Mercury and Methylmercury in Fish and Water from the Sacramento-San Joaquin Delta: Year Two (August 2017 - June 2018)

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Abstract

Monitoring of sport fish, water, and sediment was conducted by the Delta Regional Monitoring Program (Delta RMP) from August 2017 to June 2018 to address high priority information needs related to implementation of the Sacramento–San Joaquin Delta Estuary TMDL for Methylmercury (Wood et al. 2010). This data report presents the methods and results for the second year of mercury monitoring by the Delta RMP.

About 15% of all samples were analyzed for quality assurance and quality control purposes. Ninety-seven percent of the lab results for this project met the requirements of the Delta RMP Quality Assurance Program Plan. Results that did not meet the requirements were for ancillary parameters in sediment (total organic carbon) and water (dissolved organic carbon, volatile suspended solids).

Two species of sport fish, largemouth bass (*Micropterus salmoides*) and spotted bass (*Micropterus punctulatus*), were collected at six sampling locations in August 2017. The length-adjusted (350 mm) mean methylmercury (measured as total mercury, which is a routinely used proxy for methylmercury in predator fish) concentration in bass ranged from 0.24 ppm (wet weight) at Middle River to 1.34 ppm at the Lower Mokelumne River. Water concentrations of methylmercury in unfiltered water ranged from 0.044 to 0.39 ng L^{-1}. Concentrations of total mercury in unfiltered water ranged from 0.73 to 16 ng L^{-1}. Mean thalweg and bank sediment THg concentrations ranged from 0.01 to 0.12 μg g^{-1} and 0.02 to 0.13 μg g^{-1}, respectively. Thalweg MeHg sediment concentrations varied from 0.02 to 0.97 ng g^{-1}. Bank MeHg sediment concentrations ranged from 0.39 to 1.7 ng g^{-1}.

Historic data from the same or nearby monitoring stations from 1998-2011 are also presented to provide context. Monitoring results for both sport fish and water were generally comparable to historic observations. Year 2 mercury concentrations in fish were significantly higher than year 1 concentrations at three stations: Lower Mokelumne River, Little Potato Slough, and San Joaquin River at Vernalis. The sample size for water concentrations from the first two years of monitoring is small. More intensive (near monthly) sampling began late in year two and was continued into year 3, and will provide a better basis for evaluation of patterns and correlations.

For the next several years, annual monitoring of sport fish will be conducted to firmly establish baseline concentrations and interannual variation in support of monitoring of long-term trends as an essential performance measure for the TMDL. Monitoring of water will solidify the linkage analysis (the quantitative relationship between

methylmercury in water and methylmercury in sport fish) in the TMDL. Water monitoring will also provide data that will be useful in verifying patterns and trends predicted by numerical models of mercury transport and cycling being developed for the Delta and Yolo Bypass by the California Department of Water Resources (DWR).

Introduction

Concentrations of methylmercury (MeHg) in fish from the Sacramento-San Joaquin Delta (the Delta) (Figure 1) exceed thresholds for protection of human and wildlife health. The Delta Methylmercury TMDL (Wood et al. 2010) is the driver of actions to control MeHg in the Delta, establishing water quality goals and directing various discharger groups to conduct monitoring and implement measures to minimize impairment of beneficial uses.

MeHg concentrations in largemouth bass[1] are the most important performance measure of progress in addressing MeHg impairment in the Delta. The TMDL established three water quality objectives for MeHg in fish tissue: 0.24 ppm in muscle of large, trophic level four (TL4) fish such as black bass[2]; 0.08 ppm in muscle of large TL3 fish such as common carp (*Cyprinus carpio*); and 0.03 ppm in whole TL2 and TL3 fish less than 50 mm in length such as inland silverside (*Menidia beryllina*). Furthermore, the TMDL established an implementation goal of 0.24 ppm in largemouth bass muscle at a standard size of 350 mm as a means of ensuring that all of the fish tissue objectives are met. Largemouth bass are widely distributed throughout the Delta and are excellent indicators of spatial variation due to their small home ranges. Past data from 1998-2007 for largemouth bass were a foundation for the development of the TMDL, including the division of the Delta into eight subareas (Figure 1).

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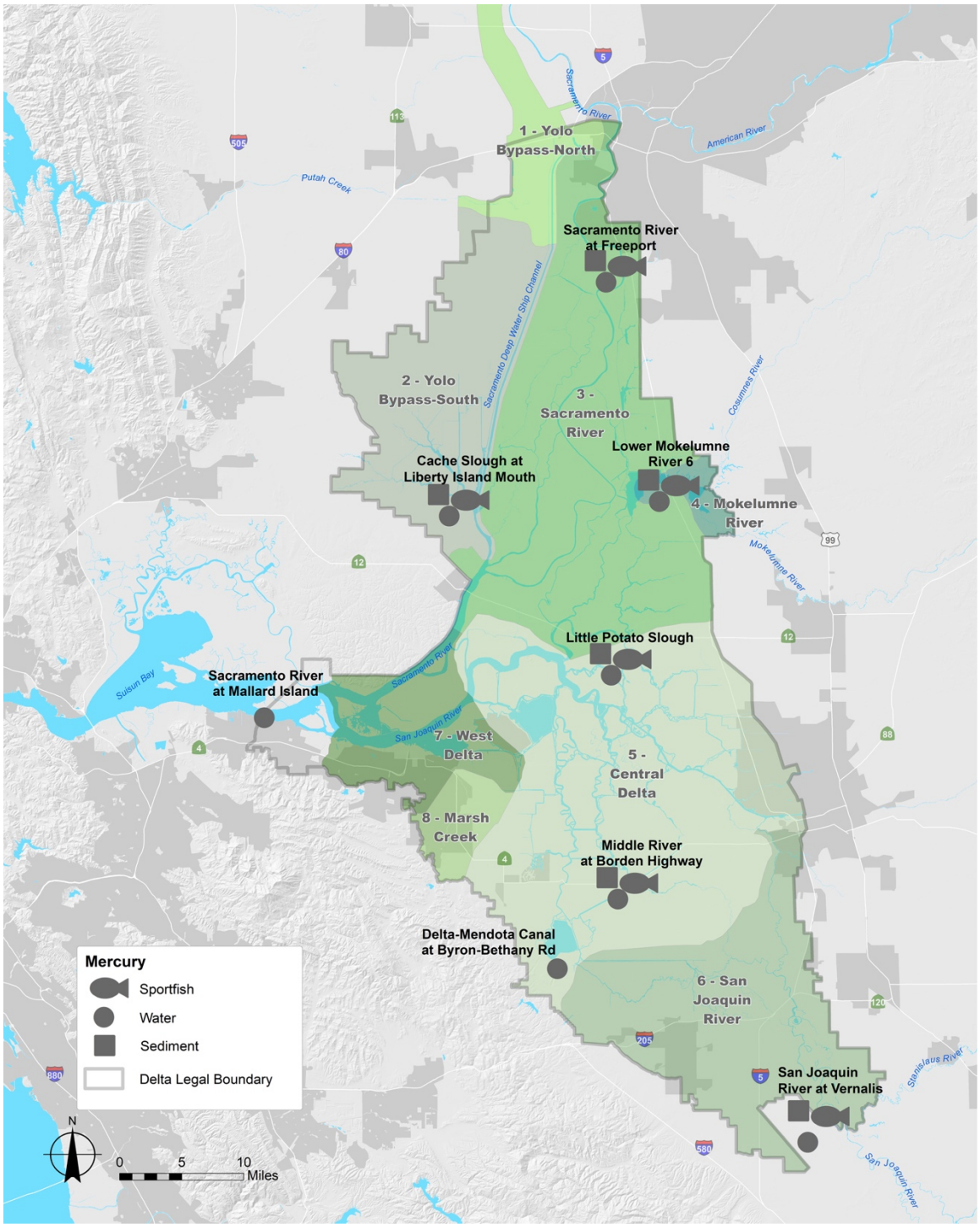
[1] Nearly all of the mercury present in edible fish muscle is MeHg, and analysis of fish tissue for total mercury provides a valid, cost-effective estimate of MeHg concentration (Wiener et al. 2007)

[2] "Black bass" refers collectively to largemouth bass [*Micropterus salmoides*], smallmouth bass [*Micropterus dolomieu*], and spotted bass [*Micropterus punctulatus*]

Figure 1 Map showing the boundary of the Delta, the eight subareas delineated in the TMDL, and the sampling stations for fish, water, and sediment. Note: Lower Mokelumne River 6 station was not sampled until October 2017.



Additional data on MeHg in water has also been identified as a high priority information need. The analysis conducted for the TMDL established that there is a statistically significant relationship between the annual mean concentration of MeHg in unfiltered water and mean MeHg in 350 mm largemouth bass when the data are organized by subarea. This linkage provides a connection, essential for management, between MeHg inputs and impairment of beneficial uses. Because of this linkage, the TMDL established an implementation goal of 0.06 ng/L of unfiltered aqueous MeHg. In response to TMDL control study requirements, the Department of Water Resources (DWR) is developing numerical MeHg transport and cycling simulation models for the Delta and Yolo Bypass. Monitoring of aqueous MeHg is therefore needed to:

1) better quantify the fish-water linkage that is the foundation of the TMDL,
2) evaluate attainment of the TMDL implementation goal,
3) support calculations of mercury and MeHg loads and mass balances,
4) support development of mercury models for the Delta and Yolo Bypass, and
5) support evaluation of the fish data by providing information on processes and trends.

Applicable Management Decisions and RMP Assessment Questions

The Delta Methylmercury TMDL is the embodiment of management decisions for MeHg in the Delta, establishing goals for cleanup and calling for a variety of control studies and actions. The Delta RMP is conducting mercury monitoring in order to support TMDL implementation.

Two tiers of assessment questions have been defined for the mercury monitoring program. **Primary** assessment questions are those that are explicitly addressed by the monitoring and drive the monitoring design. Secondary assessment questions are addressed to some extent by the monitoring, but are not drivers of the monitoring design. The monitoring will contribute some information but will not fully answer the secondary assessment questions.

Primary Assessment Questions

One priority question for this initial phase of MeHg monitoring is from the Status and Trends category of the Delta Regional Monitoring Program (DRMP) management and assessment questions:

Status and Trends

ST1. What are the status and trends in ambient concentrations of methylmercury and total mercury in sport fish and water, particularly in subareas likely to be affected by major existing or new sources (e.g., large-scale restoration projects)?

ST1.A. Do trends over time in methylmercury in sport fish vary among Delta subareas?

Question 1A is a high priority for managers that relates to the TMDL, and is a primary driver of the sampling design for fish monitoring. Annual monitoring of methylmercury in fish tissue is urgently needed to 1) firmly establish a baseline for each Delta subarea and 2) to characterize the degree of interannual variation, which is essential to designing an efficient monitoring program for detection of long-term trends. In addition to addressing status and trends, this monitoring will establish a foundation for tracking the effectiveness of management actions - another category of the Delta RMP core management questions.

Sources, Pathways, Loadings and Processes

SPLP1. Which sources, pathways and processes contribute most to observed levels of methylmercury in fish?

SPLP1.A. What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)?

A mass budget for MeHg in the Delta is a critical element of the TMDL. The mass budget provides essential context for understanding the importance of inputs from discharges and internal sources and processes. Obtaining data to expand and update the dataset on MeHg inputs to the Delta is a high priority to support TMDL refinement and implementation. MeHg export from the Delta is similarly an important component of the mass budget and a high priority information need.

Fish-Water Linkage Analysis
(new priority question articulated by Mercury Subcommittee)

FWLA1. Are there key datasets needed to strengthen the technical foundation of contaminant control programs?

Another priority question that will be addressed relates to the linkage analysis discussed in the previous section, which is a key element of the technical basis for the TMDL. This question was not articulated in the core management questions and assessment questions established by the Steering Committee, but was nevertheless identified as a priority by the Mercury Subcommittee. Additional data on MeHg in water is one of the key datasets needed to strengthen the technical foundation of the TMDL.

Secondary Assessment Questions

Sources, Pathways, Loadings and Processes

SPLP1. Which sources, pathways and processes contribute most to observed levels of methylmercury in fish?

SPLP1.B. How do internal sources and processes influence methylmercury levels in fish in the Delta?

SPLP1.C. How do currently uncontrollable sources (e.g., atmospheric deposition, both as direct deposition to Delta surface waters and as a contribution to nonpoint runoff) influence methylmercury levels in fish in the Delta?

Forecasting Scenarios

FS1. What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?

These secondary assessment questions relating to Sources, Pathways, Loadings, and Processes and Forecasting Scenarios for this initial phase of MeHg monitoring relate to one of the major control studies called for in the TMDL: an effort to combine modeling, field data, and laboratory studies to evaluate the potential effects of water project operational changes on MeHg in Delta channels. The Department of Water Resources (DWR) is currently developing two mathematical models, one each for the Delta and Yolo Bypass, that will allow testing of various land and water management scenarios (DiGiorgio et al. 2016). These models will be useful in addressing this set of Delta RMP management questions. The opportunity to inform these models, which are being developed with a considerable investment of funding from the California Department of Water Resources (DWR), makes monitoring to address these questions a near-term priority for the Delta RMP. The water monitoring included in this study will generate data that are valuable for verifying trends and patterns predicted by the MeHg

models. It should be noted that these models will predict concentrations of MeHg in the water column, but will not include a bioaccumulation component that translates the water concentrations into fish tissue concentrations.

This Report

This data report presents the methods and results for the second year of monitoring by the Delta Regional Monitoring Program. In 2017 the Delta RMP continued mercury monitoring of fish and water. The monitoring program is described in the FY17-18 Detailed Workplan and Budget (2017). In addition, a year of quarterly sediment monitoring was started in 2017. Black bass were collected in late summer (August) from six stations distributed across the subareas. Sampling of total mercury and MeHg (and ancillary parameters) in water continued starting in October 2017 with an additional two water sites starting January 2018. Monitoring of sediment was initiated October 2017. Historic data from the same or nearby monitoring stations are also presented to provide context.

Methods

Sample Collection

Fish samples were collected from six stations in the Delta, sediment sample collections were co-located with fish stations, and water samples were collected at the six fish stations and two additional stations (Figure 1). Fish collections were completed August 2017 and water and sediment collections occurred between October 2017 and June 2018. Details on sampling stations and dates are listed in Table 1 and in greater detail in the cruise report (Appendix 1).

Table 1 Sampling station code, name, latitude, longitude, and collection dates.

