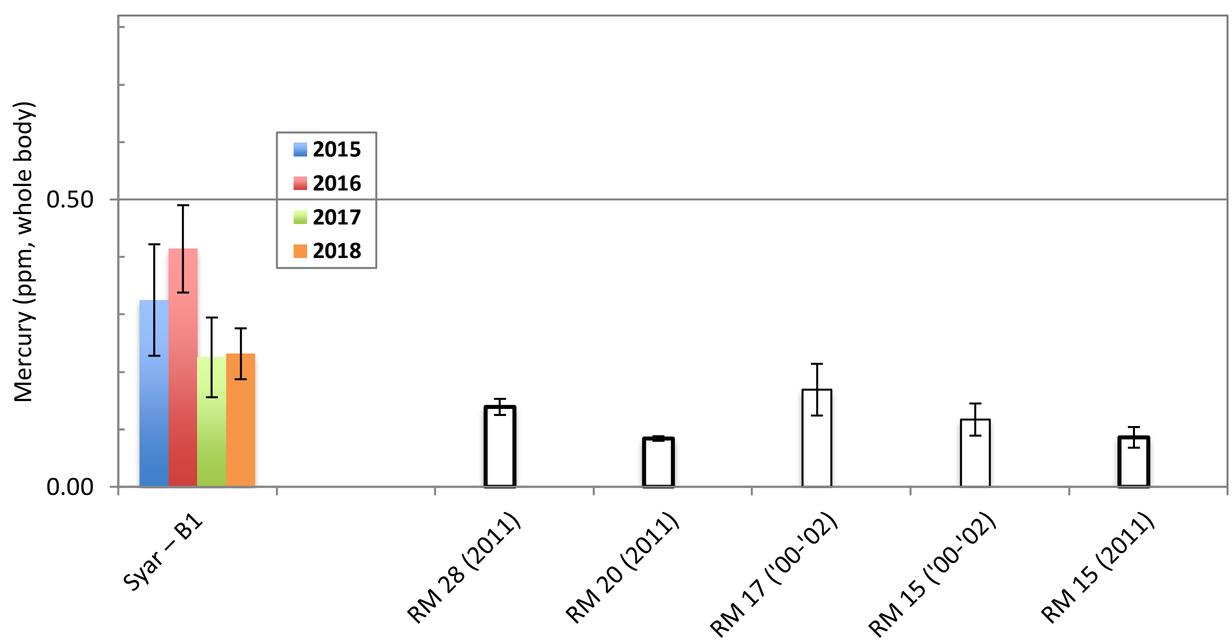


Figure 37. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 38. 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	2015	**4**	5-10	31	0.3	**0.268**	± 0.043
Syar – B1	2016	**–**	–	–	–	**–**	
Syar – B1	2017	**4**	9-10	35	0.4	**0.309**	± 0.110
Syar – B1	2018	**4**	6-9	31	0.4	**0.163**	± 0.056
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**

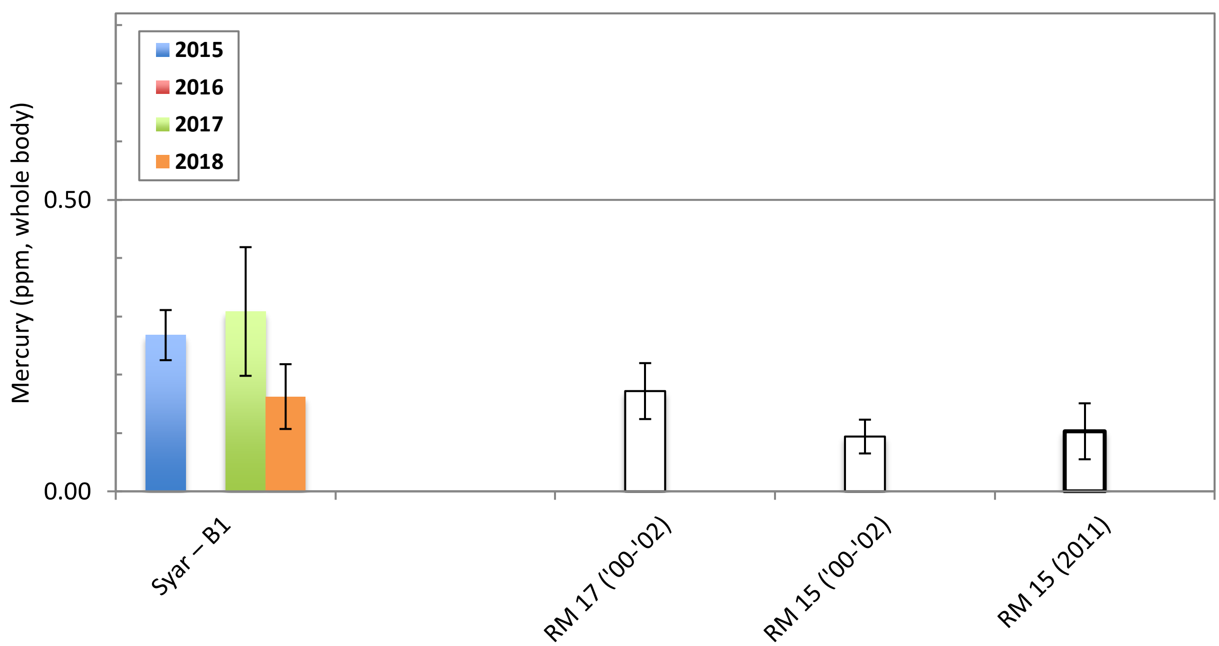
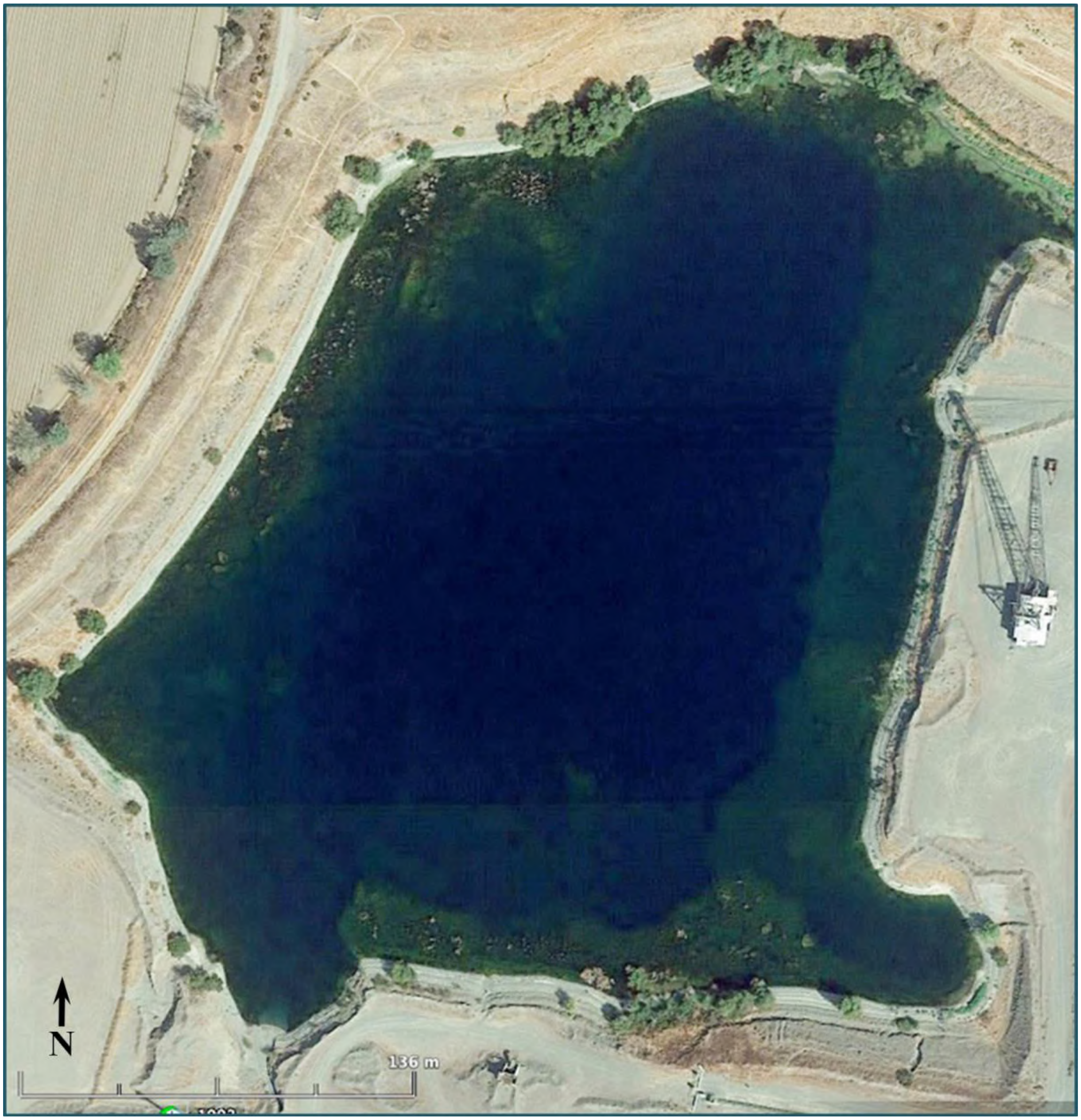


Figure 38. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

7. SYAR–WEST POND



7. SYAR–WEST POND *(Tables 39-45, Figures 39-45)*

As described in the previous section, this pond is located about half a kilometer west of the B1 Pond. It is approximately 300 m x 400 m in size. The West Pond is considerably deeper overall than the B1 Pond, with extensive areas more than 9 m (30 feet) deep. This pond was added to the monitoring in 2017, in line with the Ordinance. This (2018) was Year 2 of monitoring for the Syar–West Pond.

As at the other sites, we sampled the West Pond during day, twilight, and night conditions on multiple days with a range of techniques. We were able to obtain useful samples of most of the fish species present. These included fillet muscle samples of a full set of 20 Largemouth Bass (*Micropterus salmoides*). The small, young fish present were juvenile Largemouth Bass (2-4"), juvenile Green Sunfish (*Lepomis cyanellus*, 1-2") and Mosquitofish (*Gambusia affinis*, 1-2"). Each of these was sampled with 4 multi-individual composites.

In total, 20 large fish muscle samples and 12 small fish composite samples, or 32 separate mercury samples, were analyzed from the Syar–West Pond in the Fall 2018 monitoring. The analytical results from each individual large fish muscle sample and each small, young fish composite sample can be seen in Tables 39 and 40 and, graphically, in Figures 39 and 40. Then, for each sample type, the new data are shown in reduced form (means, error bars, etc.) and compared to the most closely comparable historic creek data (Tables 41-45, Figures 41-45).

Large, Angling-sized Fish

Largemouth Bass

The West Pond adult Largemouth Bass samples had fillet muscle mercury ranging from 0.193-2.398 ppm, averaging 0.798 ppm. This was down somewhat from 2017 (0.925 ppm), though not significantly. As noted in the nearby B1 Pond, the bulk of the fish ($\leq$ app. 350 mm) clustered in a narrower range of concentrations (0.193-1.180 ppm, mean = 0.678 $\pm$ 0.289 ppm, n=18). This was statistically similar to the levels found in similar bass from the B1 Pond, which averaged 0.815 $\pm$ 0.164 ppm. Relative to historic/baseline creek comparisons, the full 2018 Syar – West Pond bass sample was statistically similar to 5 of the 7 comparison data sets and remained significantly higher than 2 of 7. The main cohort of 2018 bass described above (n=18) were not significantly higher in mercury than any of the corresponding creek samples.

Green Sunfish

Adult Green Sunfish could not be found for collection in 2018. We are including data from 2017 in Table 42 and Fig. 42 for completion.

Small, Young Fish

Juvenile Largemouth Bass

The juvenile bass had whole-body mercury of 0.118-0.305 ppm, averaging 0.153 ppm. This was down significantly from 2017 (0.418 ppm). This may be partly a function of smaller fish sizes in 2018 (averaging 77 mm and 6 g) vs. 2017 (123 mm, 27 g), but the drop was large in any case. As compared to corresponding samples from the adjacent B1 Pond (0.368 ppm), levels were significantly lower. Relative to baseline juvenile bass comparison data from Cache Creek, the 2018 juvenile bass were statistically similar to the River Mile 28 samples (0.142 ppm) and statistically higher than the set from River Mile 15 (0.050 ppm).

Juvenile Green Sunfish

The juvenile Green Sunfish multiple-fish composites had whole-body mercury ranging from 0.077-0.113 ppm, averaging 0.102 ppm. As just discussed for juvenile bass, this was a large, and significant, decline from 2017 (0.237 ppm). Also as seen in the juvenile bass, the Syar – West Pond juvenile Green Sunfish were significantly lower in mercury than corresponding samples from the nearby B1 Pond (0.231 ppm). Relative to baseline/historic juvenile Green Sunfish comparisons from Cache Creek, the 2018 Syar–West Pond samples were statistically similar in mercury levels to 3 baseline sets and significantly lower than 2.

Mosquitofish

The Mosquitofish multiple-fish composites had whole-body mercury ranging from 0.073-0.123 ppm, averaging 0.088 ppm. Consistent with the other Syar–West Pond 2018 small fish findings, this was down steeply and significantly from 2017 (0.236 ppm). It was also significantly lower than the corresponding samples from the B1 Pond (0.163 ppm). As compared to historic Cache Creek samples, the 2018 Syar–West Pond Mosquitofish mercury levels were statistically similar to 3 of 5 baseline sets and significantly lower than 2.

Summary

In summary, all 3 small fish indicator species showed a large, statistically significant drop in mercury levels between 2017 and 2018. This was a clear indication of lower methylmercury exposure levels in 2018. The reasons for this are not obvious at this time. Annual precipitation was 19.0" in 2018, vs. 27.2" in 2017, 22.9" in 2016, and drought conditions (8.2") in 2015. The adult bass also dropped in average concentrations, though the change was not statistically significant. That is typical for large fish, even with big swings in methylmercury exposure conditions, as the adult fish mercury levels are a function of accumulation across all the years of their growth, so the effects of any one year are muted. The 2018 decline in fish mercury in the Syar–West Pond was larger than what was found in the nearby B1 Pond; the West Pond small fish all dropped to levels significantly below those in the B1 Pond. In comparison to corresponding baseline/historic samples from Cache Creek, the West Pond small fish in 2018 were statistically similar to or significantly lower in mercury for 11 of 12 comparisons. The juvenile bass were still significantly higher than one baseline comparison. The adult Largemouth Bass were statistically similar to 5 of the 7 baseline comparison data sets and remained significantly higher than 2 of 7. The main cohort of 2018 bass at or below about 350 mm (14") were not significantly higher in mercury than any of the corresponding creek samples. Despite being statistically elevated over baseline in 2017, on average across all sample types, that was not the case in 2018. Therefore, the Syar–West Pond fish have not been "elevated over baseline for 2 or more consecutive years" and do not trigger remediation considerations at this time.

Table 39. Syar–West Pond: Large fish sampled, Fall 2018

Fish Species	Fish Total Length (mm)	(inches)	Fish Weight (g)	(lbs)	Muscle Mercury (µg/g = ppm, wet wt)
Largemouth Bass	218	8.6	120	0.3	**0.768**
Largemouth Bass	220	8.7	105	0.2	**0.433**
Largemouth Bass	223	8.8	125	0.3	**0.193**
Largemouth Bass	235	9.3	150	0.3	**0.392**
Largemouth Bass	237	9.3	140	0.3	**0.645**
Largemouth Bass	239	9.4	150	0.3	**0.663**
Largemouth Bass	240	9.4	165	0.4	**0.363**
Largemouth Bass	241	9.5	155	0.3	**0.651**
Largemouth Bass	242	9.5	155	0.3	**0.602**
Largemouth Bass	248	9.8	185	0.4	**0.303**
Largemouth Bass	257	10.1	190	0.4	**0.676**
Largemouth Bass	290	11.4	290	0.6	**0.691**
Largemouth Bass	296	11.7	310	0.7	**1.036**
Largemouth Bass	308	12.1	345	0.8	**1.034**
Largemouth Bass	310	12.2	370	0.8	**1.148**
Largemouth Bass	318	12.5	410	0.9	**0.876**
Largemouth Bass	335	13.2	470	1.0	**0.546**
Largemouth Bass	343	13.5	570	1.3	**1.180**
Largemouth Bass	370	14.6	665	1.5	**1.356**
Largemouth Bass	396	15.6	760	1.7	**2.398**

Table 40. Syar–West Pond: Small Fish Sampled, Fall 2018

(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**	65	2.5	3.5	0.12	**0.187**
Largemouth Bass (juv)	**1**	74	2.9	5.3	0.19	**0.118**
Largemouth Bass (juv)	**2**	81	3.2	6.5	0.23	**0.234**
Largemouth Bass (juv)	**2**	87	3.4	8.2	0.29	**0.305**
Green Sunfish (juv)	**4**	29	1.1	0.4	0.01	**0.108**
Green Sunfish (juv)	**2**	34	1.3	0.7	0.02	**0.077**
Green Sunfish (juv)	**2**	35	1.4	0.7	0.02	**0.113**
Green Sunfish (juv)	**3**	37	1.5	0.8	0.03	**0.112**
Mosquitofish	**6**	24	1.0	0.1	0.00	**0.075**
Mosquitofish	**7**	27	1.1	0.2	0.01	**0.073**
Mosquitofish	**7**	30	1.2	0.3	0.01	**0.081**
Mosquitofish	**6**	37	1.4	0.5	0.02	**0.123**

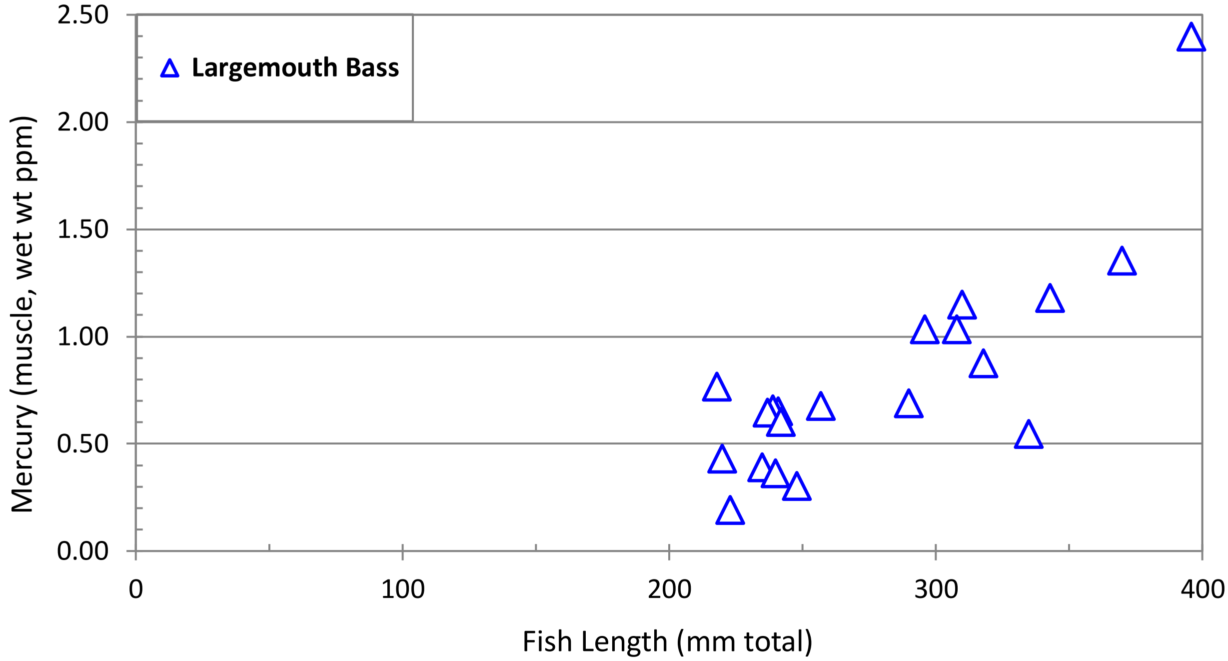


Figure 39. **Syar–West Pond: large fish sampled, Fall 2018**
(fillet muscle mercury in individual fish)