Station Code	Station Name	Latitude	Longitude	Fish Collection Dates	Water Collection Dates	Sediment Collection Dates
510ST1317	Sacramento R @ Freeport	38.4556	-121.5019	2017-08-14	2017-10-18, 2018-01-29, 2018-02-26, 2018-03-19, 2018-04-17, 2018-05-15, 2018-06-20	2017-10-18, 2018-01-29, 2018-04-17, 2018-06-20
510ADVLIM	Cache Slough at Liberty Island Mouth	38.2421	-121.6854	2017-08-15	2017-10-18, 2018-01-29, 2018-02-26, 2018-03-19, 2018-04-17, 2018-05-15, 2018-06-20	2017-10-18, 2018-01-29, 2018-04-17, 2018-06-20
544LILPSL	Little Potato Slough	38.0963	-121.4960	2017-08-14	2017-10-18, 2018-01-29, 2018-02-26, 2018-03-19, 2018-04-17, 2018-05-15, 2018-06-20	2017-10-18, 2018-01-29, 2018-04-17, 2018-06-20
544MDRBH4	Middle R @ Borden Hwy (Hwy 4)	37.8908	-121.4883	2017-08-15	2017-10-19, 2018-01-30, 2018-02-27, 2018-03-20, 2018-04-18, 2018-05-16, 2018-06-21	2017-10-19, 2018-01-30, 2018-04-18, 2018-06-21
544ADVLM6	Lower Mokelumne R 6	38.2554	-121.4401	2017-08-14	2017-10-18, 2018-01-29, 2018-02-26, 2018-03-19, 2018-04-17, 2018-05-15, 2018-06-21	2017-10-18, 2018-01-29, 2018-04-17, 2018-06-21

541SJC501	San Joaquin R @ Vernalis/Airport Way	37.6756	-121.2642	2017-08-15	2017-10-19, 2018-01-30, 2018-02-27, 2018-03-20, 2018-04-18, 2018-05-16, 2018-06-21	2017-10-19, 2018-01-30, 2018-04-18, 2018-06-21
207SRD10A	Sacramento River at Mallard Island	38.0429	-121.9201	Not included	2018-01-30, 2018-02-27, 2018-03-20, 2018-04-18, 2018-05-16, 2018-06-20	Not included
544DMC020	Delta-Mendota Mendota Canal at Byron-Bethany Road (aka DMC off HWY 4)	37.8121	-121.5790	Not included	2018-01-30, 2018-02-27, 2018-03-20, 2018-04-18, 2018-05-16, 2018-06-21	Not included

Fish collection methods are briefly described here with greater detail given in Appendix 1. Sixteen individual bass were collected from each station by electrofishing. At each location, all fish collected were of the same species: at 5 of the 6 sampling locations, we collected largemouth bass, however at the Sacramento River at Freeport, field crews captured spotted bass. Upon collection, each fish collected was tagged with a unique ID. Physical parameters measured for each individual fish included: weight, total length, fork length, and presence of any abnormalities. Large fish were partially dissected in the field using the following protocol: fish were placed on a cutting board covered with a clean plastic bag where the head, tail, and entrails were removed using a clean cleaver. Fish samples were stored on dry ice for the duration of transport to the Marine Pollution Studies Laboratory (MPSL-DFW) at Moss Landing Marine Labs (MLML) in Moss Landing, CA. At MPSL-DFW samples were stored in a -30 °C freezer until processed for authorized dissection and analysis.

A handheld YSI instrument was calibrated before and after each fish sampling event and was used to measure the following ancillary water column parameters: temperature, pH, dissolved oxygen concentration, conductivity, salinity, and turbidity.

Water sampling methods are briefly described here and in greater detail in Appendix 1. Water samples were collected using a depth-integrated sampler (SWAMP Clean Water Team SOP 2.1.1.4) modified to accommodate a 4 L glass bottle and to collect trace metal samples cleanly. Care was taken to lower and raise the bottle through the water column at a sufficient rate so that the bottle was not completely filled upon retrieval. A new pre-cleaned bottle was used for each station and sampling event.

Aliquots of raw water for the determination of MeHg, total Hg, and total suspended solids (TSS) were collected, prior to collecting filtered samples, by vigorously shaking 4 L and pouring off unfiltered water sample aliquots.

Aliquots of filtered water for the determination of dissolved organic carbon (DOC), MeHg and total Hg were filtered in the field using an E/S portable peristaltic pump, acid-cleaned tubing sets, and trace metal clean 0.45 µm groundwater filters.

Samples for chlorophyll *a* analysis were field-filtered by forcing water with a 60-mL syringe through a filter holder containing a 25 mm glass microfiber filter. Filters were placed on dry ice for transport to MPSL.

All water samples were immediately stored on wet ice (4°C) following collection and transported to MPSL-DFW.

Sediment sampling methods are briefly described here and in greater detail in Appendix 1. Two sediment grab samples (thalweg and bank) were collected using a Van Veen grab and clean polyethylene scoop. At each sediment station, four analytes were collected in three containers: grain size, TOC and Total Hg/MeHg. Grain size samples were stored on wet ice for the duration of the trip. TOC and Total Hg/MeHg samples were stored on dry ice for the duration of the trip. Upon return to MPSL-DFW grain size samples were stored in a refrigerator prior to analysis while TOC and Total Hg/MeHg samples were stored in a -30 °C freezer.

Sample Preparation and Analytical Methods

Water samples for Hg determination were preserved by acidification within 24 hr of collection. Aqueous total Hg and MeHg analysis followed modified U.S. Environmental Protection Agency (USEPA) Method 1631E and Method 1630,

respectively. Total mercury[3] in fish tissue and sediment were determined using a Milestone Direct Mercury Analyzer (DMA-80) following USEPA Method 7473. Sediment MeHg concentrations were determined by KBr, $CuSO_4$ extraction into CH_2Cl_2 followed by aqueous partitioning (Bloom 1989; Heim et al. 2007). The distillate was then analyzed following USEPA Method 1630.

Analysis of TSS and volatile suspended solids (VSS) was conducted by passing a subsample through a 0.45 µm pre-combusted glass fiber filter, drying at 105 °C, and determining TSS as the mass of material retained on the filter. The same filter was dried further at 550 °C for 3 hr with difference in mass determining VSS.

Samples were analyzed for chlorophyll *a* by fluorescence following USEPA Method 445.0 using a Turner Instruments TD700.

Sediment grain size analysis was done using method MPSL-113.

Sediment TOC analysis was done using method EPA 9060.

Quality Assurance

About 15% of all samples that were analyzed were for quality assurance and quality control purposes. Ninety seven percent of the lab results met the requirements of the Delta RMP Quality Assurance Program Plan (QAPP). The primary issues found were blank contamination in some of the ancillary measurements for sediment (total organic carbon) and water (dissolved organic carbon, volatile suspended solids), where blank samples had concentrations similar to or greater than some of the lower concentration field samples (i.e., >30% of the concentration in those samples). Those results were flagged as rejected. January 2018 water samples subcontracted to Delta Environmental had non-detects for DOC well below historical averages for four stations (according to Moss Landing), and results were censored based on best professional judgement. A detailed assessment of the QA data for this dataset is provided in Appendix 2.

Statistical Methods

The measurement of MeHg in individual bass samples (Appendix 3) provided a foundation for statistical procedures to adjust for the relationship with fish length

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[3] Nearly all of the mercury present in edible fish muscle is MeHg, and analysis of fish tissue for total mercury provides a valid, cost-effective estimate of MeHg concentration (Wiener et al. 2007)

(Figures 2 and 3; Appendices 4 and 5). A length of 350 mm has been used for length-adjustment of black bass in the TMDL and in past studies (e.g., Davis et al. 2008, Melwani et al. 2009, Wood et al. 2010), and represents the middle of the distribution of legal-sized (>305 mm, or 12 inches) fish that are commonly caught.

Estimates of length-adjusted means presented in this report are based on simple linear regressions of the data for each station. This approach provides an independently-derived estimate of the station mean that can be compared to any other station mean of interest: other station means from the same sampling period; means from the same station in past sampling; or any other station mean of interest.

Figure 2 Length-adjusted (350 mm) mean MeHg concentration (ppm wet weight) in black bass at each station, August-September 2016.

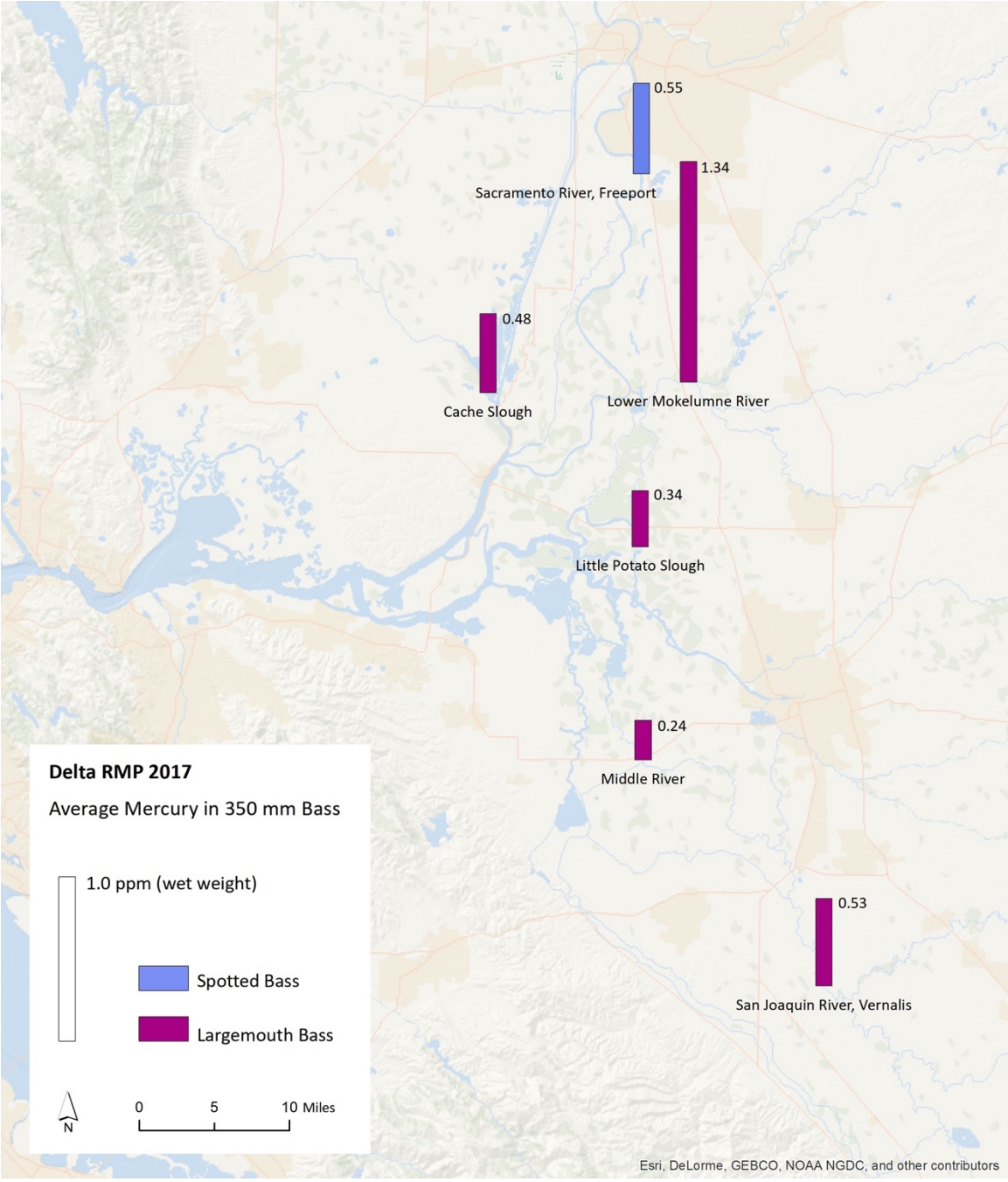


Figure 3 Long-term time series of mean MeHg (ppm wet weight) in black bass for Delta RMP stations and nearby stations sampled historically. Details on following page.

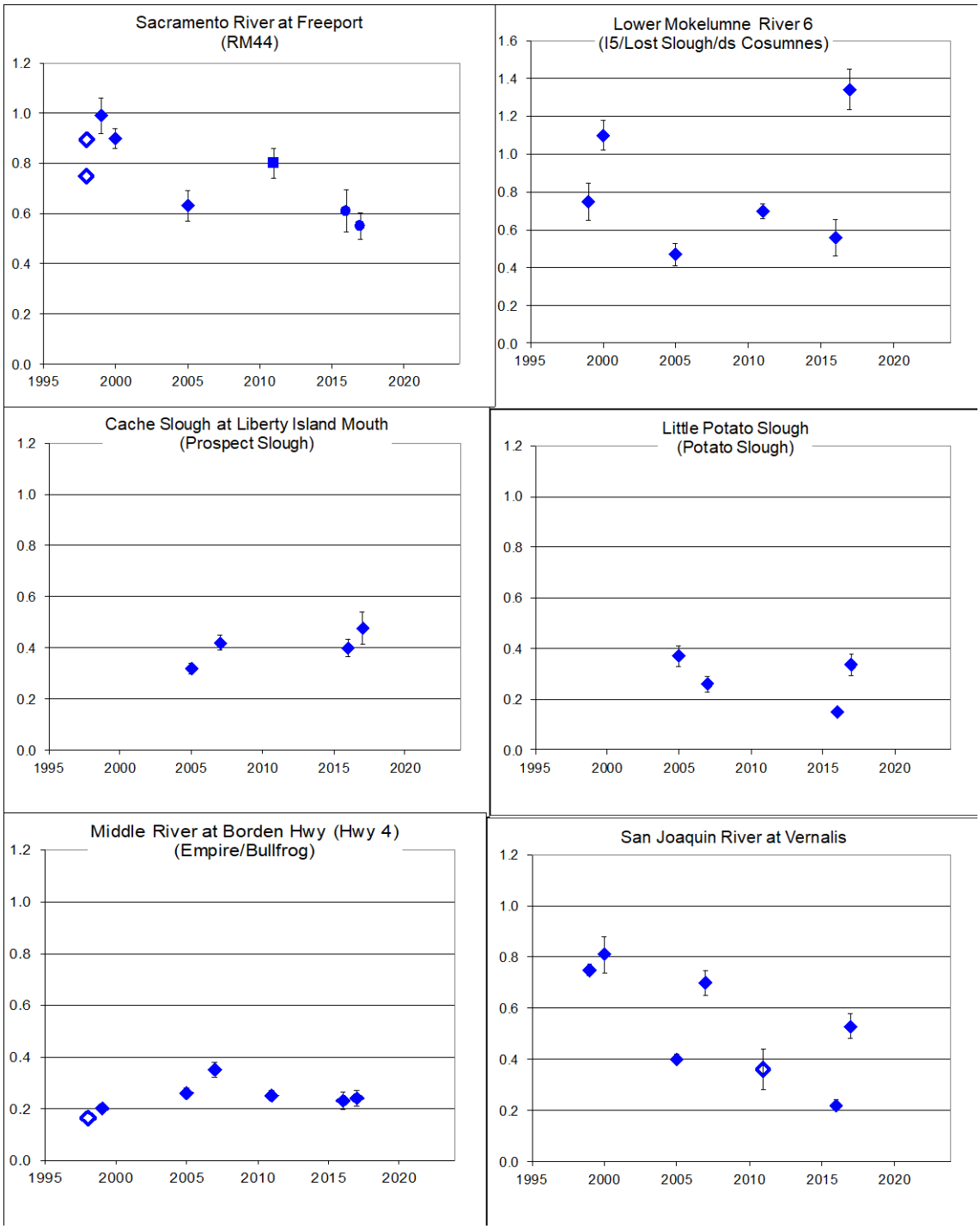


Figure 3 Details

Note different scale of the plot for Lower Mokelumne River 6. Points generally show 350 mm length-adjusted means (exceptions to this noted in plot details below) and error bars indicate two times the standard error. Filled symbols indicate 350 mm length-adjusted means, hollow symbols indicate individual composite samples or arithmetic means when the station did not have a significant length:MeHg correlation. Diamonds indicate largemouth bass; squares are spotted bass; circles are smallmouth bass. Data sources: Delta RMP - 2016; the Surface Water Ambient Monitoring Program (Davis et al. 2013) - 2011; the Fish Mercury Project (Melwani et al. 2009) - 2005-2007; the CALFED Mercury Project (Davis et al. 2003) - 1999-2000; the Delta Fish Study (Davis et al. 2000) - 1998; and the Sacramento River Watershed Program (2002) - 1998.

Sacramento River at Freeport
Stations - Freeport: 2016-2017; RM44: All other years
Statistics - Individual composite results: 1998; 350 mm length adjusted mean: all other years

Lower Mokelumne River 6
Stations - Lower Mokelumne River 6: 2016-2017; Mokelumne River near I-5: 2011; Lost Slough: 2005; Mokelumne River downstream of the Cosumnes River: 1999, 2000

Cache Slough at Liberty Island Mouth
Stations - Cache Slough at Liberty Island Mouth: 2016-2017; Prospect Slough: 2005, 2007

Little Potato Slough
Stations - Little Potato Slough: 2016-2017; Potato Slough (aka San Joaquin River at Potato Slough): 2005, 2007

Middle River at Borden Hwy (Hwy 4)
Stations - Middle River at Borden Hwy (Hwy 4): 2016-2017; Middle River near Empire Cut: 2011; Middle River at Bullfrog: 1998, 1999, 2007; Middle River at HWY 4: 2005
Statistics - Individual composite result: 1998; 350 mm length adjusted mean: all other years

San Joaquin River at Vernalis
Stations - Same station all years

Results

Fish

Results from the second round of Delta RMP fish monitoring are presented in Figure 3, with data from prior fish sampling in or near these stations provided for context. The existing time series are characterized by a high degree of inconsistency in stations, species, and sampling approach over time, highlighting the need to build a consistent dataset for trend evaluation.