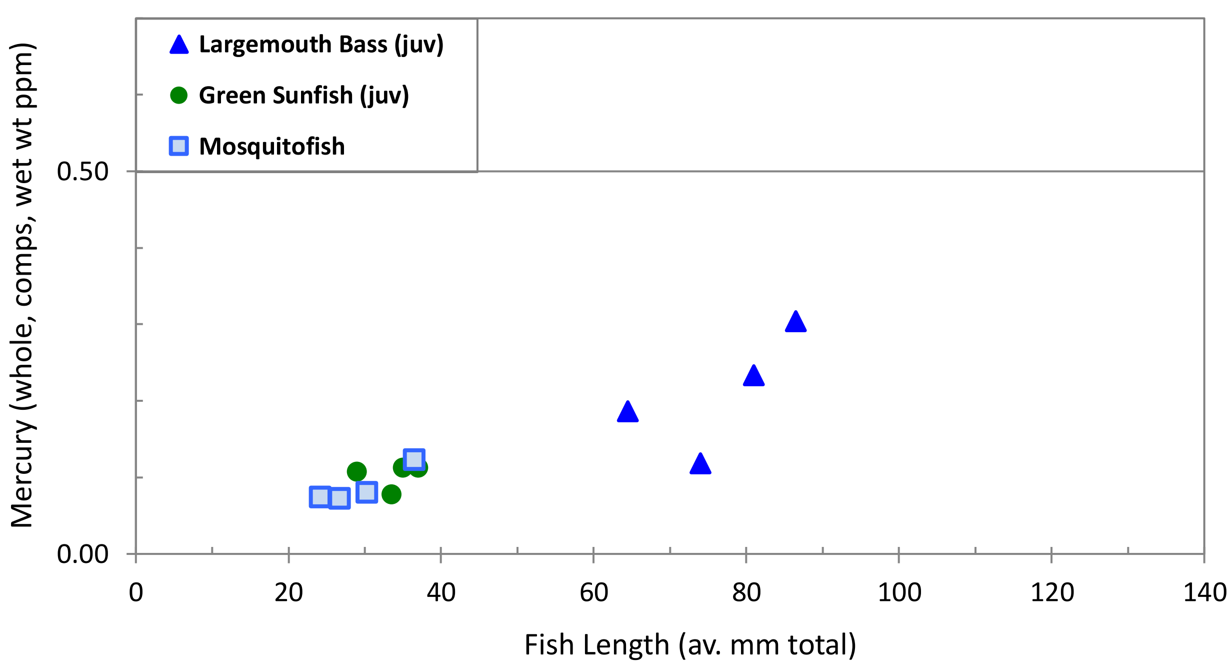


Figure 40. **Syar–West Pond: small, young fish sampled, Fall 2018**
(mercury in whole-body, multi-individual composite samples)

Table 41. 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 – West Pond	2017	**17**	283	320	**0.925**	± 0.205
Syar – West Pond	2018	20	278	292	**0.798**	± 0.229
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**

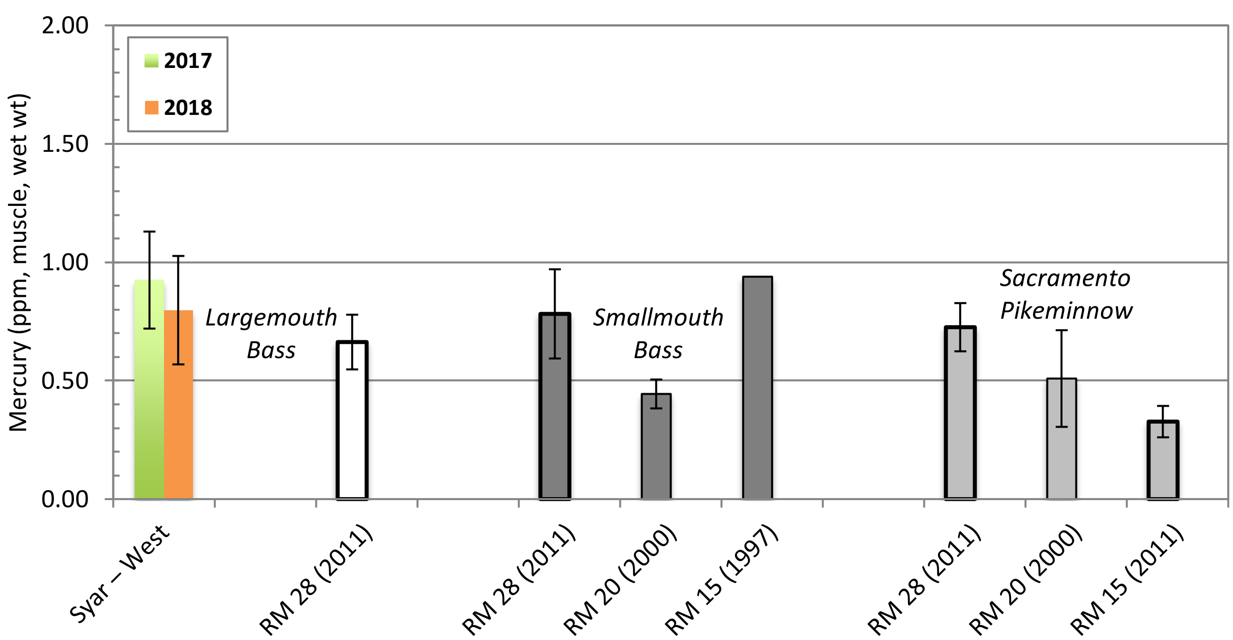


Figure 41. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 42. 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 – West Pond	2017	**4**	93	12	**0.579**	± 0.089
Syar – West Pond	2018	–				
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**

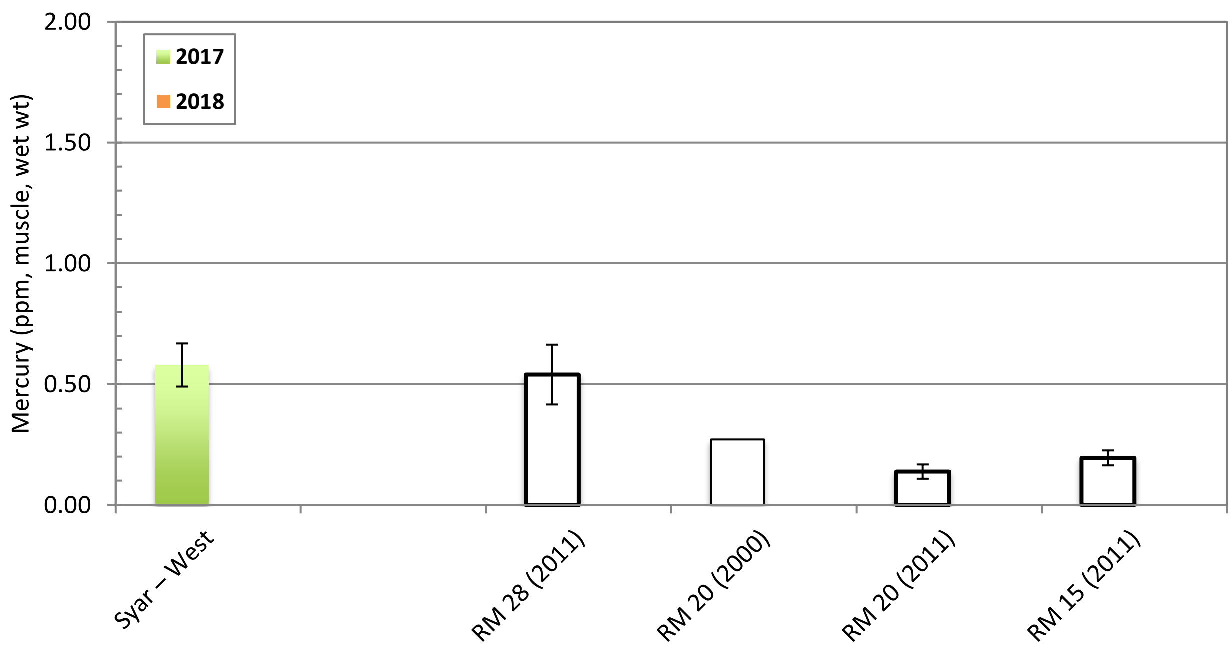


Figure 42. Green Sunfish summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 43. 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 – West Pond	2017	**2**	1	123	27	**0.418**	± 0.042
Syar – West Pond	2018	**4**	2	77	6	**0.153**	± 0.048
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**

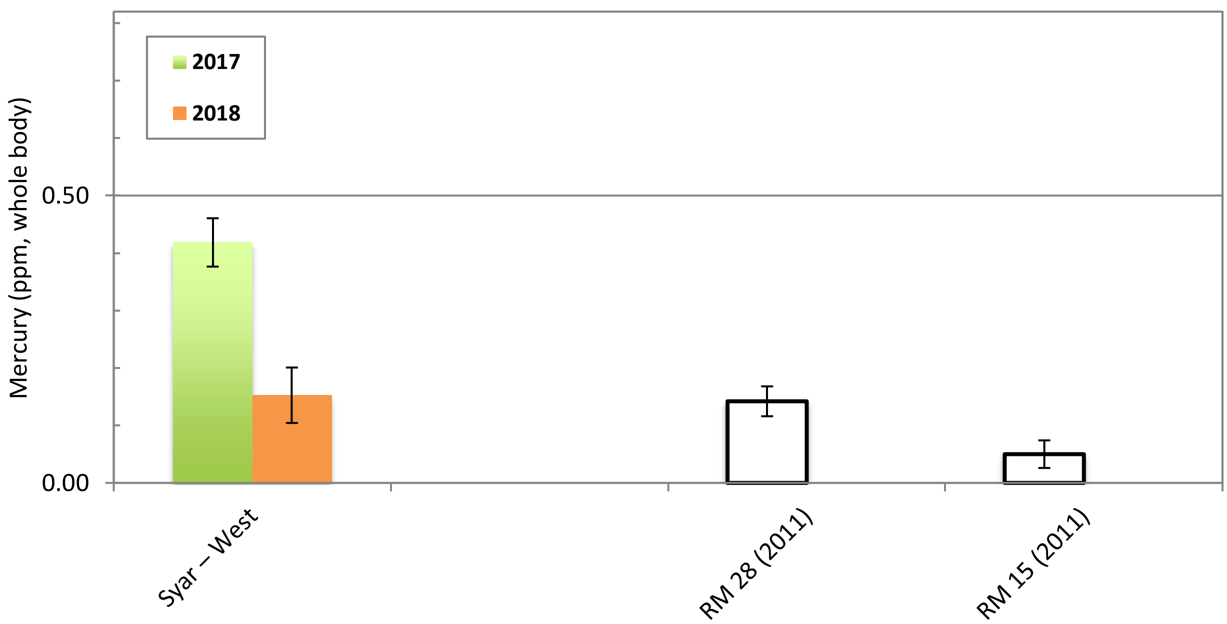


Figure 43. Juvenile Largemouth Bass summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 44. 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 – West Pond	2017	**4**	5-10	45	1.7	**0.237**	± 0.077
Syar – West Pond	2018	**4**	2-4	34	0.6	**0.102**	± 0.017
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**

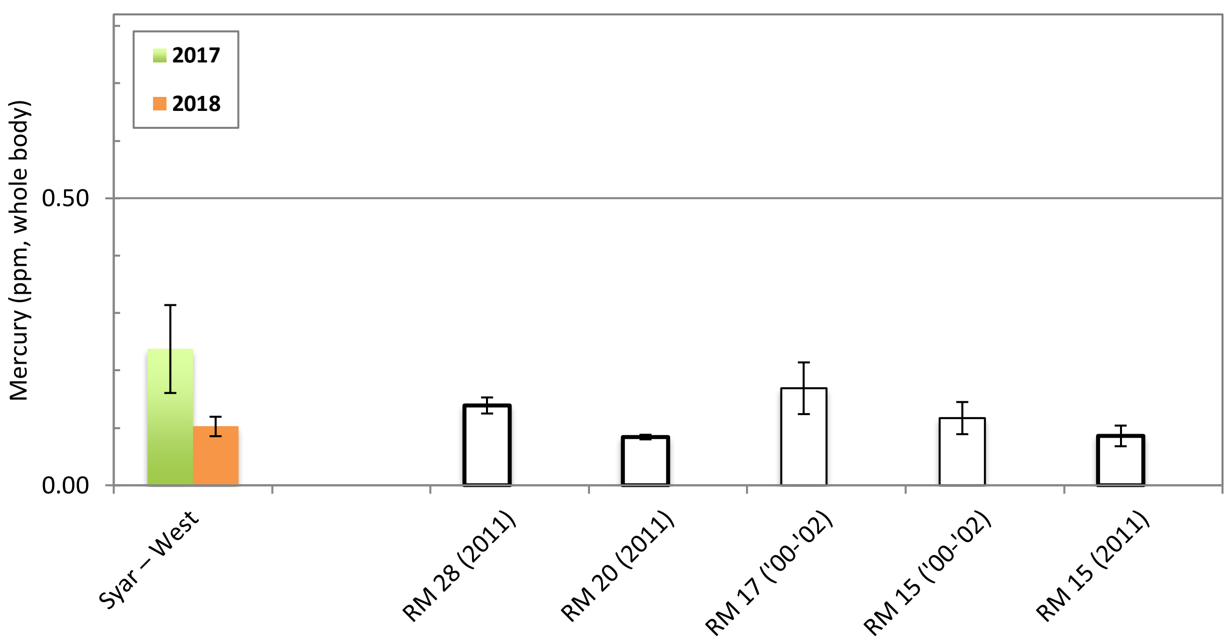


Figure 44. Juv. Green Sunfish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 45. 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 – West Pond	2017	**4**	10	34	0.4	**0.236**	± 0.068
Syar – West Pond	2018	**4**	6-7	29	0.3	**0.088**	± 0.024
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**

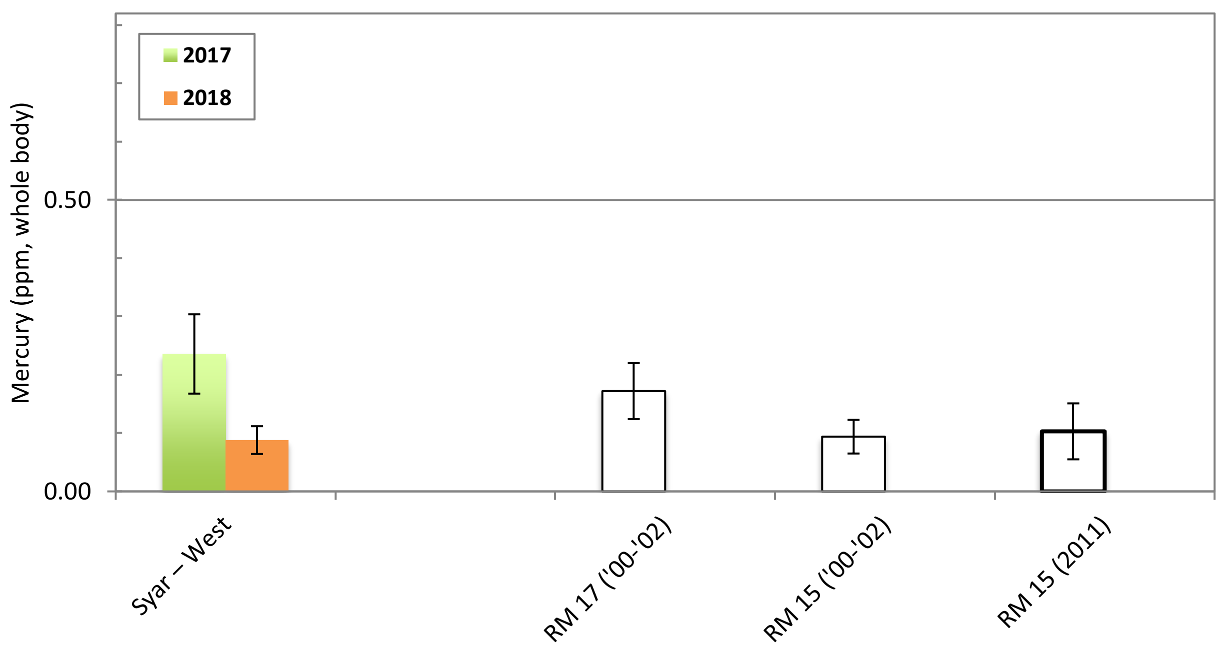


Figure 45. Mosquitofish summary data, and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

8. 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 findings into relative context. For each sample type, data are presented numerically in a table and then graphically with an accompanying figure.

Table 46. 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 (West)	2015	**18**	305	393	**0.278**	± 0.055
Cemex – Phase 1 (West)	2016	**20**	313	383	**0.350**	± 0.066
Cemex – Phase 1 (West)	2017	**17**	299	357	**0.393**	± 0.079
Cemex – Phase 1 (West)	2018	20	298	331	**0.481**	± 0.131
Cemex – Phase 3-4 (East)	2015	**20**	344	526	**0.840**	± 0.113
Cemex – Phase 3-4 (East)	2016	**20**	344	557	**0.858**	± 0.139
Cemex – Phase 3-4 (East)	2017	**20**	334	479	**1.093**	± 0.172
Cemex – Phase 3-4 (East)	2018	20	331	463	**0.918**	± 0.119
Teichert – Reiff	2017	**5**	189	78	**1.679**	± 0.180
Teichert – Reiff	2018	10	251	181	**1.997**	± 0.170
Teichert – Storz	2017	**20**	245	203	**0.657**	± 0.038
Teichert – Storz	2018	20	255	197	**0.611**	± 0.082
Syar – B1	2015	**18**	281	355	**1.628**	± 0.332
Syar – B1	2016	**20**	318	489	**1.640**	± 0.152
Syar – B1	2017	**16**	260	265	**0.904**	± 0.239
Syar – B1	2018	20	295	335	**0.977**	± 0.198
Syar – West	2017	**17**	283	320	**0.925**	± 0.205
Syar – West	2018	20	278	292	**0.798**	± 0.229
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**

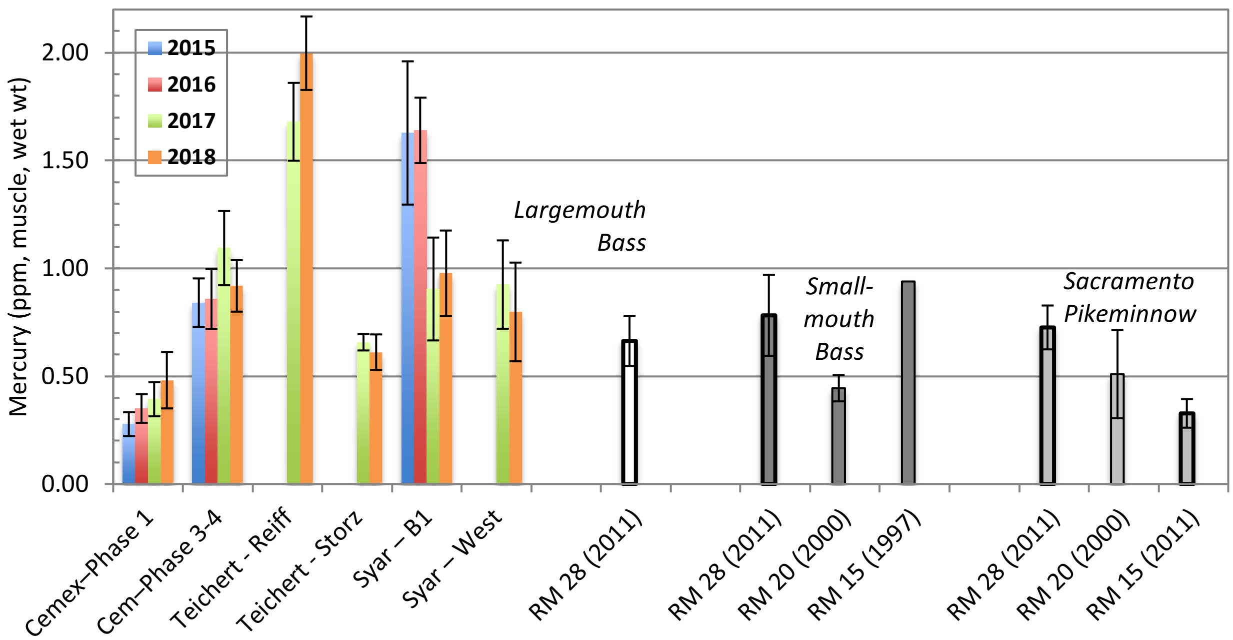


Figure 46. Largemouth Bass summary data, and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 47. 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 (West)	2015	**2**	595	2,130	**0.198**	
Cemex – Phase 1 (West)	2016	**2**	412	1,150	**0.100**	
Cemex – Phase 1 (West)	2017	**2**	531	1,440	**0.236**	
Cemex – Phase 1 (West)	2018	3	533	1973	**0.337**	± 0.587
White Catfish						
Cemex – Phase 1 (West)	2016	**3**	661	2,900	**0.372**	
Cemex – Phase 1 (West)	2017	**6**	615	2,120	**0.448**	± 0.134
Cemex – Phase 1 (West)	2018	1	398	1115	**0.571**	
Teichert – Reiff	2015	**20**	347	658	**0.737**	± 0.156
Teichert – Reiff	2016	**20**	297	341	**0.996**	± 0.153
Teichert – Reiff	2017	**16**	355	677	**1.287**	± 0.197
Teichert – Reiff	2018	–				
Historic/Baseline Data						
Channel Catfish						
Rumsey	2000	1	411	565	0.225	
River Mile 28	**2011**	**5**	**239**	**102**	**0.229**	**± 0.102**
River Mile 20	2000	1	368	380	0.225	
River Mile 03	1997	10	336	304	0.174	± 0.019