Length-adjusted (350 mm) bass means in 2017 ranged from 0.24 ppm MeHg (all fish results presented in wet weight) at Middle River at Borden Highway to 1.34 ppm at Lower Mokelumne River.

Variation in the availability of largemouth bass at the Sacramento River at Freeport continues to pose a problem. In 2016 and again in 2017, spotted bass were collected, while previous efforts obtained smallmouth bass (2011) and largemouth bass (1998, 1999, 2000, and 2005). Largemouth bass have been collected consistently over the years at the other stations.

Length-adjusted mean concentrations measured in 2017 at three stations (Sacramento River at Freeport, Cache Slough at Liberty Island Mouth, and Middle River at Borden Hwy) were not significantly different from the means for 2016 (non-overlapping 95% confidence intervals of the mean) (Figure 3). At the other three stations, however, the 2017 means were all significantly higher than the 2016 means (Figure 3). The 2017 mean at Lower Mokelumne River was the highest observed for stations in this area over the period of record. The mean concentration in 2017 at Little Potato Slough was higher than 2016, but within the range of previous observations in this area. The 2017 mean at San Joaquin River at Vernalis was higher than in 2016, but in the middle of the range of prior observations for this area. Up until 2016, the time series at San Joaquin River at Vernalis was suggesting a significant decreasing trend.

Fish sampling in August 2017 occurred after high flows in January and February of 2017 that ended a five-year drought.

Water

Appendix 6 presents a tabulation of 2017-18 results for all of the parameters measured in water.

The concentration of MeHg in unfiltered water ranged from 0.044 – 0.385 ng L^{-1}. Figure 4 presents long-term time series of March to October annual means of unfiltered

MeHg concentrations for Delta RMP sites. These means are based on limited numbers of samples, as indicated in the caption for Figure 4. Sacramento River concentrations have remained constant with good agreement between historic data and current data. Lower Mokelumne results were similar to previously reported values given the large variability of MeHg concentrations for this site. Cache Slough MeHg concentrations were in good agreement with previously reported values. No historic data are available for Little Potato Slough but MeHg concentrations were consistent with concentration reported for 2016. Middle River MeHg concentrations were within the range of historic data. San Joaquin River 2017 and 2018 MeHg concentrations were similar to previously reported with 2017 on the higher end and 2018 on the lower end when compared to historic results. Sacramento River at Mallard 2018 results were in good agreement with previously reported MeHg concentrations. Delta Mendota Canal MeHg concentrations were within the range of previously reported MeHg concentrations (Figure 4).

Particulate MeHg concentrations (calculated as the difference of unfiltered and filtered MeHg) ranged from less than the reporting limit to 0.13 ng L^{-1}. Filtered MeHg concentrations averaged 65% of unfiltered MeHg concentrations.

Unfiltered total Hg concentrations ranged from 0.73 – 15.9 ng L^{-1}. Filtered total Hg concentrations ranged from 0.31 – 5.36 ng L^{-1}. Total Hg was found to be predominantly in the particulate form and was positively correlated to TSS concentrations (correlation data not shown).

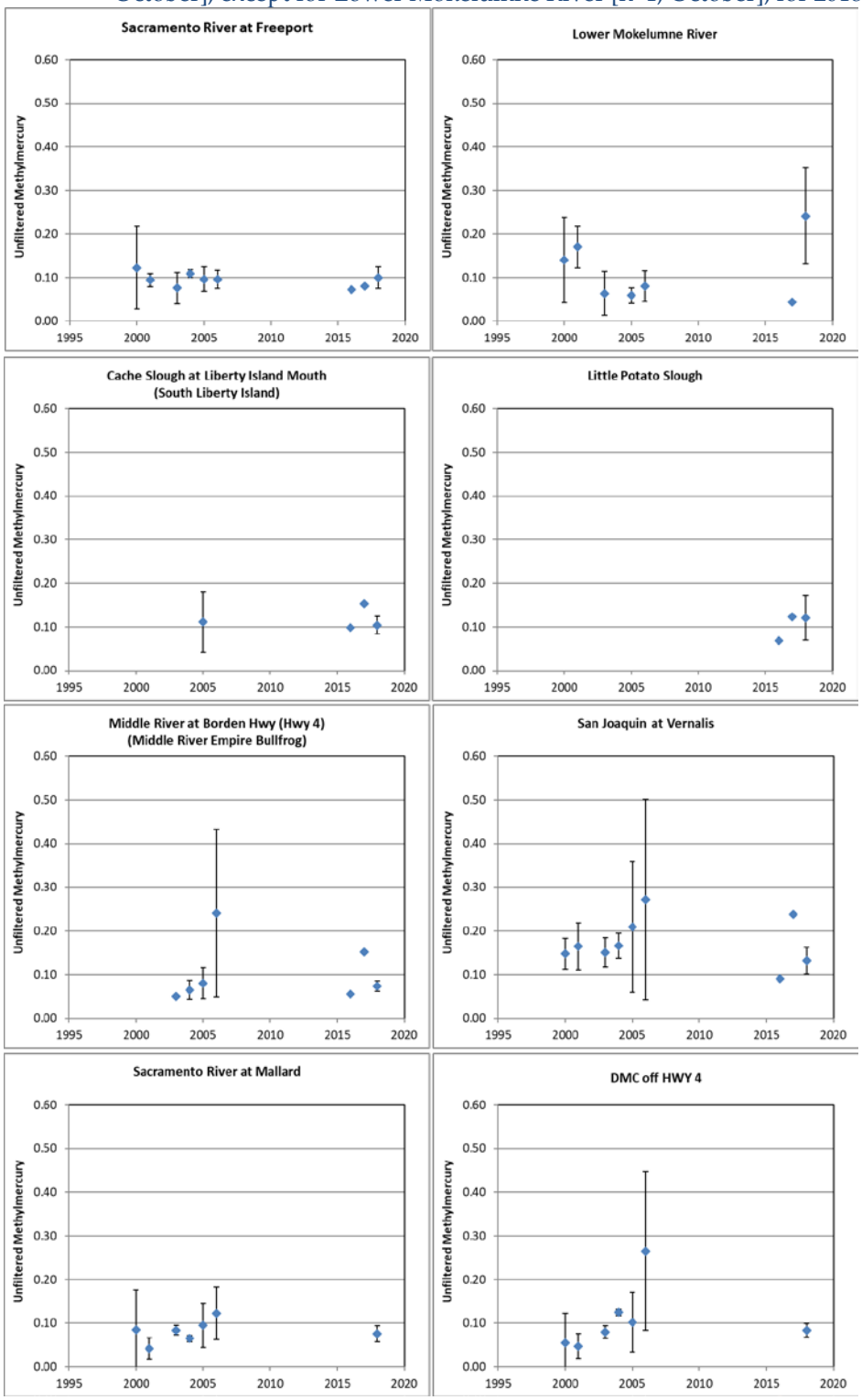
The following ranges in ancillary parameters were measured in Delta surface water: temperature = 9.7 – 24.2 °C; pH = 6.8 – 8.5; dissolved oxygen = 7.2 – 12.6 mg L^{-1}; dissolved oxygen = 71 – 128% saturation; specific conductivity = 34- 3932 μS cm^{-1}; salinity = 0–1.9 ‰; turbidity = 2 – 224 NTU.

Concentrations of DOC in the Delta were fairly consistent ranging from 1.2 to 8.1 mg L^{-1} for all sites and sampling events.

Chlorophyll *a* concentrations varied widely across sites and time with a range of less than the reporting limit to 37 μg L^{-1}.

Similarly, TSS concentrations had a large range both spatially and temporally. The range of TSS was 1.3 – 136 mg L^{-1}. Concentrations of VSS were less than the reporting limit to 54 mg L^{-1}.

Figure 4 Annual mean aqueous unfiltered MeHg concentration (ng L^{-1}) at each Delta RMP monitoring station sampled from October 2017 through June 2018. Lower Mokelumne River station was added in October 2017. Plots based on available March-October data for each calendar year (for 2016 n=1 [August]; for 2017 n=2 [April and October], except for Lower Mokelumne River [n=1, October]; for 2018 n=4 [Mar-June].



Sediment

Mean thalweg and bank sediment THg concentrations ranged from 0.01 to 0.12 μg g^{-1} and 0.02 to 0.13 μg g^{-1}, respectively. Thalweg MeHg sediment concentrations varied from 0.02 to 0.97 ng g^{-1}. Bank MeHg sediment concentrations ranged from 0.39 to 1.7 ng g^{-1}. Mercury methylation potential was determined by proxy using MeHg as percent of THg. Percent MeHg for thalweg and bank were 0.16 to 0.87% and 0.42 to 1.3%, respectively.

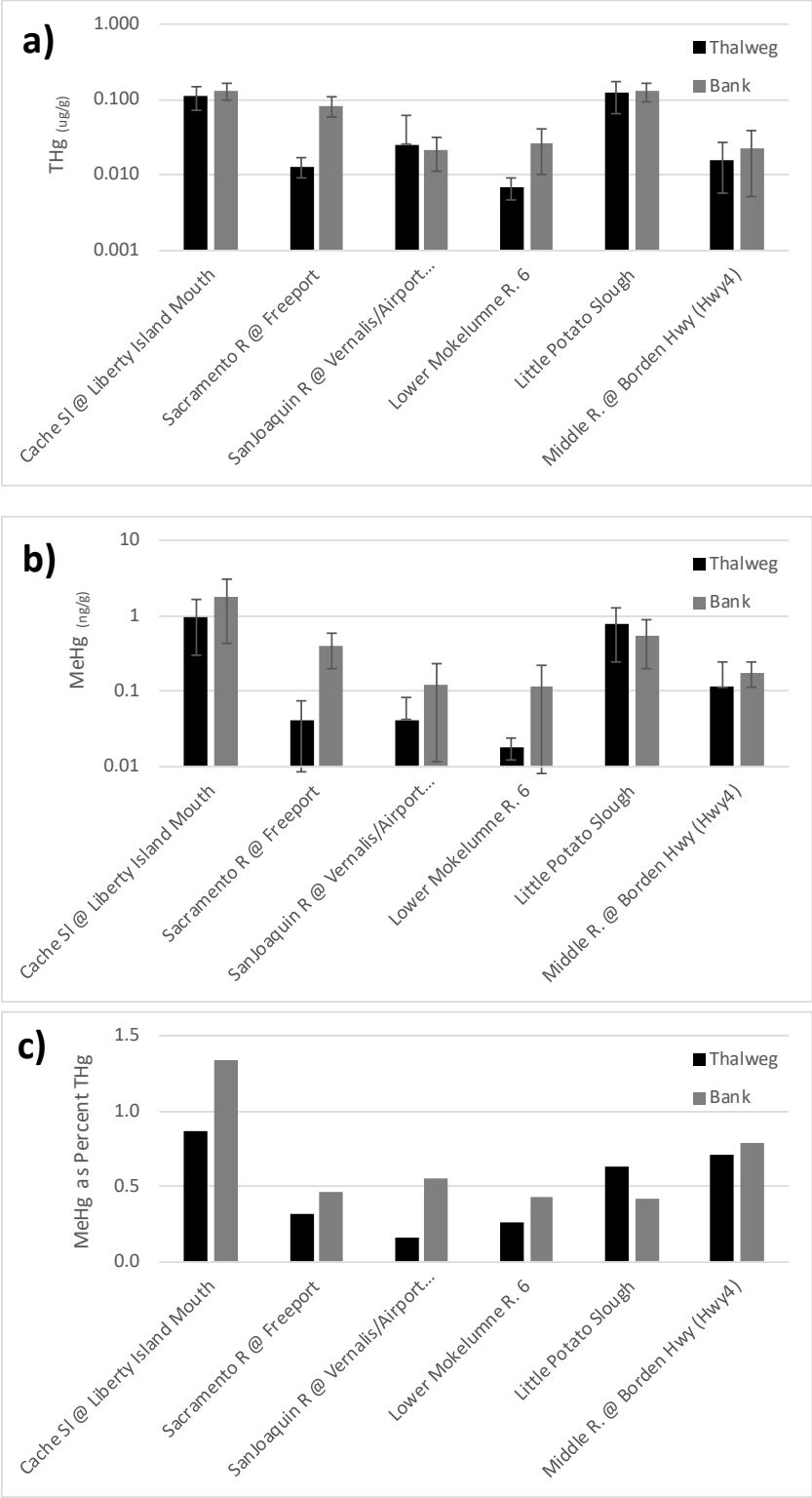
Mean grain sizes for thalweg sites were as follows: 9.8% clay, 32.9% silt, and 59.8% sand. For bank sites mean grain size of all sites was 10.1% clay, 49.0% silt, and 40.9% sand. Both thalweg and bank sediments at Cache Slough and Little Potato Slough were silty clay; sandy sediments were observed for thalweg and bank sediments at all other sites.

Percent TOC in thalweg and bank sediments ranged from 0.04 to 5.93% and 0.07 to 5.20% respectively. For both thalweg and bank sediments, higher TOC was observed at Cache Slough and Little Potato Slough compared to other sites.

Mean percent moisture of thalweg and bank sediments was 36.5 ± 16.3% (mean and standard deviation) and 40.6 ± 14.1% respectively.

Appendix 7 presents a tabulation of 2017–18 results for all of the parameters measured in sediment. Figure 5 shows the average sediment concentration for total mercury and methylmercury in sediment collected from the thalweg and bank at Delta RMP monitoring stations.

Figure 5. Annual mean sediment THg concentration (a), MeHg concentration (b), and MeHg as percent THg (c) for samples collected from the thalweg and bank at Delta RMP monitoring stations.



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Appendix 1: Cruise Report

Appendix 1

Cruise Report for the Delta Regional Monitoring Program (Delta RMP) Monitoring For Status and Trends of Mercury in Black Bass and Water

For Work Completed July 2017 through June 2018
Sampling Dates: August 14, 2017 – June 21, 2018

Written by: April Sjoboen Guimaraes, Billy Jakl, and Wesley Heim
Marine Pollution Studies Laboratory (MPSL-DFW) at Moss Landing Marine Laboratories

Introduction

This report describes the sampling activities in different subareas of the Delta region of California. This sampling effort focuses on providing essential performance measures for evaluating the effectiveness of the methylmercury (MeHg) TMDL in the Delta. The TMDL is a key management plan that utilizes a conceptual model for MeHg in the Delta that has been based on extensive monitoring and research conducted by CALFED in the 2000s. This conceptual model shows an observed linkage between MeHg concentration in water and the concentrations in predator fish. The observed linkage was strongest with the black bass species, specifically largemouth bass, which represents the indicator of impairment and water quality objectives. Sampling activities included the collection of fish tissue (black bass), water and sediment samples with basic field parameters. Samples were collected by the Marine Pollution Studies Laboratory-DFW (MPSL-DFW) at Moss Landing Marine Laboratories (MLML).

1.0 Cruise Report

1.1 Objectives

The objectives were to provide spatial and temporal fish, water, and sediment data to update the TMDL conceptual model. Black bass were collected annually using an electrofisher boat at six fixed stations selected for long-term monitoring. Sixteen black bass were collected spanning a broad size range for each station. Each bass was analyzed individually for mercury (Hg) to support analysis of covariance for size:Hg relationship. The annual fish collection was paired with water collection at eight water stations. Quarterly sediment collection was done at six stations.