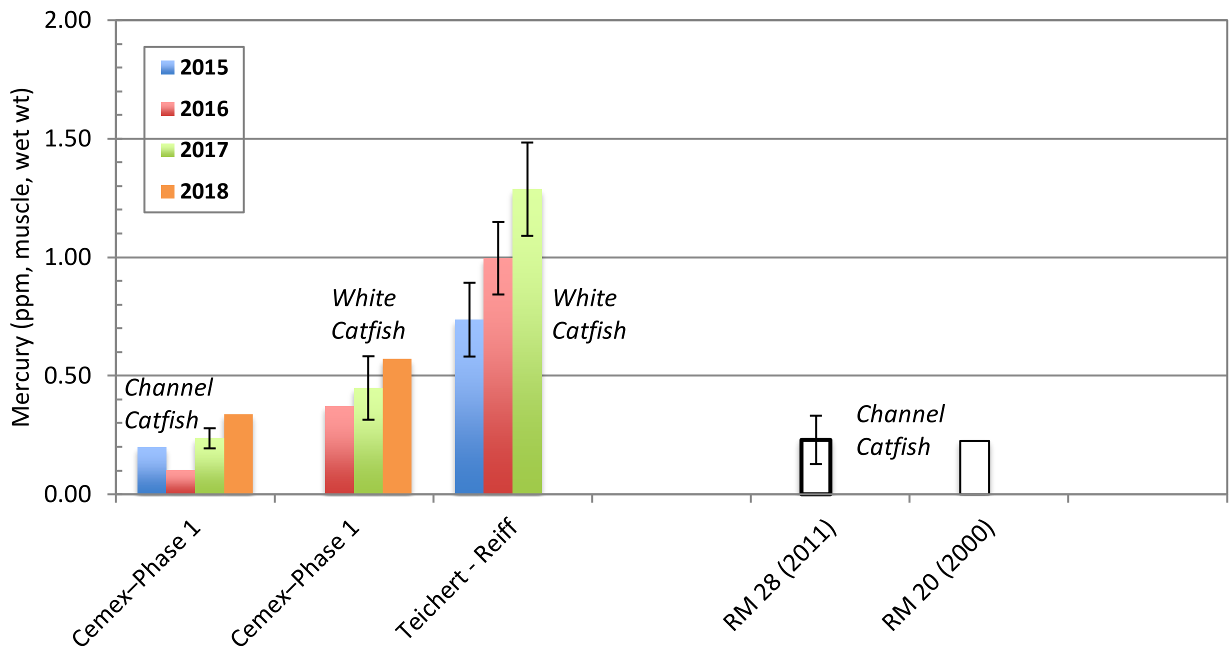


Figure 47. **Catfish summary data (all sites) and historic creek comparisons**
(mean fillet muscle mercury, with 95% confidence intervals)

Table 48. 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 1 (West)	2017	**5**	105	35	**0.273**	± 0.094
Cemex – Phase 1 (West)	2018	1	200	165	**0.227**	
Cemex – Phase 3-4 (East)	2015	**10**	133	67	**0.534**	± 0.076
Cemex – Phase 3-4 (East)	2016	**1**	101	16	**0.382**	
Cemex – Phase 3-4 (East)	2017	**–**				
Cemex – Phase 3-4 (East)	2018	–				
Teichert – Reiff	2015	**1**	140	40	**0.328**	
Teichert – Reiff	2016	**–**				
Teichert – Reiff	2017	**–**				
Teichert – Reiff	2018	–				
Syar – B1	2015	**10**	118	25	**0.777**	± 0.086
Syar – B1	2016	**1**	83	12	**1.446**	
Syar – B1	2017	**–**				
Syar – B1	2018	–				
Syar – West Pond	2017	**4**	93	12	**0.579**	± 0.089
Syar – West Pond	2018	–				
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**

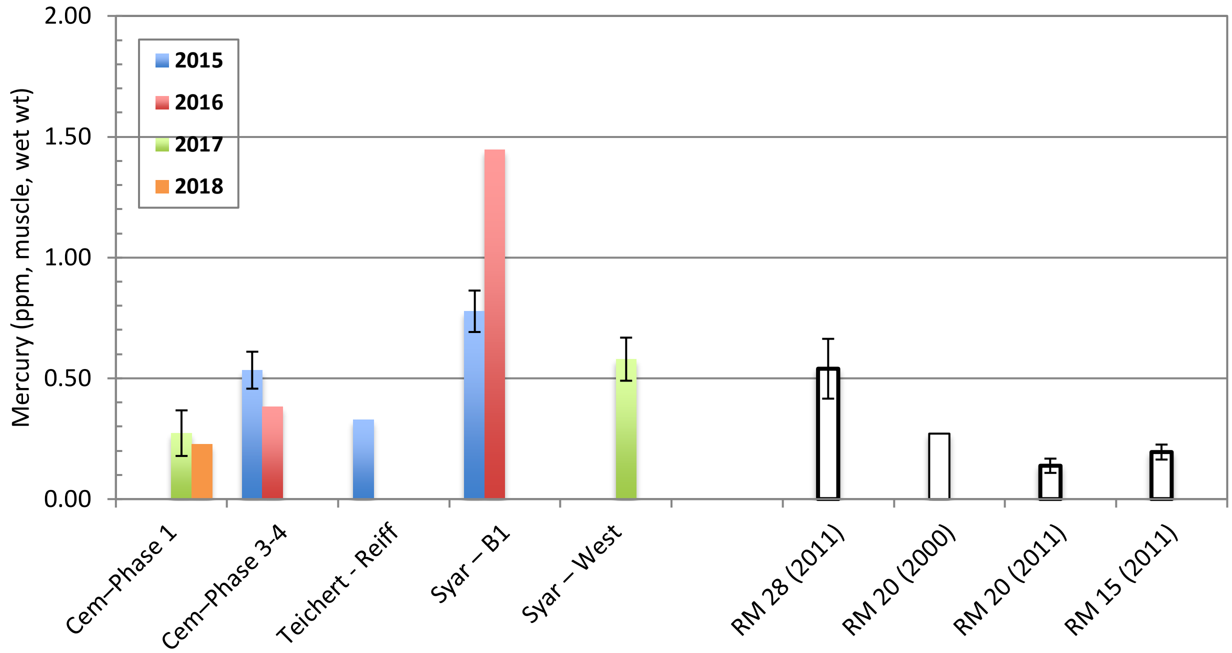


Figure 48. Green Sunfish summary data (all sites) and historic creek comparisons
(mean fillet muscle mercury, with 95% confidence intervals)

Table 49. Carp 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.
Carp						
Teichert – Reiff	2015	**2**	421	918	**0.351**	
Teichert – Reiff	2016	**5**	430	975	**0.854**	± 0.387
Teichert – Reiff	2017	**9**	481	1,499	**1.122**	± 0.321
Teichert – Reiff	2018 (no samples)					
Historic/Baseline Data (most comparable species available)						
Sacramento Sucker						
Rumsey	2000	6	328	396	0.198	± 0.113
River Mile 20	2000	5	253	174	0.154	± 0.034
River Mile 15	**2011**	**8**	**276**	**231**	**0.143**	**± 0.011**
River Mile 08	2000	4	319	336	0.339	
River Mile 03	1997	5	343	402	0.263	± 0.068

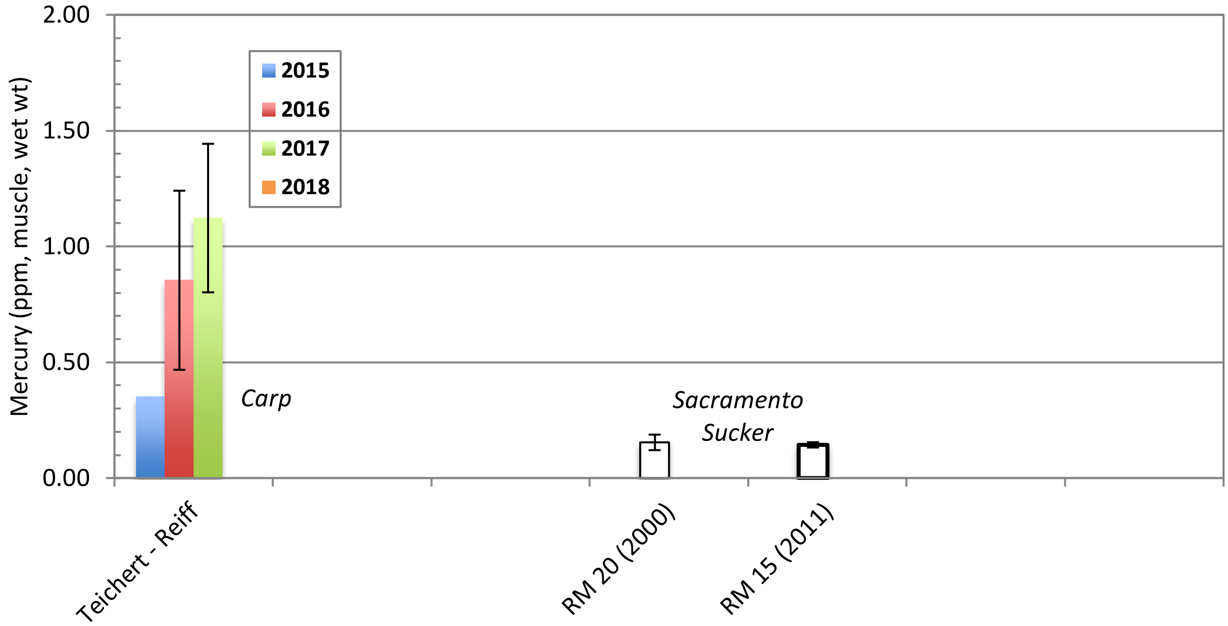


Figure 49. **Carp summary data (all sites) and historic creek comparisons**
(mean fillet muscle mercury, with 95% confidence intervals)

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

Table 50. 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 (West)	2015	**4**	8	109	17	**0.044**	± 0.007
Cemex – Phase 1 (West)	2016	**4**	3	102	17	**0.094**	±0.012
Cemex – Phase 1 (West)	2017	**4**	2	117	22	**0.146**	± 0.023
Cemex – Phase 1 (West)	2018	**1**	1	78	6	**0.068**	
Cemex – Phase 3-4 (East)	2015	**4**	7	108	16	**0.334**	± 0.052
Cemex – Phase 3-4 (East)	2016	**4**	2	114	18	**0.372**	±0.053
Cemex – Phase 3-4 (East)	2017	**4**	2-3	108	16	**0.249**	± 0.033
Cemex – Phase 3-4 (East)	2018	–	–				
Teichert – Reiff	2017	**4**	1-2	137	32	**0.798**	± 0.188
Teichert – Reiff	2018	**4**	4-6	111	17	**0.445**	± 0.138
Teichert – Storz	2017	**4**	1	143	35	**0.337**	± 0.059
Teichert – Storz	2018	–	–				
Syar – B1	2015	**4**	7	159	44	**0.589**	± 0.030
Syar – B1	2016	**4**	10	74	5	**0.524**	±0.119
Syar – B1	2017	**4**	1-2	102	18	**0.461**	± 0.175
Syar – B1	2018	**4**	2	88	9	**0.368**	± 0.040
Syar – West Pond	2017	**2**	1	123	27	**0.418**	± 0.042
Syar – West Pond	2018	**4**	2	77	6	**0.153**	± 0.048
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**

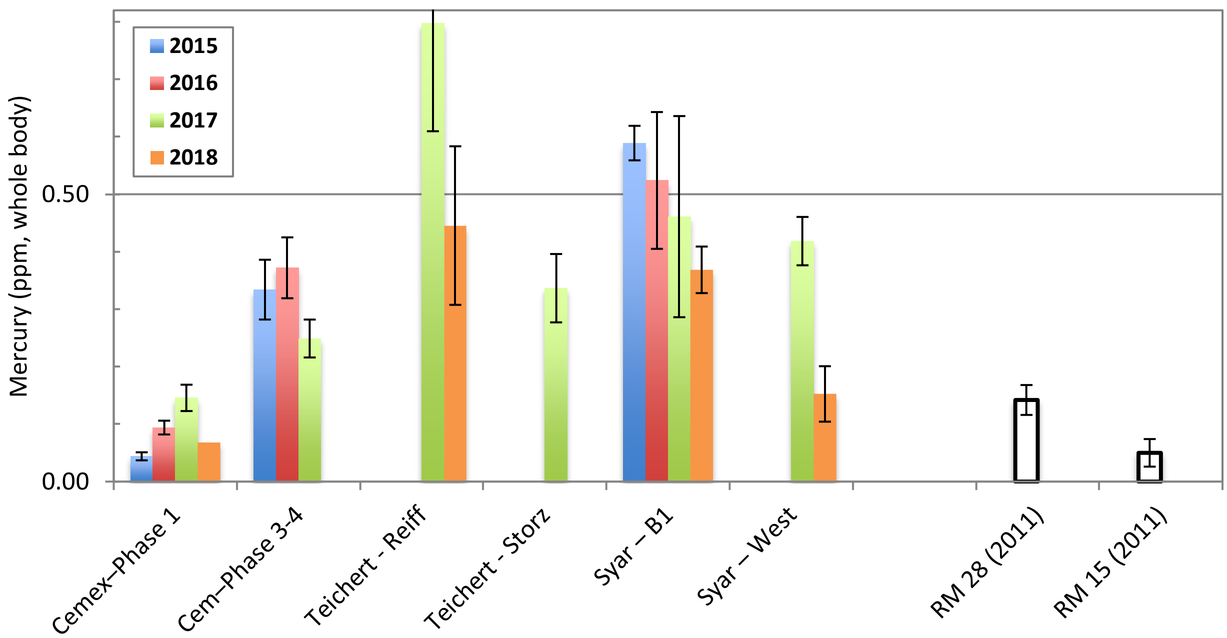


Figure 50. **Juvenile Bass summary data (all sites) and historic creek comparisons** *(means of multiple whole-body, multi-individual composite samples)*

Table 51. 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 1 (West)	2017	**4**	8-10	47	1.9	**0.118**	± 0.023
Cemex – Phase 1 (West)	2018	**4**	2	51	2.1	**0.035**	± 0.009
Cemex – Phase 3-4 (East)	2015	**4**	10	47	1.8	**0.275**	± 0.022
Cemex – Phase 3-4 (East)	2016	**4**	4-5	49	2.0	**0.233**	± 0.026
Cemex – Phase 3-4 (East)	2017	**4**	2-6	36	0.7	**0.150**	± 0.051
Cemex – Phase 3-4 (East)	2018	**4**	1	34	0.5	**0.112**	± 0.020
Teichert – Reiff	2015	**–**	1	68	2.7	**0.241**	
Teichert – Reiff	2016	**–**	–				
Teichert – Reiff	2017	**–**	–				
Teichert – Reiff	2018	**4**	2	48	2.3	**0.252**	± 0.020
Syar – B1	2015	**4**	8-9	47	1.7	**0.325**	± 0.097
Syar – B1	2016	**4**	4	50	1.9	**0.414**	± 0.076
Syar – B1	2017	**4**	6-7	40	1.0	**0.225**	± 0.069
Syar – B1	2018	**4**	10	37	0.8	**0.231**	± 0.044
Syar – West Pond	2017	**4**	5-10	45	1.7	**0.237**	± 0.077
Syar – West Pond	2018	**4**	2-4	34	0.6	**0.102**	± 0.017
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**

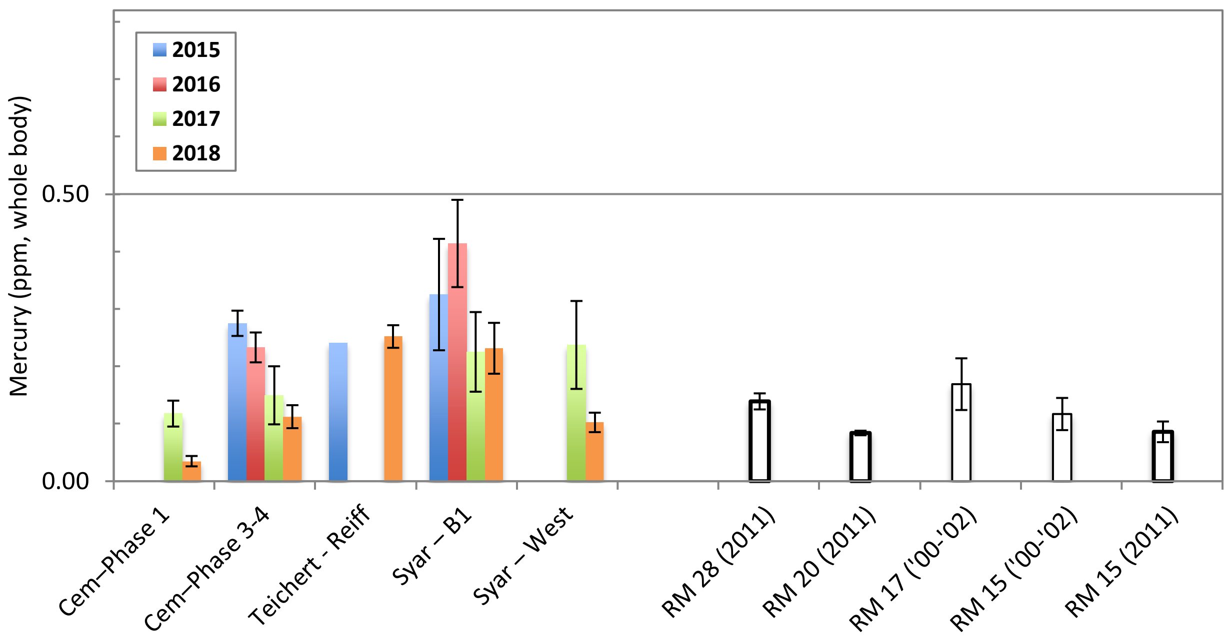


Figure 51. Juv. Green Sunfish summary data (all sites) and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 52. 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 (West)	2016	**4**	10	34	0.4	**0.093**	± 0.039
Cemex – Phase 1 (West)	2017	**4**	10	33	0.4	**0.135**	± 0.038
Cemex – Phase 1 (West)	2018	**4**	6-10	34	0.5	**0.083**	± 0.032
Cemex – Phase 3-4 (East)	2015	**4**	10	37	0.6	**0.228**	± 0.059
Cemex – Phase 3-4 (East)	2016	**4**	10	37	0.6	**0.157**	± 0.037
Cemex – Phase 3-4 (East)	2017	**4**	6-10	34	0.5	**0.286**	± 0.071
Cemex – Phase 3-4 (East)	2018	**4**	3-10	34	0.5	**0.203**	± 0.043
Teichert – Reiff	2015	**4**	12	38	0.6	**0.094**	± 0.010
Teichert – Reiff	2016	**4**	10	36	0.5	**0.212**	± 0.041
Teichert – Reiff	2017	**–**	–				
Teichert – Reiff	2018	**4**	10	35	0.5	**0.262**	± 0.053
Teichert – Mast	2017	**8**	10	35	0.5	**0.312**	± 0.131
Teichert – Mast	2018	**8**	10	34	0.5	**0.182**	± 0.043
Teichert – Storz	2016	**4**	10	35	0.5	**0.229**	± 0.109
Teichert – Storz	2017	**4**	8-10	29	0.2	**0.282**	± 0.022
Teichert – Storz	2018	**4**	10	30	0.3	**0.087**	± 0.033
Syar – B1	2015	**4**	5-10	31	0.3	**0.268**	± 0.043
Syar – B1	2016	**–**	–				
Syar – B1	2017	**4**	9-10	35	0.4	**0.309**	± 0.110
Syar – B1	2018	**4**	6-9	31	0.4	**0.163**	± 0.056
Syar – West Pond	2017	**4**	10	34	0.4	**0.236**	± 0.068
Syar – West Pond	2018	**4**	6-7	29	0.3	**0.088**	± 0.024
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**