Water collections provide the MeHg TMDL water concentrations to track performance relative to the established 0.06 ng/L unfiltered MeHg goal, and provide a valuable tool for understanding processes leading to accumulation in fish and impairment. Depth-integrated water sampling were collected in the thalweg at eight stations that are strategically located to correlate with the fish monitoring and to provide information that will be useful input to the Hg model in development for the Delta by DWR. The paired fish and water data will allow further assessment of the strength of the correlation between these two matrices. The chemical analyte groups for the water collection include: total Hg (THg), filtered THg, total MeHg and filtered MeHg. Ancillary water parameters, such as chlorophyll *a*, dissolved organic carbon (DOC), total suspended solids (TSS), and volatile

suspended solids (VSS) were collected to aid in interpretation of the MeHg data (taken from section 7.6 scientific merit).

Sediment samples were collected in the thalweg and bank at six stations. The chemical analyte groups for the sediment collection include: total Hg, MeHg, grain size, total organic carbon (TOC), and moisture.

1.2 MPSL-DFW/CDFW Sampling personnel

April Guimaraes	Project Associate, Crew Lead
William Jakl	Research Tech, Crew Lead
Autumn Bonnema	Project Assistant
Gary Ichikawa	Environmental Scientist
Wesley Heim	Primary Investigator
Jessica Heath	Research Tech
Chris Beebe	Research Tech
Scot Lucas	Research Tech

1.3 Authorization to collect samples

All sampling personnel are MPSL-DFW staff (San Jose State University Foundation and the California Department of Fish and Wildlife) contracted through the San Francisco Estuary Institute/Aquatic Science Center to conduct the sample collection activities listed herein.

1.4 Station selection

Based upon the recommendations of the Delta RMP Steering Committee and Technical Advisory Committee with representatives from the Central Valley Regional Water Quality Control Board, USEPA, California Department of Water Resources, the State and Federal Contractors Water Agency, and various discharger groups, selected stations represent key subareas of the delta.

1.5 Summary of types of samples authorized to be collected

Up to sixteen (16) black bass individuals of the same species were collected using an electrofisher for each of the six stations. The sixteen individuals spanned a broad size range to support assessment of the size:Hg relationship and ANCOVA analysis. Upon collection, each fish collected was tagged with a unique ID that corresponded to the latitude/longitude where it was collected. Physical parameters were collected for each individual fish, which included: weight, total length, fork length, and presence of any abnormalities. Fish samples were stored on wet ice for the duration of the trip. Large fish were partially dissected in the field using the following protocol: fish were placed on a cutting board covered with a clean plastic bag where the head, tail, and guts are removed using a clean (laboratory detergent, DI) cleaver. The sex of the fish was noted. The cutting board was re-cleaned between stations.

At the MPSL-DFW lab, samples were stored in a freezer until they were processed for authorized dissection and analysis.

A depth-integrated water sample was collected at six (6) stations October 2017 and eight (8) stations subsequently, following MPSL-DFW SOP MPSL-111 Revision 2 using a bucket sampler (SWAMP Clean Water Team SOP 2.1.1.4) modified to accommodate a trace metal cleaned 4L glass bottle (I-Chem Part # 145-4000) (MPSL-101). A new trace metal cleaned 4L glass bottle, tubing and filter were used for each site. In the thalweg, the bucket sampler with the 4L was lowered to 0.5m from the bottom to a maximum depth of 15m and raised through the water column at a sufficient rate so that the bottle was not completely filled upon retrieval, achieving a depth-integrated sample. Total samples were aliquoted into analyte-specific bottles by pouring. The 4L bottle was agitated between samples to maintain consistency. Filtered samples were collected by attaching a 45µm ground water filter to trace metal clean tubing and a peristaltic pump, and aliquoted to the analyte-specific bottle. At each water station, four analytes were collected: THg, filtered THg, total MeHg and filtered MeHg. Ancillary water samples were collected to help interpretation of Hg data at each station: chlorophyll *a*, DOC and TSS/VSS. DOC samples were acidified upon collection. All samples were stored on wet ice for the duration of the trip.

At the MPSL-DFW lab, THg and MeHg samples were acidified. MeHg samples were stored in a refrigerator until they were analyzed.

Two sediment grab samples (thalweg and bank) were collected at six (6) stations using a Van Veen grab and clean polyethylene scoop. In the thalweg, the Van Veen grab was lowered to collect the sediment in the same location where the water sample had been collected. A polyethylene scoop was used to aliquot the sediment to appropriate sample containers. A second sample was collected along the bank in close proximity to the target station. At each sediment station, four analytes were collected in three containers: grain size, TOC and Hg/MeHg. Grain size samples were stored on wet ice for the duration of the trip. TOC and Hg/MeHg samples were stored on dry ice for the duration of the trip.

At the MPSL-DFW lab, grain size samples were stored in the refrigerator until analyzed. TOC and Hg/MeHg samples were stored in the freezer until they were analyzed.

Basic field parameters (temperature, pH, specific conductance, dissolved oxygen concentration, dissolved oxygen saturation, and turbidity) along with station information (station depth, location, weather) were also noted.

1.6 Results

Two MPSL-DFW teams sampled the six subareas for fish tissue. Several MPSL-DFW crews completed the monthly water sampling and quarterly sediment sampling efforts. Details on fish catch, fish total length, descriptions and maps of sample collection for all stations can be found in the pages that follow. Also included are the dates of the depth-integrated water and sediment sampling events.

Sacramento River at Freeport (510ST1317)

Latitude: 38.4556
Longitude: -121.50189
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/14/17
Date(s) of Water Collection: 10/18/17, 1/29/18, 2/26/18, 3/19/18, 4/17/18, 5/15/18, 6/20/18
Date(s) of Sediment Collection: 10/18/17, 1/29/18, 4/17/18, 6/20/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Gary Ichikawa, Scot Lucas

Sportfish Caught: Spotted Bass, TL (mm)															
208	213	214	214	217	228	245	268	284	305	309	310	313	332	335	340

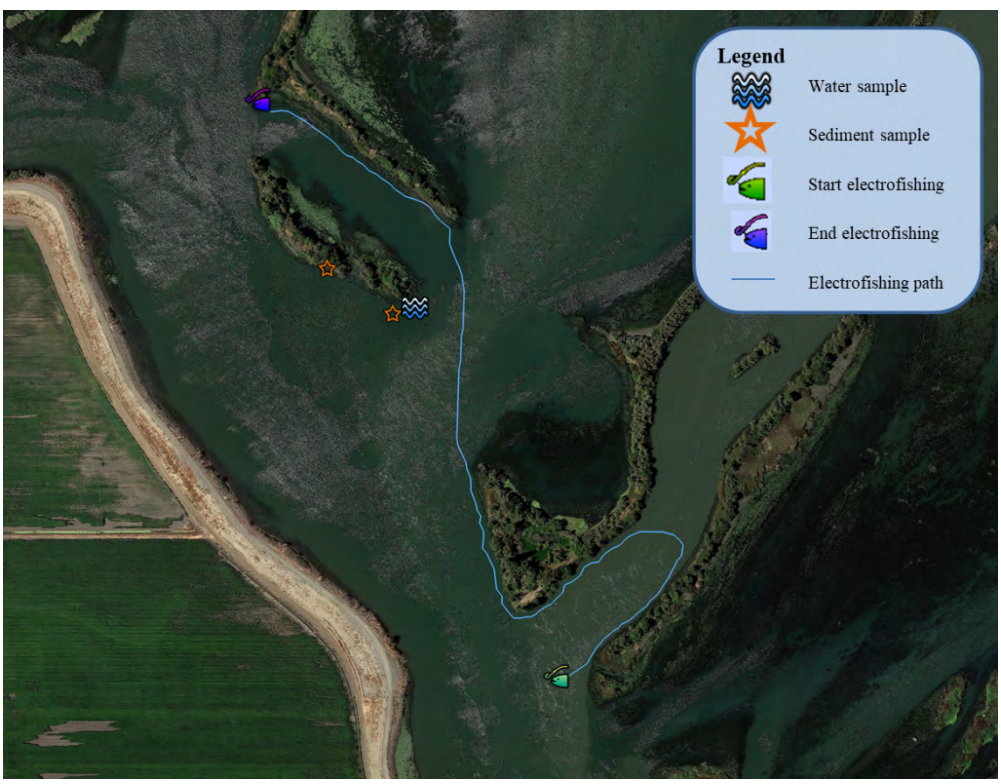
Comments: The sampling vessel was launched from Garcia Bend Park in Sacramento, CA. Sixteen (16) Spotted bass were sampled along a transect adjacent to the target station. All water collection was done in close proximity of the target station where the channel discharge was greatest. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.

Cache Slough at Liberty Island Mouth (510ADVLIM)

Latitude: 38.24213
Longitude: -121.68539
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/15/17
Date(s) of Water Collection: 10/18/17, 1/29/18, 2/26/18, 3/19/18, 4/17/18, 5/15/18, 6/20/18
Date(s) of Sediment Collection: 10/18/17, 1/29/18, 4/17/18, 6/20/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Gary Ichikawa, Scot Lucas

Sportfish Caught: Largemouth Bass, TL (mm)															
225	232	245	271	277	288	314	322	325	325	327	330	374	411	425	508

Comments: The sampling vessel was launched from Arrowhead Marina in Clarksburg, CA. Sixteen (16) Largemouth bass were sampled along the transect adjacent to the target station. All water collection was done in close proximity of the target station where the channel discharge was greatest. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.



Lower Mokelumne River 6 (544ADVLM6)

Latitude: 38.25542
Longitude: -121.4401
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/14/17
Date(s) of Water Collection: 10/18/17, 1/29/18, 2/26/18, 3/19/18, 4/17/18, 5/15/18, 6/21/18
Date(s) of Sediment Collection: 10/18/17, 1/29/18, 4/17/18, 6/21/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Gary Ichikawa, Scot Lucas

Sportfish Caught: Largemouth Bass, TL (mm)															
218	220	242	250	252	259	312	317	370	371	375	380	387	407	507	541

Comments: The sampling vessel was launched from New Hope Landing in Walnut Grove, CA. Sixteen (16) Largemouth bass were sampled along the transect adjacent to the target station. All water collection was done in close proximity of the target station where the channel discharge was greatest. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.

Little Potato Slough (544LILPSL)

Latitude: 38.09627
Longitude: -121.49602
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/14/17
Date(s) of Water Collection: 10/18/17, 1/29/18, 2/26/18, 3/19/18, 4/17/18, 5/15/18, 6/20/18
Date(s) of Sediment Collection: 10/18/17, 1/29/18, 4/17/18, 6/20/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Gary Ichikawa, Scot Lucas

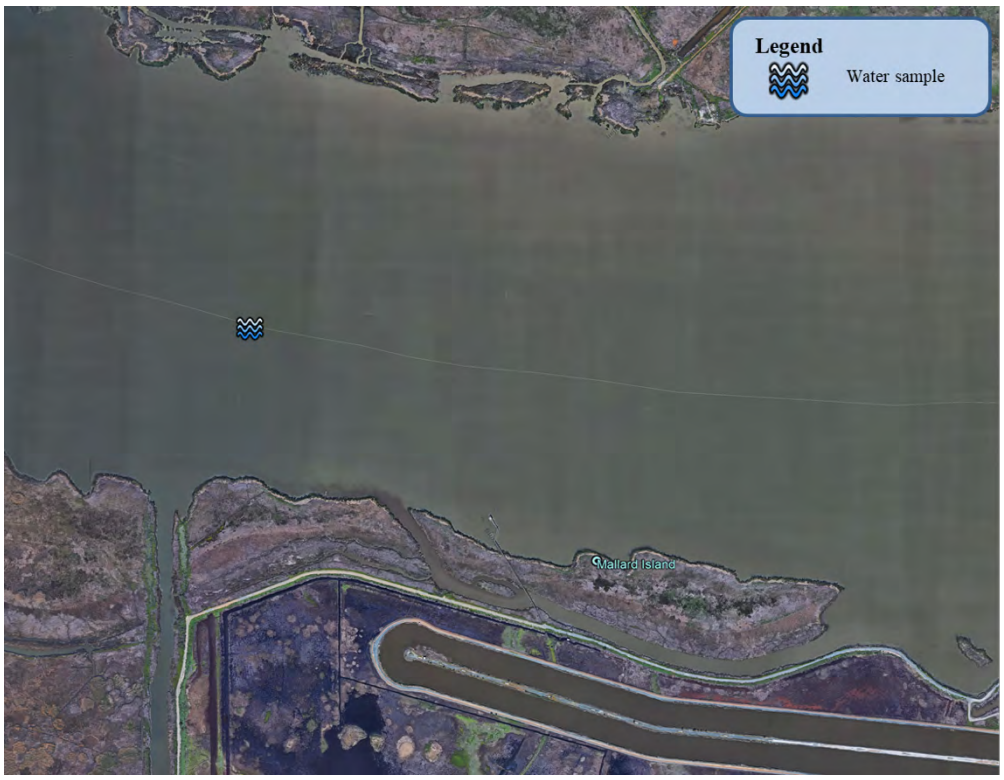
Sportfish Caught: Largemouth Bass, TL (mm)															
212	228	248	251	252	275	318	344	350	350	362	395	404	411	415	443

Comments: The sampling vessel was launched from Tower Park Marina in Lodi, CA. Sixteen (16) Largemouth bass were sampled along the transect adjacent to the target station. All water collection was done in close proximity of the target station where the channel discharge was greatest. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.

Sacramento River at Mallard Island (207SRD10A)

Latitude: 38.04288
Longitude: -121.92011
Collection Objective: Water (Monthly)
Collection Method: Depth-integrated water sampler
Date(s) of Water Collection: 1/30/18, 2/27/18, 3/20/18, 4/18/18, 5/16/18, 6/20/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Scot Lucas

Comments: The sampling vessel was launched from Pittsburg Yacht Club in Pittsburg, CA. All water collection was done in close proximity of the target station where the channel discharge was greatest.

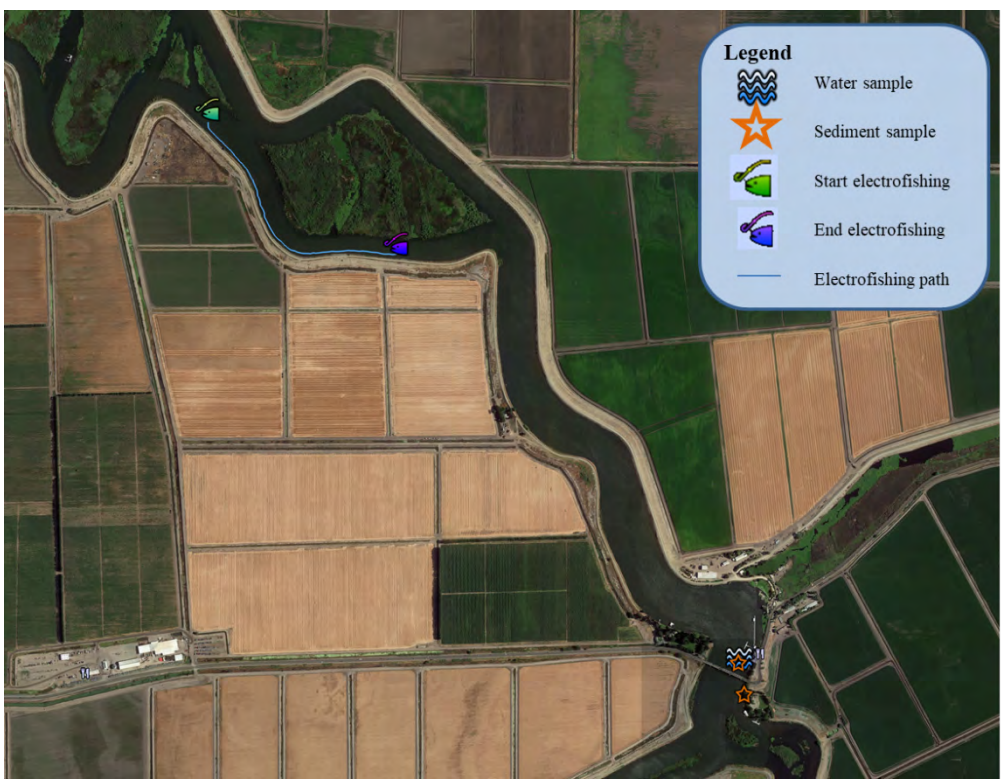


Middle River at Borden Hwy (544MDRBH4)

Latitude: 37.89083
Longitude: -121.48833
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/15/17
Date(s) of Water Collection: 10/19/17, 1/30/18, 2/27/18, 3/20/18, 4/18/18, 5/16/18, 6/21/18
Date(s) of Sediment Collection: 10/19/17, 1/30/18, 4/18/18, 6/21/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Gary Ichikawa, Scot Lucas

Sportfish Caught: Largemouth Bass, TL (mm)															
211	229	246	252	270	295	323	324	325	345	352	368	385	412	422	460

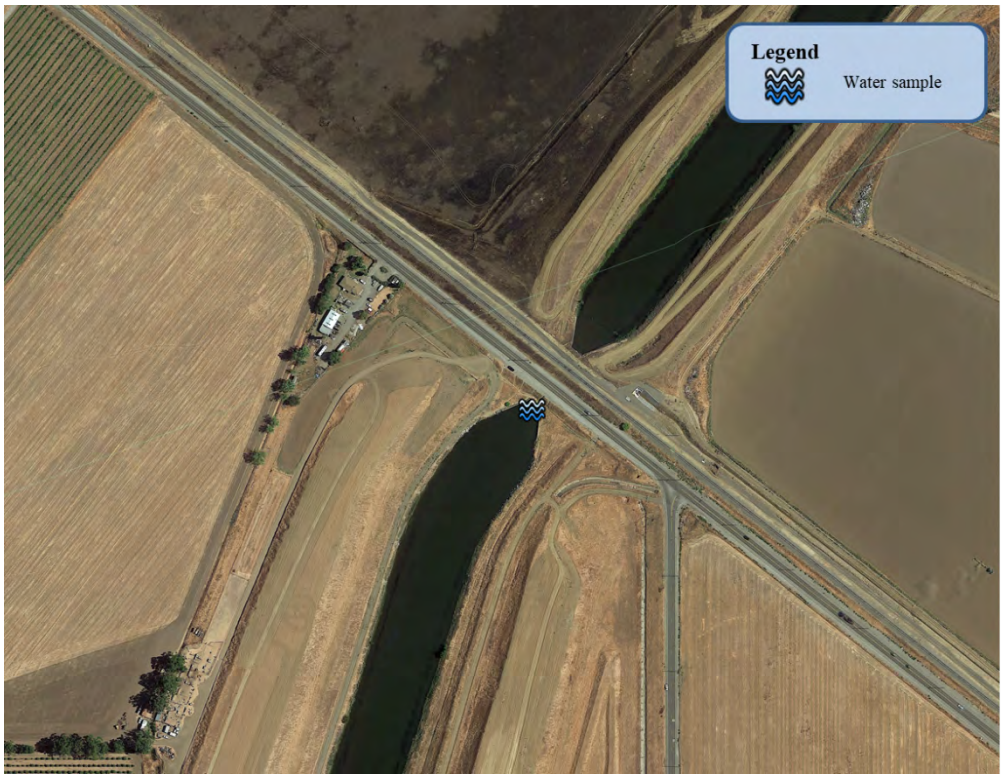
Comments: The sampling vessel was launched from Discovery Bay Yacht Harbor in Discovery Bay, CA. Sixteen (16) Largemouth bass were sampled along the transect adjacent to the target station. All water collection was done in close proximity of the target station where the channel discharge was greatest. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.



DMC off HWY 4 (544DMC020)

Latitude: 37.81212
Longitude: -121.57904
Collection Objective: Water (Monthly)
Collection Method: Depth-integrated water sampler
Date(s) of Water Collection: 1/30/18, 2/27/18, 3/20/18, 4/18/18, 5/16/18, 6/21/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Scot Lucas

Comments: All water collection was done off the bank in close proximity of the target station where the channel discharge was greatest.

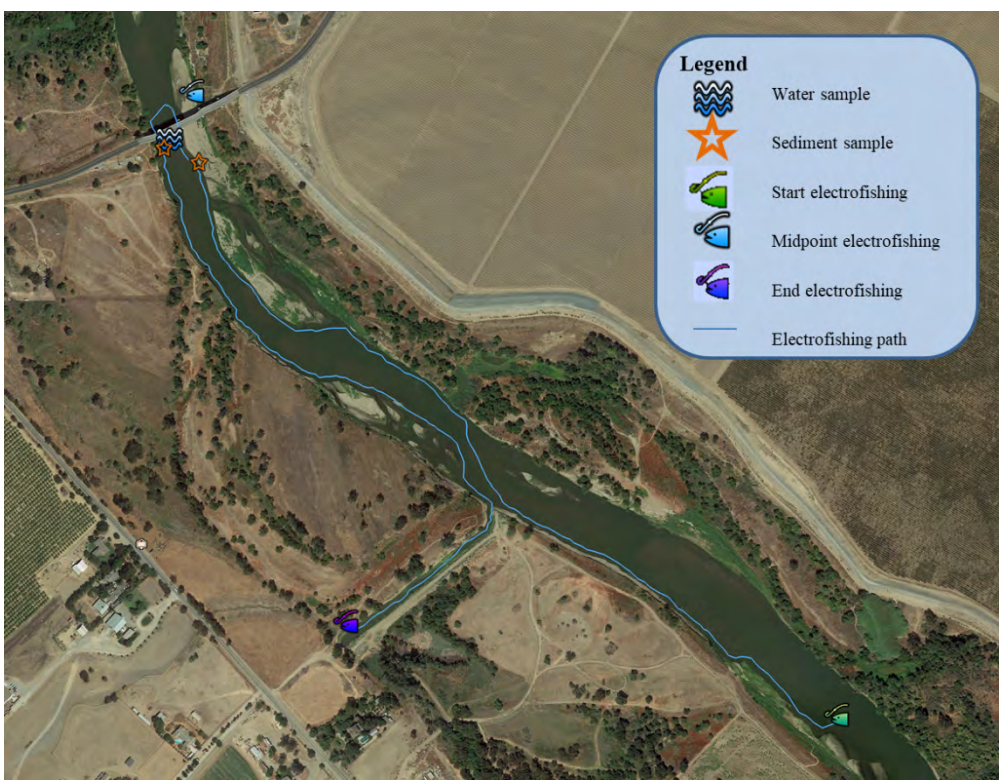


San Joaquin River at Vernalis/Airport (541SJC501)

Latitude: 37.67556
Longitude: -121.26417
Collection Objective: Fish (Annually) Water (Monthly) Sediment (Quarterly)
Collection Method: Electrofishing vessel, depth-integrated water sampler, Van Veen grab and polyethylene scoop
Date(s) of Fish Collection: 8/15/17
Date(s) of Water Collection: 10/19/17, 1/30/18, 2/27/18, 3/20/18, 4/18/18, 5/16/18, 6/21/18
Date(s) of Sediment Collection: 10/19/17, 1/30/18, 4/18/18, 6/21/18
Samplers: April Guimaraes, William Jakl, Wesley Heim, Chris Beebe, Jessica Heath, Autumn Bonnema, Scot Lucas

Sportfish Caught: Largemouth Bass, TL (mm)															
203	205	235	256	272	284	308	309	310	326	330	350	395	408	418	445

Comments: The sampling vessel was launched from Two Rivers RV Park in Manteca, CA. Sixteen (16) Largemouth bass were sampled along the transect adjacent to the target station. Water samples in August 2017 and January 2018 were taken in the thalweg from the sampling vessel. Beginning in February 2018, due to low water levels, all water collection was done along the bank in close proximity of the target station. Sediment collection was done in the thalweg at the same location as the water sample, and along the bank in close proximity to the target station.



1.7 Summary

A total of six (6) stations were successfully sampled for fish tissue using a dedicated electrofishing vessel.

In addition, six (6) stations were successfully sampled for depth-integrated water samples and basic water parameters in October 2017. Two additional stations for a total of eight (8) stations were sampled beginning January 2018. Following retrieval, the depth-integrated water sample was aliquoted in the field into appropriate sample containers for analysis. The chemical analyte groups for this monitoring element include: total Hg, filtered Hg, total MeHg, filtered MeHg, and ancillary parameters. Field blanks were collected at a rate of 5%, or a minimum of one (1) field blank per collection event. Field duplicates were collected at a rate of 10%, or a minimum of one (1) duplicate per every ten (10) samples for each analyte, or once per collection event.

Sediment collection occurred at six (6) stations. Sediment samples were collected from the bank and thalweg at each site. The chemical analyte groups for this monitoring element include: grain size, TOC and THg/MeHg. Field duplicates were collected at a rate of 10%, or a minimum of one (1) duplicate per every ten (10) samples for each analyte, or once per collection event.

Appendix 2: Quality Assurance Review

Quality Assurance Review of FY 2017-2018 Delta RMP Mercury Analyses

General Summary

This Appendix summarizes the quality assurance (QA) review of the Delta Regional Monitoring Program (Delta RMP) 2017–2018 data for laboratory analyses of mercury and ancillary measurements in water, sediment, and fish. This review was conducted by ASC scientists and technical staff under the supervision of QA officer Dr. Donald Yee. Samples were collected and analyzed by scientists and technicians from the Marine Pollution Studies Laboratory (MPSL) in Moss Landing, California. Additional analyses of dissolved organic carbon (DOC) were performed by Delta Environmental Lab, after MPSL's instrument broke, and samples were sent to that external commercial lab.

We found that 97% of the lab results met the requirements of the Delta RMP Quality Assurance Program Plan. Table 1 provides a high-level quality assurance summary of the chemical analytical results. The primary issues found were blank contamination in some of the ancillary measurements for sediment (total organic carbon) and water (dissolved organic carbon, volatile suspended solids), where blank samples had concentrations similar to or greater than some of the lower concentration field samples (i.e., >30% of the concentration in those samples). Those results were flagged as rejected. January 2018 samples subcontracted to Delta Environmental had non-detects for DOC well below historical averages for four stations (according to Moss Landing), and results were censored based on best professional judgement.

The ancillary parameters with blank contamination were generally at small multiples of their detection limits. This is sometimes due to optimistically set low detection limits. If a similar level of blank contamination recurs in future analyses, the lab should consider adjusting detection limits to account for this low level uncertainty.

Approach

About 15% of all samples were analyzed for quality assurance and quality control purposes.

For our QA review, we used the data electronically submitted by the laboratory and compiled it into a local database to verify that the correct number of field samples and required number of QC samples are reported for the requested analyses, as specified in the Quality Assurance Program Plan or QAPP.

We compared the results for QC samples to the acceptance criteria, or measurement quality objectives listed in the QAPP (see Section 14.2.1). We did this by independently recalculating reported precision (as relative percent difference, RPD, or relative standard deviation, RSD) for lab replicates, and percent recovery for samples of a known concentration. In order to verify

that contamination of samples had not occurred in sampling or lab analysis, we compared the results for blank samples (both field and lab blanks) to method detection limits. In cases where an analyte is detected in a blank, we compare the measured concentration in the blank sample to concentrations measured in field samples to determine the proportion of the signal that originates from lab contamination.

Where deviations from the project's measurement quality objectives (MQOs) were found, we attached a flag or qualifier to the record. In some cases, records may have already been flagged by the reporting lab. Qualifiers added by ASC or the lab indicates that there has been a deviation from the project's quality criteria, and are meant to warn data users that certain records may be inaccurate or imprecise. In the most severe cases, data may be rejected and not reported.

Table 1. QA Summary for chemical analytical results. RPD = relative percent difference.

Analyte	% Exceeding hold time	% Non-detects	% Results < 3x Blank	Average % Recovery	Average RPD
Water					
Total Mercury	0%	0%	0%	100%	3%
Total Methylmercury	0%	0%	0%	91%	12%
Chlorophyll-a	0%	0%	0%	100%	1%
Dissolved Organic Carbon	0%	8%	6%	95%	8%
Total Suspended Solids	0%	0%	0%	104%	7%
Volatile Suspended Solids	0%	18%	31%	na	20%
Sediment					
Total Mercury	0%	0%	0%	100%	3%
Methylmercury	0%	0%	0%	94%	14%
Grain size	na	2%	na	na	na
Total Organic Carbon	0%	0%	9%	101%	2%

Fish

Total Mercury	0%	0%	0%	113%	5%

Details on the reviews of the reported datasets are included in the sections below.

Sediment Mercury, Methylmercury, and Moisture Data

QA by John Ross, April 3, 2019.

Reviewed by Quality Assurance Officer Don Yee, April 11, 2019.

QA Issues encountered

Accuracy

The accuracy for mercury and methyl mercury are flagged as needed following a convention for the Status and Trends data of using the average %error of the certified material samples (CRMs), when present, in preference to the %error of the matrix spike/matrix spike replicates, as the CRMs are externally validated values.

Methylmercury and mercury certified reference material (CRM) % errors averaged 6% and 1% respectively, well within the method quality objective in the 2019 Delta RMP QAPP for methylmercury LCS samples of "expected value ± 30%"; no target is listed for mercury CRMs, but with the low %error on both analytes, no accuracy flags were needed.

However, two individual mercury matrix spike/matrix spike duplicate results did not meet the method quality objective listed in the 2019 Delta RMP QAPP of "expected value ± 25%. Despite that, the average %error was within 25%, and accuracy was sufficient based on the CRM results, so no results were flagged.

Precision

The precision of field samples in the database is flagged by a convention for Status and Trends data of using lab replicates in preference to using field replicates, although both are reviewed and described narratively when provided.

Mercury and methylmercury lab replicates met the method quality objective listed in the 2019 Delta RMP QAPP of an RPD < 25% so the set of field samples was not flagged in the database. But, 1 of the mercury field replicates and 3 of the methylmercury field replicates were above the 2019 Delta RMP QAPP target of RPD < 25% (averaging 32% and 49% respectively), so the consistency of field samples is likely variable, even if samples are not flagged in the database.

The project team should consider collecting larger composites with more subsamples from a wider area, which may somewhat reduce variance among field replicates. Alternatively, collection of a larger number of individual samples for analysis can provide a more representative characterization of field heterogeneity, albeit at a higher analytical cost.

Dataset completeness & holding times

Mercury results were reported for 24 sediment samples from two locations (bank and thalweg) analyzed in 4 lab batches. Four lab replicates (including one non-project lab replicate) and 4 matrix spike/matrix spike replicates were analyzed for the 48 (24 bank and 24 thalweg)

sediment samples meeting the minimum requirement in the 2019 Delta RMP QAPP of 1 per 20 samples, or 1 per batch for those sample types.

Six field replicates were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement in the 2019 Delta RMP QAPP of not less than 5% of all samples (6 for 48; ~13%). Fifteen method blanks were analyzed meeting the minimum requirement in the 2019 Delta RMP QAPP of 1 per 20 samples, or 1 per batch for those sample types. Five certified reference material samples were also analyzed. Data were reported not blank corrected.

Mercury samples were analyzed between 4 and 99 days after collection. This is well within the 1 year holding time specified in the 2019 Delta RMP QAPP.

Methyl mercury results were reported for 24 sediment samples from two locations (bank and thalweg) analyzed in 4 lab batches. Four lab replicates were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement in the 2019 Delta RMP QAPP of not less than 5% of all samples (4 for 48; ~8%). Four matrix spike/matrix spike replicates were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement in the 2019 Delta RMP QAPP of 1 per 20 samples or 1 per batch for those sample types.

Four field replicates were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement in the 2019 Delta RMP QAPP of not less than 5% of all samples (4 for 48; ~8%). Twelve method blanks, and 4 certified reference material samples were also analyzed meeting the minimum requirement in the 2019 Delta RMP QAPP of 1 per 20 samples, or 1 per batch. Data were reported not blank corrected.

Methylmercury samples were analyzed between 27 and 130 days after collection, within the 1 year holding time specified in the 2019 Delta RMP QAPP. However, 12 of the 48 methylmercury samples were received at an improper temperature. The sediments from October 2017 were received by the laboratory at 0.5 C on 20 October 2017 instead of the correct temperature of 0 C or lower listed in the QAPP. Upon receipt at the lab, the samples were immediately placed in the freezer and chilled to -20 C. The laboratory is confident the activity of bacteria that methylate or demethylate mercury was halted before the samples were effected. Corrective action was taken, and dry ice was used to freeze samples in the field on all subsequent collections.