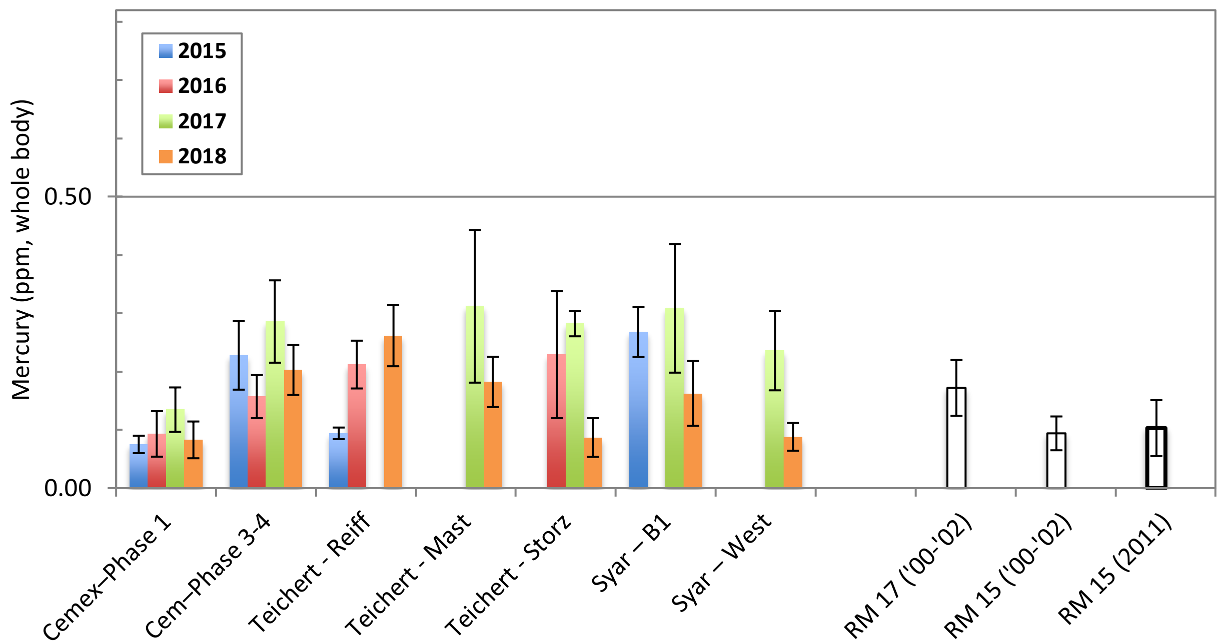


Figure 52. Mosquitofish summary data (all sites), and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

Table 53. 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	2015	**4**	10	50	1.3	**0.152**	± 0.018
Teichert – Reiff	2016	**4**	10	47	1.1	**0.412**	± 0.084
Teichert – Reiff	2017	**4**	10	49	1.1	**0.695**	± 0.141
Teichert – Reiff	2018	**4**	10	45	0.8	**0.556**	± 0.062
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
River Mile 08	2000	4	10	42	0.7	0.123	± 0.016

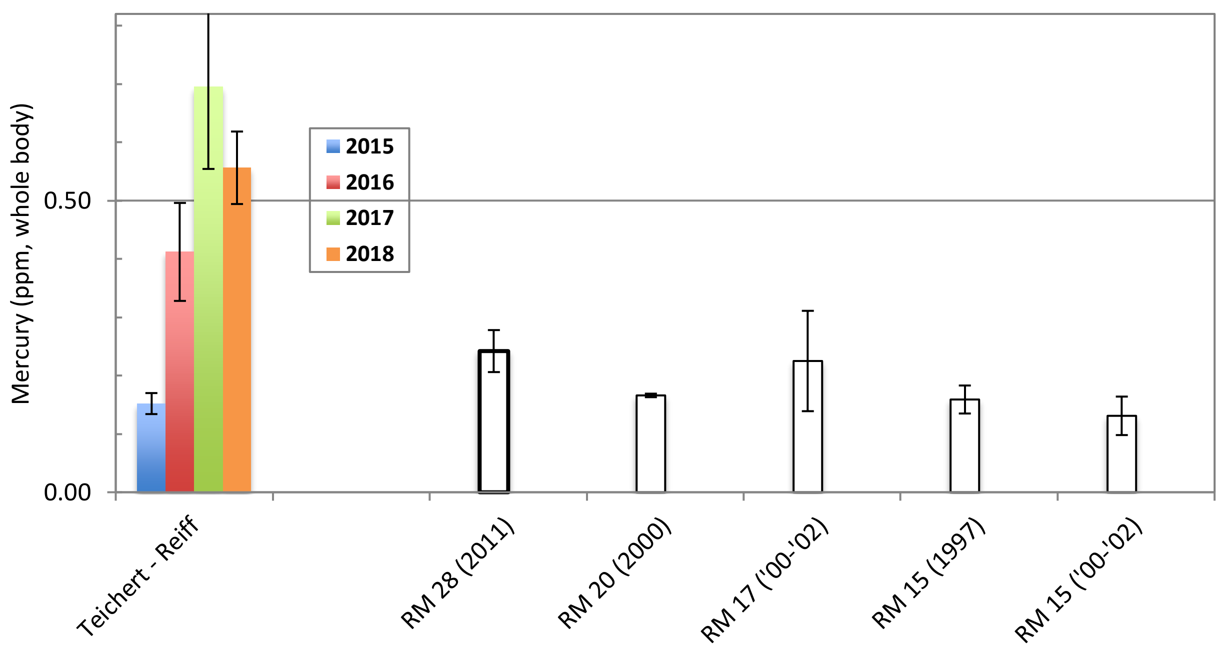


Figure 53. Red Shiner summary data (all sites), and historic creek comparisons
(means of multiple whole-body, multi-individual composite samples)

DISCUSSION AND CONCLUSIONS

There are now four years of fish mercury monitoring data from 4 of the 7 aggregate mining ponds identified by the County for annual monitoring: Cemex–Phase 1, Cemex–Phase 3-4, Teichert–Reiff, and Syar–B1. There are two years of monitoring for the 3 ponds that were added to the program in 2017. The Ordinance (1996) 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)***

Following the 2016 analyses, with two consecutive years of data from the initial four monitored ponds, those ponds were assessed for general mercury status relative to baseline creek controls. This was the conclusion at that time: "One of the 4 ponds – Cemex–Phase 1 – was clearly low in fish mercury, significantly lower than or similar to 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."

The two ponds with "ambiguous" assessments following the 2015 and 2016 collections (Cemex–Phase 3-4 and Teichert–Reiff) both showed continued increases in fish mercury in 2017, placing them clearly in the "elevated" category, consistent with the previous assessments. Based on those 2017 assessments, the following recommendations were made (in blue):

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.

Since the time of that recommendation (2017), the Teichert–Reiff, Syar–B1, and Cemex–Phase 1 ponds remained inactive, and active mining was discontinued at the Cemex–Phase 3-4 Pond. In addition, plant slurry discharges gradually slowed and ceased to the Cemex–Phase 1 and Teichert–Reiff ponds. These ponds were/are the receiving waters for the Cemex and Teichert–Esparto processing plants. It appears that this transition was accompanied by a rise in fish mercury at both locations. In 2018, the Cemex–Phase 1 and Teichert–Reiff ponds began receiving plant slurry discharges again and active mining resumed at Cemex–Phase 3-4. These changes were accompanied by an apparent leveling off or decline in fish mercury. All of these results suggest, counter-intuitively, that active mining and slurry inputs in these ponds *reduces* fish mercury levels, and cessation of mining or slurry inputs actually leads to increased concentrations. Obviously, continued mining in perpetuity is not an option. But the original Ordinance guidance to immediately discontinue mining if elevated fish mercury is found appears to not be protective as intended. For future remediation considerations, these results indicate that water column mixing may be an effective tool for certain ponds. Post-mining, mixing can be done without continued mine operations.

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.

Water column profiling was initiated in 2018, as described above. The four identified ponds were tested seasonally, five times between May and October. Results are presented in an accompanying report. The 2018 fish monitoring reported here identifies a fifth pond for water column profiling – Teichert–Mast. It will be added to the program in subsequent years (note: at the time of this final report draft, May 2020, the Mast Pond has been merged by Teichert into the Reiff Pond, creating a larger Reiff Pond complex, which will be monitored as a single pond).

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.

Sediment sampling was conducted in Fall 2018 at the 4 ponds identified at that time. Characterization and analysis of the samples has been done and will be presented in an accompanying report. The Teichert–Mast Pond was planned for sampling but it has since become part of the Reiff Pond.

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. It is this monitoring and research team's opinion that 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 probably not appropriate to apply one mitigation, that may be feasible in one system, to another very different water body. For example, a deep lake thermal destratification technique is not applicable to lakes that have no anoxic bottom waters. Similar water bodies may benefit from similar mitigation approaches, 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

Note that in December 2019 the County adopted a comprehensive update to the CCAP, which includes a revision of this code section. Future mercury monitoring and reporting will comply with the updated ordinance requirements. The 2018 monitoring work, though, was governed by the existing (1996) code. That version is reproduced below.