Moisture results were reported for 24 sediment samples from two locations (bank and thalweg) analyzed in 4 lab batches. The moisture results were also reported for 4 field replicates, 1 non-project sample, and 9 certified reference materials. There are no minimum requirements or method quality objectives listed in the 2019 Delta RMP QAPP for moisture; however, results greatly outside of typical environmental ranges (e.g., >90% or <10% moisture for aquatic

sediment) would warrant contacting the lab to check for transcription or calculation error. These target ranges will be explicitly added to the 2020 and later Delta RMP QAPPs.

Overall acceptability

Overall the data submission is acceptable. 100% of the results are reportable.

Method sensitivity

A large number of non-detects would indicate the lab methods are not sensitive enough to detect analytes in the range of interest. The lab reported results above the detection limit for all field samples of sediment for both mercury or methylmercury. This indicates that the analysis methods used were of sufficient sensitivity to detect concentrations found in the study area.

Blank contamination (procedural, field blank)

Accurate measurement of analytes at low concentrations sometimes requires correcting for background sources of contamination, such as traces in reagents, solvents, glassware, or other sample processing hardware used in the analysis. Analyzing method blanks lets us demonstrate that these materials are free from contamination that would interfere with analysis of the sample.

Mercury and methylmercury were not measured in the method blanks at concentrations equal to, or above the reporting limits (RL), meeting the method objective of the 2019 Delta RMP QAPP of being "<RL". No qualifiers were added.

Accuracy

For mercury and methylmercury, samples with a known concentration, consisting of certified reference material (CRM), were run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples) or per 20 (field) samples for larger analytical batches. Analysis of CRMs allows us to evaluate measurement accuracy, or how close our measurement comes to a consensus/expected value. Matrix spikes, where an environmental sample is "spiked" with a known amount of mercury, provide an alternative determination of method accuracy that can account for matrix interferences or other analytical problems.

The average percent error for the certified reference material samples for mercury of ~1% (average recovery 99.87%) and methyl mercury of ~6% (average recovery 94.27%) was well below a target MQO of 25%. No qualifiers were added. The average percent error examined for the mercury matrix spikes was ~24% (average recovery 123.72%), and for methylmercury it was ~7% (average recovery 96.27%), also within the target 25% error, although a few of the individual matrix spike samples were outside the target range.

Precision

The precision of analysis methods (ability to consistently obtain the same result) is determined by analyzing replicate or duplicate samples. The lab analyzed two different types of replicate samples. Lab replicates (split and analyzed in the laboratory) allows us to assess the

repeatability of lab measurements. Field replicates (two or more samples collected in the same place at the same time) allow us to assess the heterogeneity of the sampled matrix.

Lab replicates were used to decide whether precision flags were needed. The average RPD for the mercury lab replicates was ~3% and for the methylmercury lab replicates it was ~14%, both well below the MQO target of 25%. No qualifiers were added. Field replicates were examined, but not used for flagging the dataset. The average RPD for the mercury field replicates was ~32% and for the methylmercury field replicates, ~49%, both above the MQO target of 25%.

Comparison to previous years

The Data Management and Quality Assurance team will frequently compare analytical results against historical observations as a simple way of checking that the results are within realistic bounds. Mercury and methylmercury not previously analyzed in sediment for the Delta RMP, so there are no previous data from the same project for comparison. However, compared the results to those from two Bay RMP Status and Trends Delta stations, Sacramento River and San Joaquin River, collected from 1993 to 2014. The average mercury concentration in this study was 35% of the historic average, while the methylmercury average was 160% of the 1992-2014 average. The fact that these are within a similar range of historical observations gives us additional confidence in the validity of the results.

Sediment Grain Size

Quality assurance calculations and summary by John Ross, March 28, 2019.

Reviewed by the Delta RMP Quality Assurance Officer Don Yee, April 30, 2019.

Dataset completeness

Results were reported for three grain size analyte/fraction combinations (Clay <0.0039 mm; Silt 0.0039 to <0.0625 mm; and Sand 0.0625 to <2.0 mm) for 24 sediment samples from two locations (bank and thalweg) analyzed in 4 lab batches.

Three field replicates were analyzed for the 24 sediment samples collected at the bank location, and 9 field replicates were analyzed for the 24 sediment samples collected at the thalweg location. No method blanks, lab replicates or spiked samples were reported/analyzed. Such QC samples are rarely reported by labs analyzing grain size, and no minimum frequency requirement for such QC sample types is listed in the 2019 Delta RMP Quality Assurance Project Plan (QAPP). Data were reported not blank corrected.

Grain size samples were analyzed between 25 and 204 days after collection. No holding time specified in the 2019 Delta RMP QAPP.

Grain size fractions summed (with rounding error) to 100%, as they should.

Overall acceptability

Overall the data submission is acceptable. 100% of the results are reportable.

Method sensitivity

No non-detects (NDs) were reported for bank location samples. One non-detect was reported for Sand 0.0625 to <2.0 mm in the thalweg samples.

Blank contamination (procedural, field blank)

No method blanks were analyzed/reported.

Accuracy

No spiked samples were analyzed/reported.

Average precision from replicate field sample

Precision was examined using the field replicate samples. No method quality objective (MQO) is listed in the 2019 Delta RMP QAPP, but we used the SF Bay RMP target of <20% difference among samples for any fraction as a rough guideline (about double the average variation seen between sediment replicates). None of the absolute analyte/fraction percentages varied by >20% of the total mass. No qualifiers were added.

Comparison to previous years

This was the first time sediment grain size analysis has been performed for the Delta RMP. Bank collected samples were dominated by silt and sand fractions, 48% and 43%, respectively, while the Thalweg collected samples were dominated by the sand fraction (58%). Average results were compared to average results from the two Bay RMP Status and Trends delta stations, Sacramento River and San Joaquin River, from 1993-2014. The average results for this study compared to the of the 1993-2014 average were as follows:

- clay: 57% (~0.6x the prior study average)
- silt: 227% (~2.3x)
- sand: 101% (~1.0x)

The DWR water quality conditions report (2011, as an example) documented similar often sandy (and highly variable among months, e.g. 10 to 90% sand, within a site) conditions, so these results appear reasonable.

Sediment Total Organic Carbon

QA by John Ross, April 3, 2019

Reviewed by the Delta RMP Quality Assurance Officer Don Yee, April 30, 2019.

QA Issues encountered

Matrix spike/matrix spike duplicate results met the method quality objective listed in the Delta RMP QAPP of "expected value ± 10%"; the percent error (absolute value of (100%-recovery%) averaged for the reported samples was <10%.

One of the field replicates with an RPD of 40% did not meet the method quality objective listed in the 2019 Delta RMP QAPP of an RPD < 25%, however, the *average* RPD was < 25%. The precision evaluation was performed following SFEI's conventional method which uses lab replicates in preference to using field replicates.

Dataset completeness

Total organic carbon (TOC) results were reported for 24 sediment samples from two locations (bank and thalweg) analyzed in 2 lab batches.

Four lab replicates, and 2 matrix spike/matrix spike replicate were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement in the 2019 Delta RMP QAPP of 1 per 20 samples for those sample types, but failing the minimum requirement of 1 matrix spike/matrix spike replicate per batch (no MS/MSD was analyzed in one of the lab batches).

Four field replicates were analyzed for the 48 sediment samples (24 bank and 24 thalweg) meeting the minimum requirement of not less than 5% of all samples (4 for 48; ~8%). Three method blanks, and three laboratory control sample were analyzed. Data were reported not blank corrected.

TOC samples were analyzed between 141 and 387 days after collection well within the 1 year holding time specified in the 2019 Delta RMP QAPP.

Overall acceptability

Overall the data submission is acceptable. 91% of the results are reportable [5 out of 56 results (which includes field replicates) being rejected for blank contamination].

Method sensitivity

No non-detects (NDs) were reported for either bank or thalweg location samples.

Blank contamination (procedural, field blank)

TOC was measured in the method blanks of one of the two lab batches at concentrations above the method detection limit. Twenty bank location samples and seventeen thalweg location samples were qualified for blank contamination with the flag "VIP: Analyte detected in field or lab generated blank, flagged by QAO." Seventeen percent (5 out of 29) of the results for the Thalweg location samples were censored (or rejected) with the flag "VRIP: Data rejected - Analyte detected in field or lab generated blank, flagged by QAO." VRIP means the result was less than three times the blank average for results not blank corrected, or less than three times the blank standard deviation for analytes reported as blank corrected. In the not blank corrected

case, the given result could easily be half or more of the total signal, although whether the given blank (usually only a single result per batch) is high low or in the middle of typical results for a given batch is unknown. In the blank corrected case, we require at least two blank results (to get more confidence we're not subtracting a unique atypically high or low blank) for the lab to subtract a blank average. But if those blanks are highly variable (large standard deviation), then any result of a similar magnitude as that standard deviation could just be a random distribution of noise around the blank average that was subtracted. VIP means that part of the signal is blank contamination or noise, above the detection limit, but less than three times the blank (or blank standard deviation if blank subtracted).

Accuracy

Accuracy was evaluated using the matrix spikes. The average percent error of about 1% (average recovery 100.92%) was well below the MQO of 10%. No qualifiers were added.

Average precision from replicate field sample

Precision was evaluated using the lab replicates. The average RPD was about 2%, well below the MQO target of 10%. Field replicates were examined, but not used for the evaluation, with an average RPD of ~16% which was below the MQO target of 25%. No additional qualifiers were added.

Comparison to previous years

TOC not previously analyzed in sediment for the Delta RMP. Average results were compared to average results from the two RMP Status and Trends delta stations, Sacramento River and San Joaquin River, from 1993-2014. The average TOC result was 163% of the 1993-2014 average.

Mercury in Fish

QA by John Ross, September 20, 2018

Reviewed by the Delta RMP Quality Assurance Officer Don Yee, April 30, 2019.

Dataset completeness

Total mercury and moisture results were reported for 96 composite tissue samples analyzed in five lab batches. Five lab replicates (1 per batch), 5 matrix spike/matrix spike replicates (1 pair per batch), 15 method blanks (3 per batch), and 5 laboratory control material samples (LCMs) (1 per batch) were also analyzed for the 96 composite tissue samples which meets the minimum requirement in the 2017 DRMP QAPP of 1 per 20 samples or 1 per batch. Data were reported not blank corrected.

Hold Time

Samples were analyzed between 84 and 97 days after collection. A holding time of 1 year is specified in the 2017 DRMP QAPP for extraction to analysis; after samples cooled to < 6 Deg C within 24 hours of collection for mercury measured in tissue. No holding time violations were flagged.

Overall acceptability

Overall the data submission is acceptable. 100% of the results are reportable.

Method sensitivity

Method detection limits were acceptable with no non-detects (NDs) reported for mercury and moisture.

Blank Contamination (procedural, field blank)

Total mercury was not found in the method blanks at concentrations above the method detection limits. All method blank results were NDs.

Accuracy

Accuracy was evaluated using the matrix spike samples. The average %error for mercury was 13% (average recovery 113%) which is less than the 25% target MQO. Laboratory control material samples were examined, but not used for his evaluation; the average %error for mercury was 1%. No qualifying flags were added.

Average precision from replicate field sample

Precision was evaluated using the lab replicates. The average RPD for mercury was 5% well below the 25% target MQO. Matrix spike and laboratory control material samples were examined, and the respective average RPD's were 5% and 2%. No additional qualifiers were needed.

Comparison to previous years

Total mercury results were compared to those from Year 1 of the Delta RMP. The average overall mercury concentration in this study was 60% higher than the average concentration for the Year 1 composite samples. The average *Micropterus punctulatus* and *Micropterus salmoides* mercury concentrations were respectively 101% of (~1x) and 52% of (~0.5x), the average species concentration for Year 1.

Mercury and Ancillary Parameters in Water

Reviewed by Delta RMP Quality Assurance Officer Don Yee June 28, 2019

Mercury and methylmercury in water, and ancillary water quality parameters (Chl-a,DOC,TSS,VSS) were analyzed by MPSL-DFG, except for DOC analyzed by Delta

Environmental for two sampling events

Reporting Issues Encountered

The June 2018 544ADVLM6 samples for dissolved Hg, differed by nearly 10x in field replicates. Checked with the lab for possible transposition of dissolved and total results. (on the first field replicate total was ~5x lower than dissolved). The lab had noted in the database comments that the bottles appeared to have been labeled incorrectly, with one of the dissolved fraction samples appearing to have particulate matter, and a total fraction sample being clear. In the future this should be escalated to the PM when first noticed, and a decision made as to whether the sample IDs needed to be corrected before reporting.

January 2018 samples subcontracted to Delta had non-detects (<0.02 mg/L) for DOC well below historical averages for Lower Mokelumne, San Joaquin, Sacramento at Mallard, and DMC according to Moss Landing, and results were censored based on best professional judgement.

There were also other transcription errors in the data originally provided by the lab, but most were correctable without needing a full resubmission by the lab (e.g. errors included analysis date 10 years earlier, some recovery samples with no expected values reported, etc.)

Hold time & completeness

All of the project samples were analyzed within their recommended hold time for reported analytes. Results were reported for 8 sites, for 7 events each (Oct/Jan-June), for dissolved and total mercury and methylmercury, TSS and VSS, DOC, and chlorophyll a. Results for at least one lab blank were reported for each batch, with lab replicates reported meeting the 1 per 20 field sample minimum frequency for precision. CRMs (as available), LCSs, or/and MS samples were reported meeting the 1 per 20 field sample minimum to provide evidence of recovery. Field blanks and field replicates (one per sampling event) were also reported.

Overall acceptability

Overall the data are acceptable, with a small percentage (~5%) of the data censored for QA problems (mostly VSS and some DOC not being sufficiently above blank contamination levels).

Method sensitivity sensitivity

About 8% of DOC results and 18% of volatile suspended solids results were non-detect.

Blank contamination

Blank corrected is often also called "blank subtracted". It means that the average blank value was already subtracted from the reported sample result. Results were reported not blank corrected for methylmercury, volatile suspended solids, and DOC done by Delta Env. subcontractor (analyzed with Oct 2017 and Jan 2018 samples), with the rest blank corrected. For batches with >1 lab blank and blank corrected reporting, field sample results <3x stdev of the blanks were flagged for censoring, results >3x the stdev were flagged but not censored. For

analytes reported not blank corrected, or with only 1 blank per batch (where blank subtraction is inappropriate due to lack of information on blank variability or average performance), field sample results <3x the average (or single result) blank were censored, with the rest flagged for blank contamination but uncensored. Overall that led to 6% of the DOC results censored, and 31% of the VSS results censored.

Field blanks were also reported, with DOC and VSS sometimes detected, at concentrations similar to the case for lab blanks, up to ~5x the MDL. Given the similarity in concentrations, much of the field blank contamination may be the same as seen in the lab blanks.

Average precision from replicate field samples

Precision on all lab replicates was within the target range (averaging <25% RPD for all the target analytes). VSS and dissolved MeHg had the most variation (~20% average RPD), while the rest had average RPD nearer 10% or less.

Dissolved mercury field replicates however originally averaged >25% RPD (around 40%), due in large part to a June 2018 544ADVLM6 pair, which differed by nearly 10x in field replicates. This is not likely to be due to lab variation as the dissolved mercury lab replicate RPDs averaged <10%. The lab had noted the relatively lack of particulate in the total sample compared to the sample labeled dissolved, and suggested that they may have been mislabeled, but accepted the labeling as provided. After correcting the reported fractions in the database (but noting the original likely incorrect labeling in sample comments), average field replicate RPDs were also <25%.

Accuracy (CRMs or Matrix spike recoveries or Lab Control Samples)

Recovery errors for all analytes averaged <10% for all the ancillary measures, and <25% for mercury and 30% for methylmercury, for both CRMs and matrix spike sample types, so no added recovery flags were needed. Chlorophyll a was the only analyte without reported CRMs or MSs, and calibration verification lab control sample results were used instead, with acceptable performance on those (average ~1% error, well within the target <10%).

Comparison to previous years

Concentrations on the integrated water samples were similar to the prior year's, with the analytes between 70-150% of the prior year's averages. For the one grab sample, concentrations were between 3x lower to 17x higher than the prior years averages in integrated samples, but that may be expected since the grab was just a single sample, which will be above and below the typical mean for a given sample depending on the analyte.

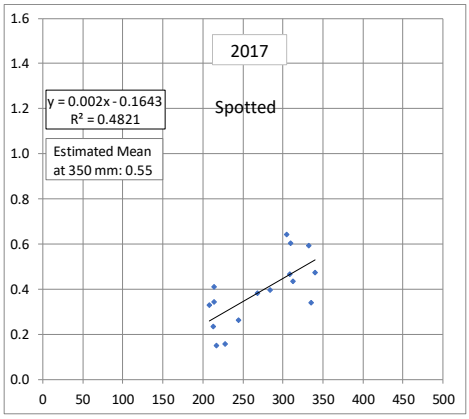
Appendix 3: Mercury Concentrations and Ancillary Measurements in Individual Fish

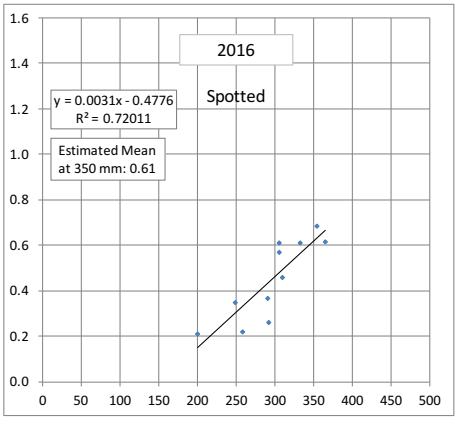
Sample Date	Station	Common Name	SampleID	Parameter	Result	Unit	Total Length (mm)
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3375	Mercury	0.25	ug/g ww	225
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3374	Mercury	0.25	ug/g ww	232
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3376	Mercury	0.34	ug/g ww	245
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3379	Mercury	0.36	ug/g ww	271
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3377	Mercury	0.27	ug/g ww	277
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3378	Mercury	0.36	ug/g ww	288
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3383	Mercury	0.51	ug/g ww	314
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3385	Mercury	0.46	ug/g ww	322
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3380	Mercury	0.35	ug/g ww	325
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3381	Mercury	0.42	ug/g ww	325
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3384	Mercury	0.32	ug/g ww	327
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3382	Mercury	0.40	ug/g ww	330
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3386	Mercury	0.85	ug/g ww	374
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3387	Mercury	0.38	ug/g ww	411
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3388	Mercury	0.81	ug/g ww	425
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	I_510ADVLIM_B3389	Mercury	0.62	ug/g ww	508
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3244	Mercury	0.31	ug/g ww	212
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3246	Mercury	0.30	ug/g ww	228
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3245	Mercury	0.39	ug/g ww	248
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3247	Mercury	0.25	ug/g ww	251
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3248	Mercury	0.22	ug/g ww	252
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3249	Mercury	0.39	ug/g ww	275
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3250	Mercury	0.21	ug/g ww	318
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3303	Mercury	0.33	ug/g ww	344
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3301	Mercury	0.26	ug/g ww	350
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3302	Mercury	0.24	ug/g ww	350
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3304	Mercury	0.29	ug/g ww	362
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3305	Mercury	0.54	ug/g ww	395
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3306	Mercury	0.28	ug/g ww	404
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3307	Mercury	0.38	ug/g ww	411
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3309	Mercury	0.39	ug/g ww	415
14-Aug-17	Little Potato Slough	Largemouth Bass	I_544LILPSL_B3308	Mercury	0.45	ug/g ww	443
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3311	Mercury	1.28	ug/g ww	218
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3310	Mercury	1.11	ug/g ww	220
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3313	Mercury	1.32	ug/g ww	242
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3312	Mercury	1.29	ug/g ww	250
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3314	Mercury	1.34	ug/g ww	252
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3315	Mercury	1.25	ug/g ww	259
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3317	Mercury	1.27	ug/g ww	312
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3316	Mercury	1.69	ug/g ww	317
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3318	Mercury	1.29	ug/g ww	370
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3319	Mercury	1.19	ug/g ww	371
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3320	Mercury	0.97	ug/g ww	375
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3321	Mercury	1.20	ug/g ww	380
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3322	Mercury	1.32	ug/g ww	387
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3323	Mercury	1.32	ug/g ww	407
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3324	Mercury	1.36	ug/g ww	507
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	I_544ADVLM6_B3325	Mercury	2.05	ug/g ww	541
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3358	Mercury	0.28	ug/g ww	211
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3359	Mercury	0.25	ug/g ww	229
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3360	Mercury	0.22	ug/g ww	246
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3361	Mercury	0.32	ug/g ww	252
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3362	Mercury	0.15	ug/g ww	270
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3363	Mercury	0.20	ug/g ww	295
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3366	Mercury	0.21	ug/g ww	323
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3364	Mercury	0.14	ug/g ww	324
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3365	Mercury	0.21	ug/g ww	325
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3367	Mercury	0.21	ug/g ww	345
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3368	Mercury	0.21	ug/g ww	352
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3369	Mercury	0.18	ug/g ww	368
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3370	Mercury	0.27	ug/g ww	385
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3371	Mercury	0.35	ug/g ww	412
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3372	Mercury	0.29	ug/g ww	422
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	I_544MDRBH4_B3373	Mercury	0.27	ug/g ww	460
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3329	Mercury	0.33	ug/g ww	208
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3326	Mercury	0.23	ug/g ww	213
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3328	Mercury	0.41	ug/g ww	214
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3330	Mercury	0.34	ug/g ww	214
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3327	Mercury	0.15	ug/g ww	217
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3331	Mercury	0.16	ug/g ww	228
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3332	Mercury	0.26	ug/g ww	245
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3333	Mercury	0.38	ug/g ww	268
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3334	Mercury	0.40	ug/g ww	284
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3340	Mercury	0.64	ug/g ww	305
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3337	Mercury	0.47	ug/g ww	309
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3336	Mercury	0.60	ug/g ww	310
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3335	Mercury	0.44	ug/g ww	313
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3339	Mercury	0.59	ug/g ww	332
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3338	Mercury	0.34	ug/g ww	335
14-Aug-17	Sacramento River/Freeport	Spotted Bass	I_510ST1317_B3341	Mercury	0.47	ug/g ww	340
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3342	Mercury	0.48	ug/g ww	203
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3343	Mercury	0.38	ug/g ww	205

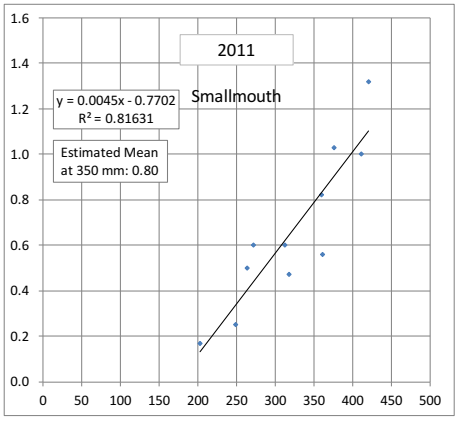
Sample Date	Station	Common Name	SampleID	Parameter	Result	Unit	Total Length (mm)
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3344	Mercury	0.51	ug/g ww	235
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3345	Mercury	0.34	ug/g ww	256
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3346	Mercury	0.60	ug/g ww	272
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3347	Mercury	0.63	ug/g ww	284
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3349	Mercury	0.56	ug/g ww	308
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3348	Mercury	0.50	ug/g ww	309
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3352	Mercury	0.61	ug/g ww	310
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3350	Mercury	0.40	ug/g ww	326
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3351	Mercury	0.48	ug/g ww	330
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3354	Mercury	0.39	ug/g ww	350
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3353	Mercury	0.57	ug/g ww	395
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3355	Mercury	0.60	ug/g ww	408
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3356	Mercury	0.68	ug/g ww	418
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	I_541SJC501_B3357	Mercury	0.47	ug/g ww	445

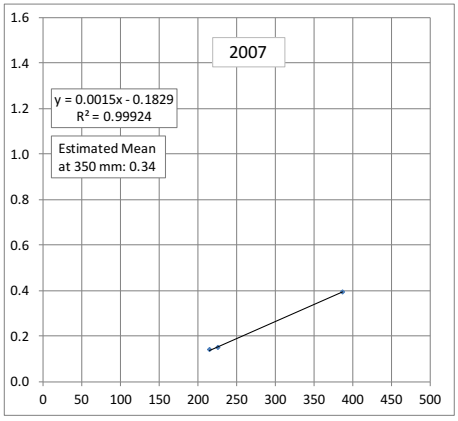
Appendix 4: Mercury Concentration versus Length at Each Station, Including Historic Data