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 FALL 2018 MONITORING

GENERAL FIELD WORK, AND INTRODUCING MAIN FISH

A1. Weighing – Green Sunfish

A2. White Catfish

A3. Measuring length – Channel Catfish

A4. Largemouth Bass

A5. Fillet muscle sample into analytical tube

A6. Small fish in seine – juvenile Largemouth Bass, Red Shiners, and Mosquitofish

CEMEX–PHASE 1 (West) POND

A7. Cemex–Phase 1 Pond

A8. Catfish, bass, sunfish

A9. Small fish samples

CEMEX–PHASE 3-4 (East) POND

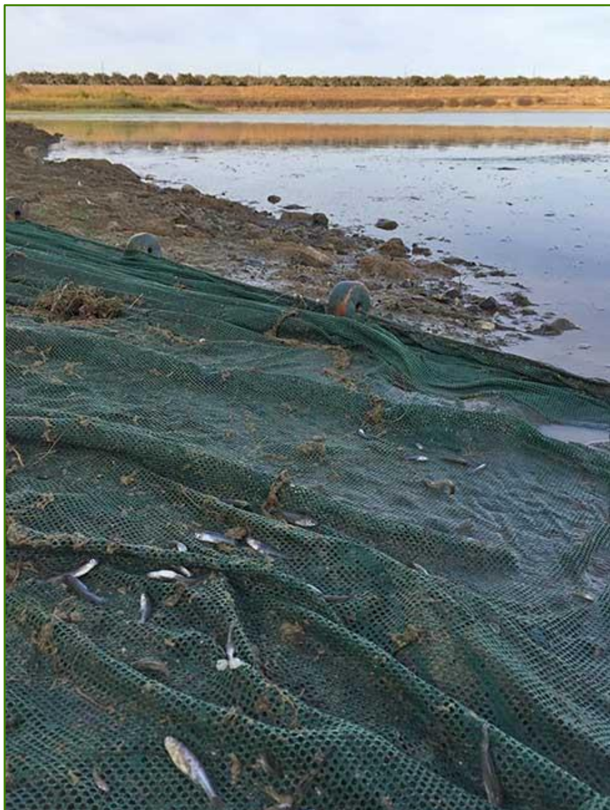
A10. Cemex–Phase 3-4 Pond

A11. Seining for small fish

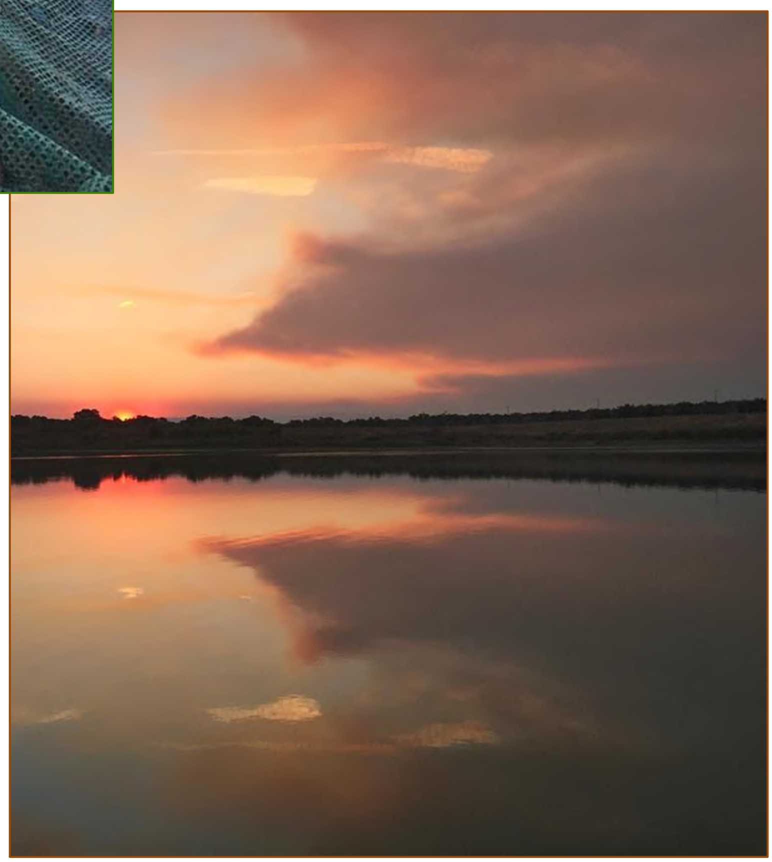
A12. Cemex–Phase 3-4 Largemouth Bass

A13. Small fish samples

TEICHERT–REIFF POND



A14. Shore seine for small fish



A15. Reiff Pond – smoke during Fall 2018 fires

A16. Reiff Pond – Largemouth Bass

A17. juvenile Largemouth Bass

A18. Reiff Pond – Mosquitofish

A20. juvenile Green Sunfish

TEICHERT–MAST POND

A21. Mast Pond – Northwest basin

A22. Seining southeast basin

A23. Mast – dense Mosquitofish population (no other species at this time)

A24. Mosquitofish composites: standard sets + 'giants'

TEICHERT–STORZ POND

A25. Storz Pond – tough access

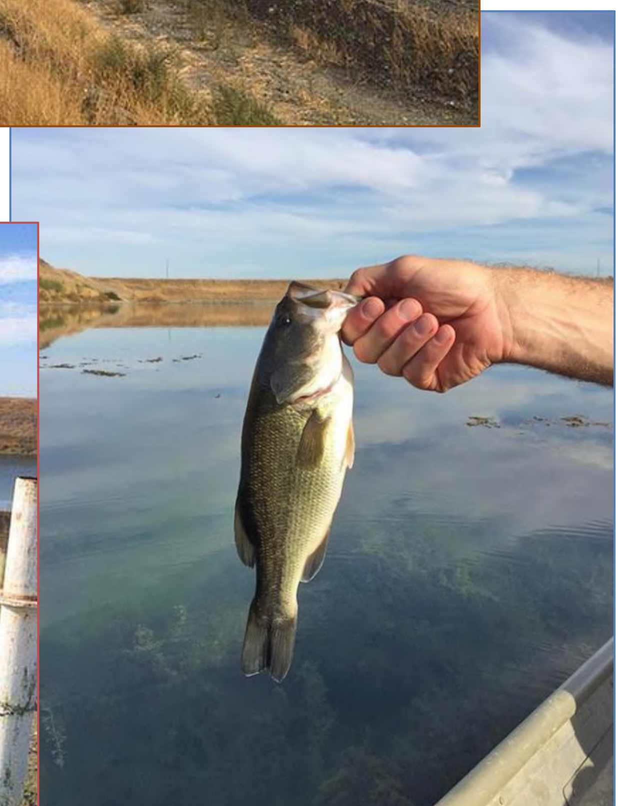
A26. Seining for small fish

A27. Storz Pond, Largemouth Bass

A28. Mosquitofish

SYAR–B1 POND

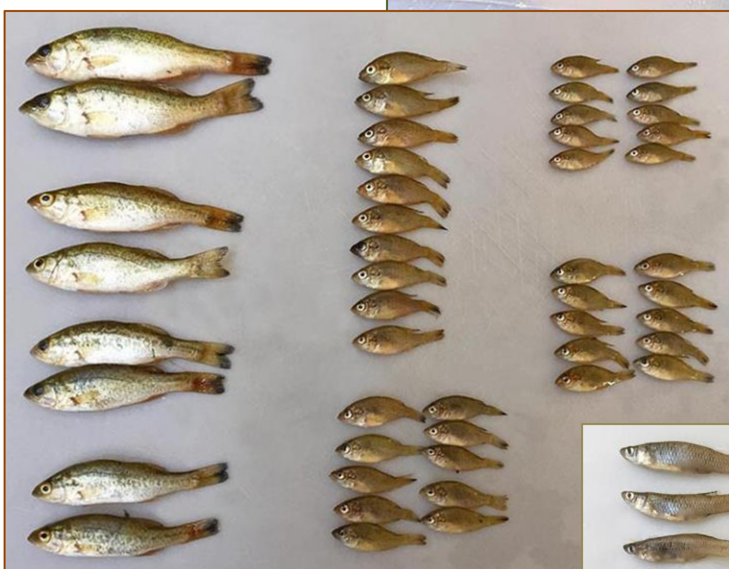
A29. Syar–B1 Pond



A30. B1 Pond, Largemouth Bass

A31. Posting warning of high fish mercury

A32. B1 Pond – Largemouth Bass



A33. juvenile Bass and Green Sunfish

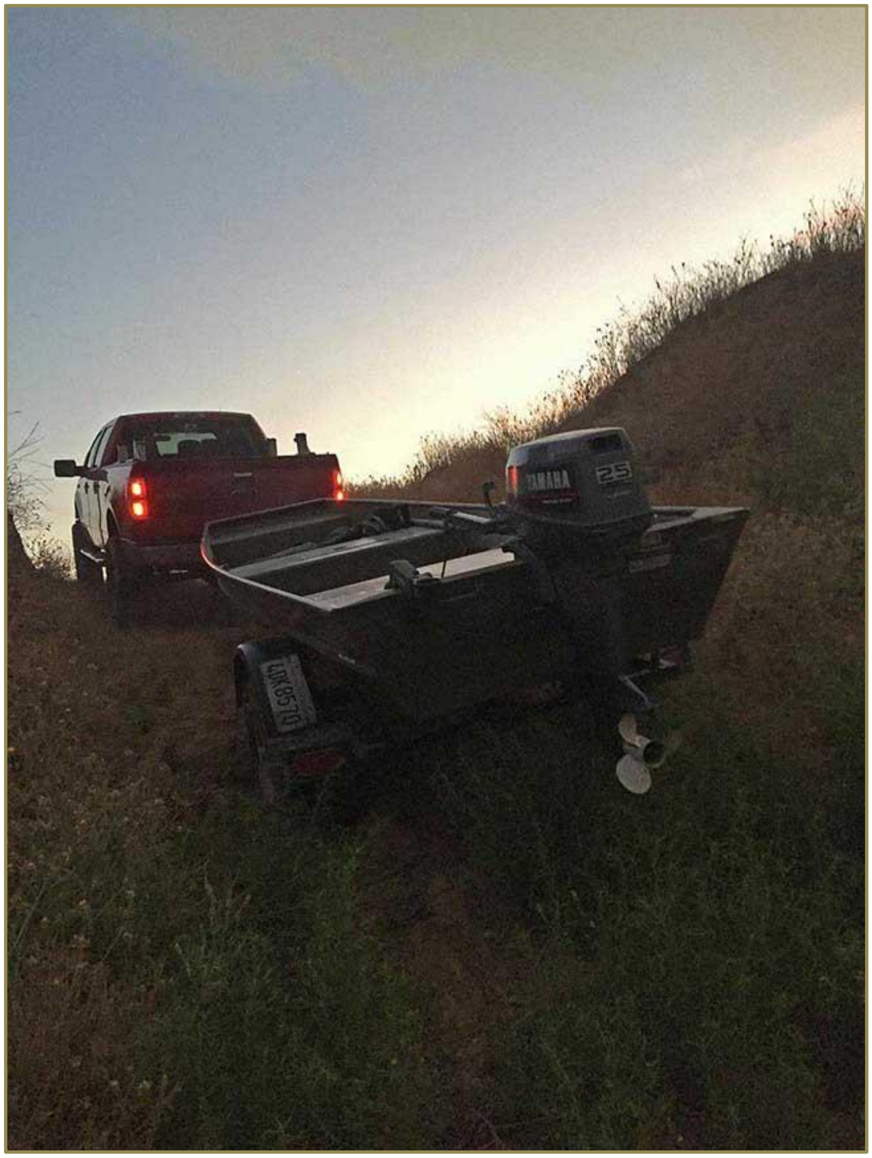
A34. Mosquitofish

SYAR–WEST POND

A35. West Pond, Largemouth Bass

A36. Largemouth Bass

A37. West Pond small fish samples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