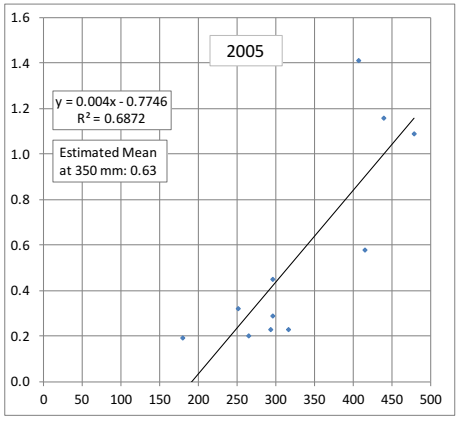
Sacramento River at Freeport

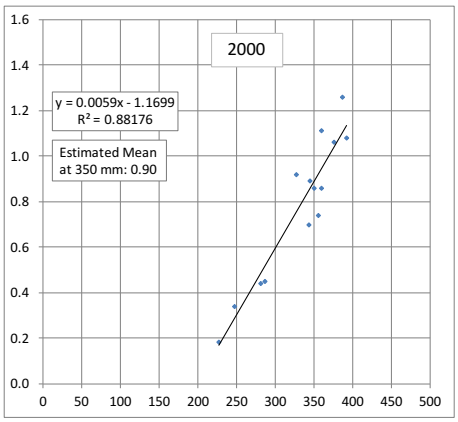


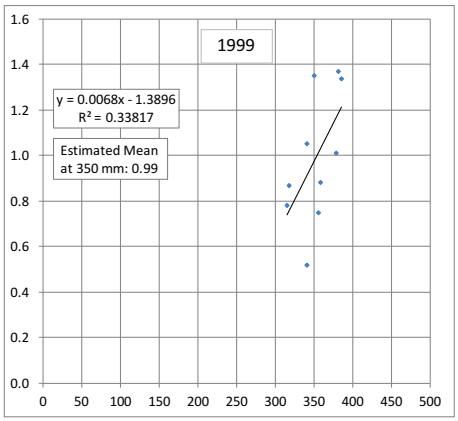




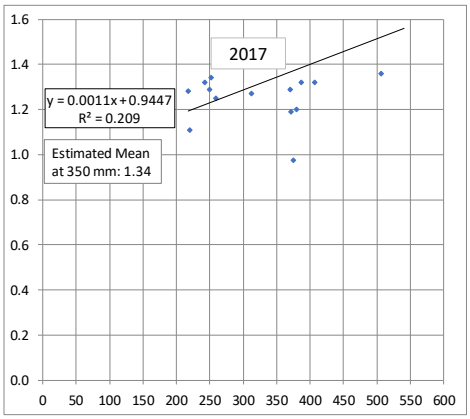


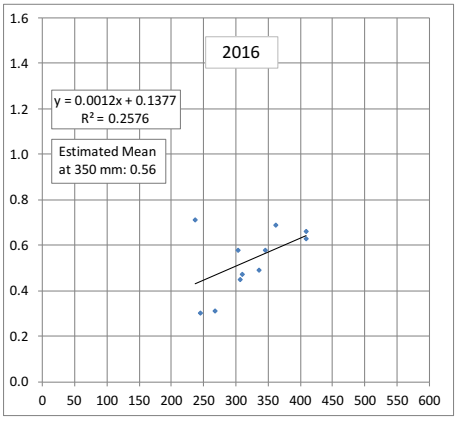


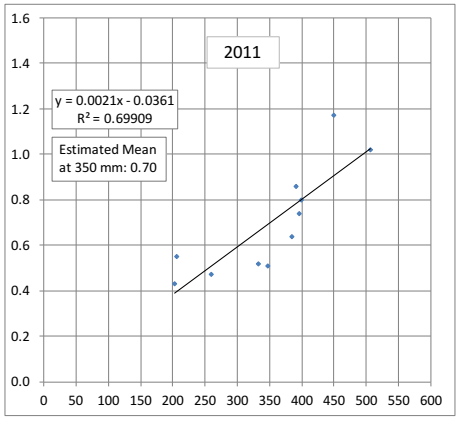


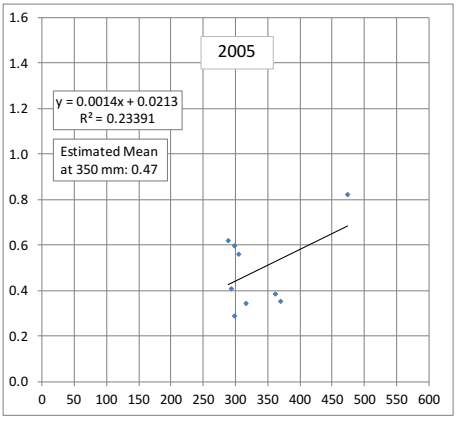


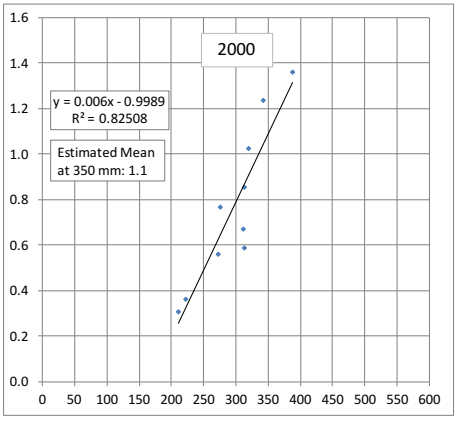
Lower Mokelumne River 6

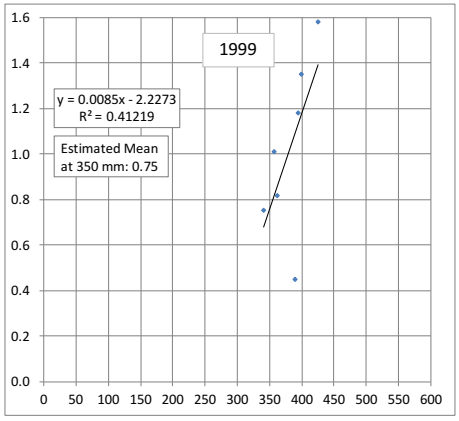




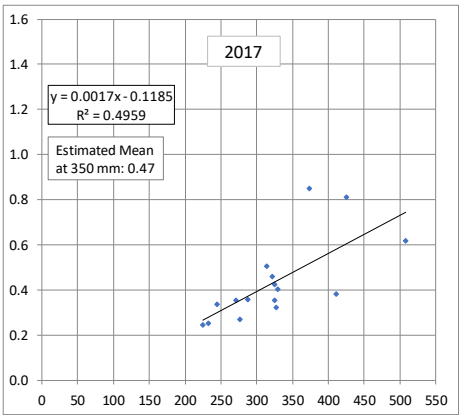


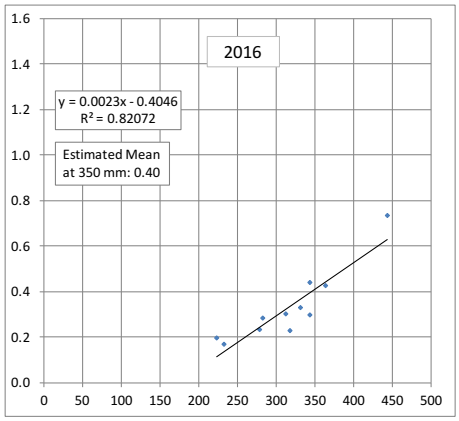


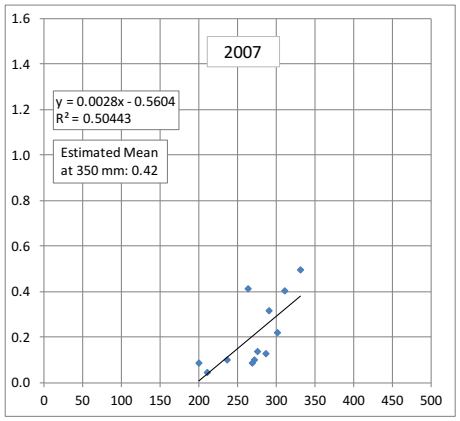


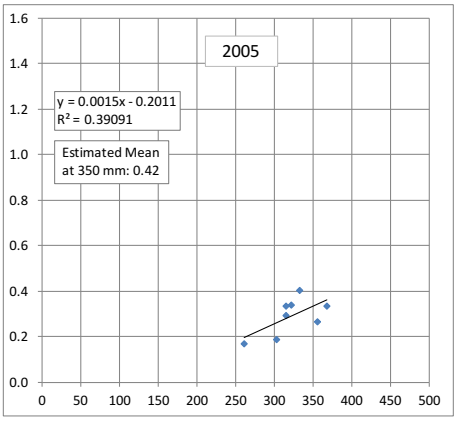


Cache Slough at Liberty Island Mouth

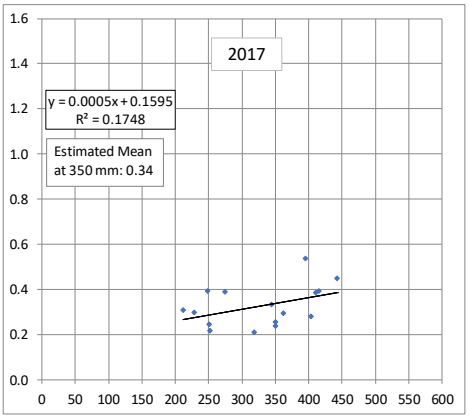


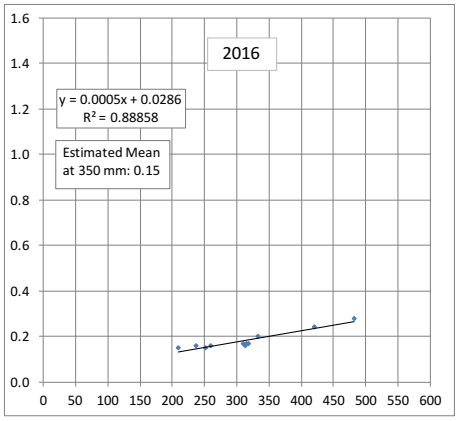


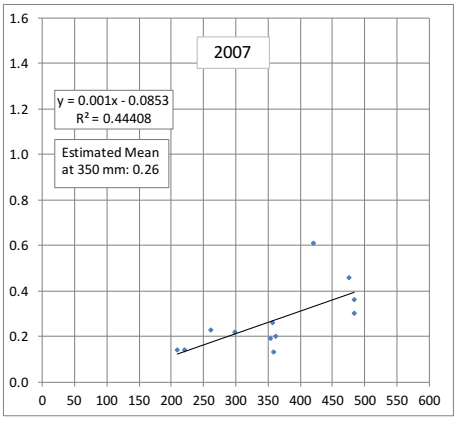


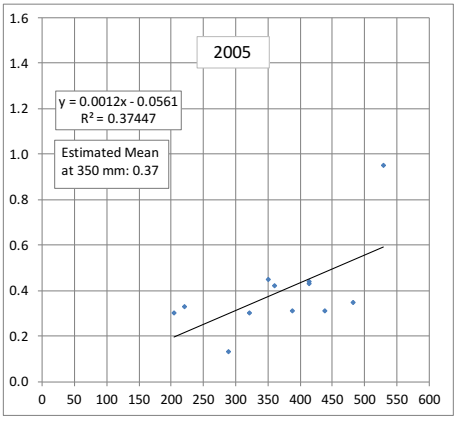


Little Potato Slough

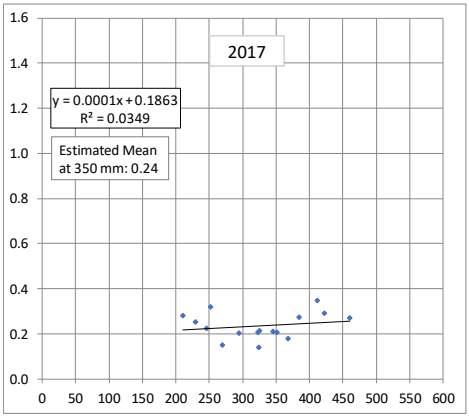


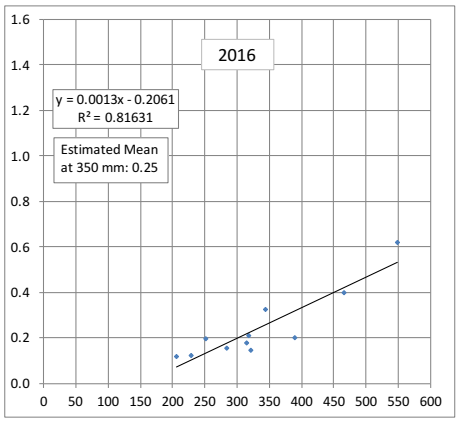


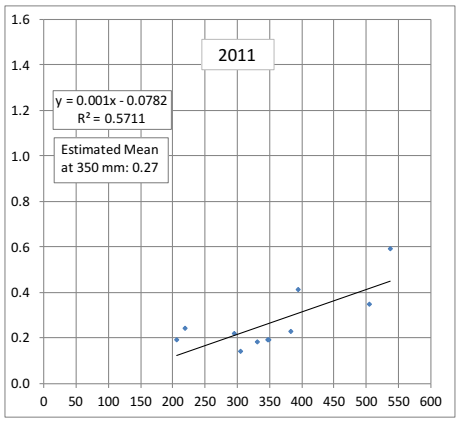


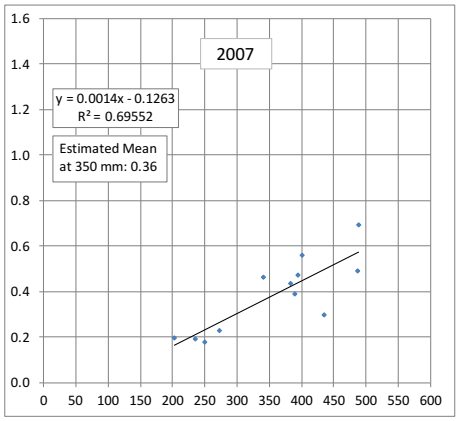


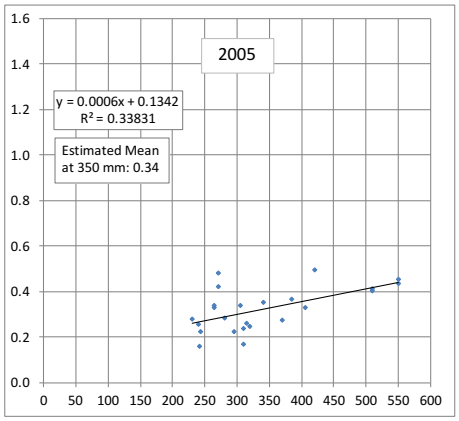
Middle River at Borden Hwy (Hwy 4)

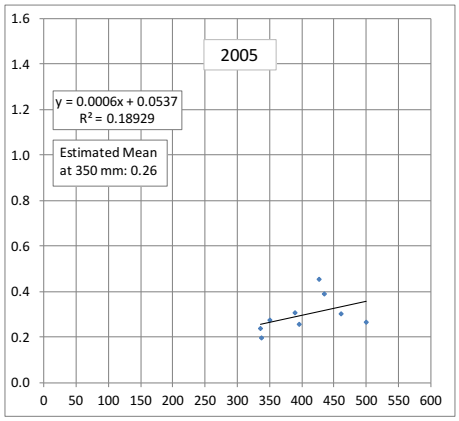


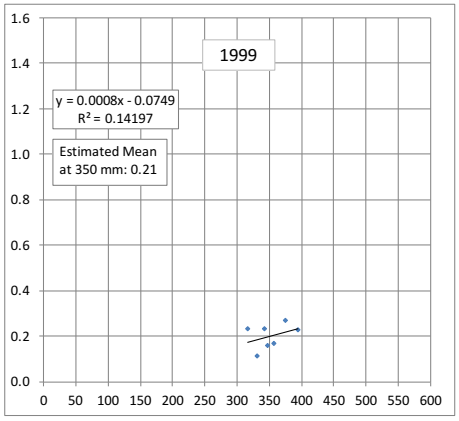




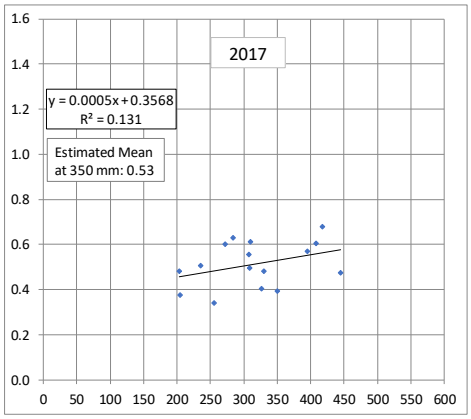


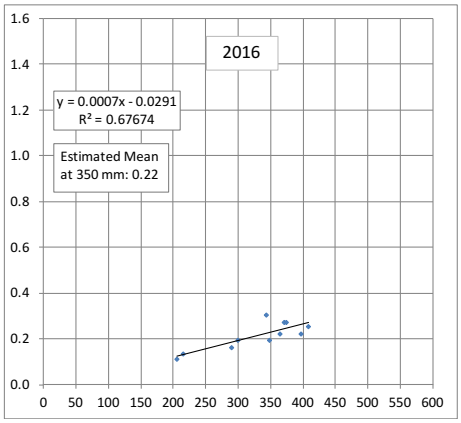


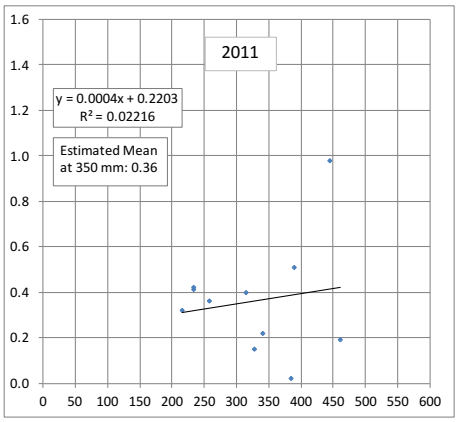


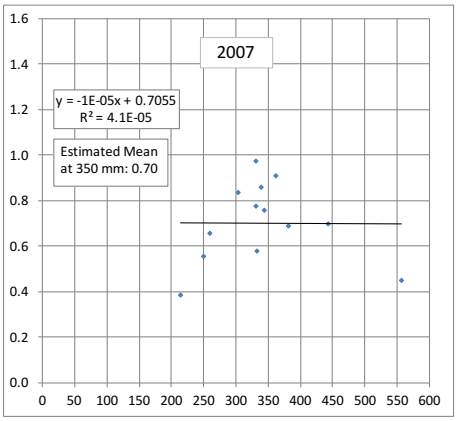


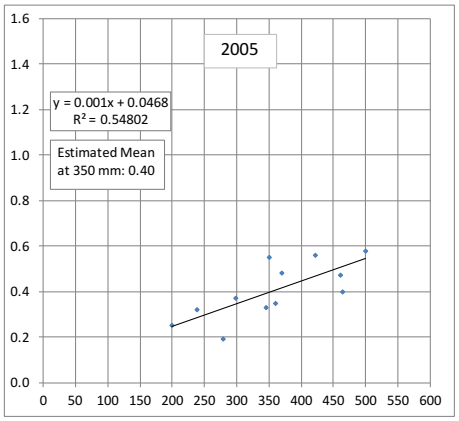
San Joaquin River at Vernalis

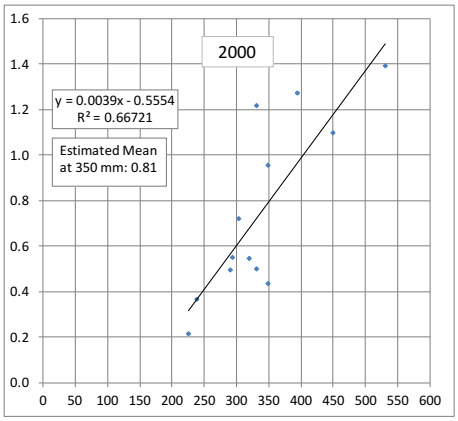


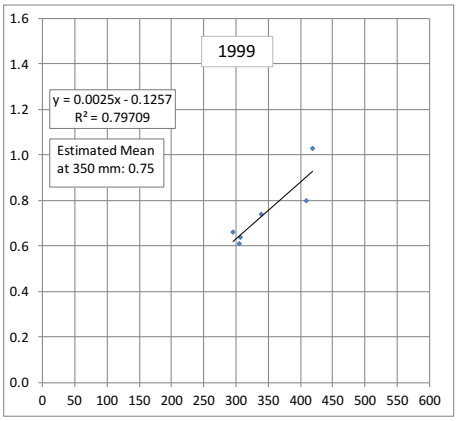












Appendix 5: Length-adjusted Average Mercury Concentrations in Black Bass

Sample Date	Station	Common Name	SampleID	Number Of Fish In Sample	Tissue Code	Prep Preservation	Parameter	Result	Unit	Sample Type
14-Aug-17	Sacramento River/Freeport	Spotted Bass	NA	16	FIL	Skin off	Mercury	0.55	ug/g ww	350 mm Length-adjusted Mean
14-Aug-17	Lower Mokelumne River 6	Largemouth Bass	NA	16	FIL	Skin off	Mercury	1.34	ug/g ww	350 mm Length-adjusted Mean
15-Aug-17	Cache Slough at Liberty Island Mouth	Largemouth Bass	NA	16	FIL	Skin off	Mercury	0.48	ug/g ww	350 mm Length-adjusted Mean
14-Aug-17	Little Potato Slough	Largemouth Bass	NA	16	FIL	Skin off	Mercury	0.34	ug/g ww	350 mm Length-adjusted Mean
15-Aug-17	Middle River at Borden Hwy (Hwy 4)	Largemouth Bass	NA	16	FIL	Skin off	Mercury	0.24	ug/g ww	350 mm Length-adjusted Mean
15-Aug-17	San Joaquin River at Airport Way near Vernalis	Largemouth Bass	NA	16	FIL	Skin off	Mercury	0.53	ug/g ww	350 mm Length-adjusted Mean

Appendix 6: Mercury and Ancillary Concentrations in Water

StationCode	Station	Sample Date DD/MMM/YYYY	DOC (mg/L)	Chl a (ug/L)	TSS (mg/L)	VSS (mg/L)	ufTHg (ng/L)	fTHg (ng/L)	ufMeHg (ng/L)	fMeHg (ng/L)
510ADVLIM	Cache Sl @ Liberty Island Mouth	18-Oct-2017	1.68	1.12	70.3	54.2	1.60	0.492	0.100	0.063
510ADVLIM	Cache Sl @ Liberty Island Mouth	29-Jan-2018	3.14	1.47	14.8	5.71	3.52	1.30	0.093	0.056
510ADVLIM	Cache Sl @ Liberty Island Mouth	26-Feb-2018	2.11	1.72	8.69	2.77	1.68	0.592	0.060	0.068
510ADVLIM	Cache Sl @ Liberty Island Mouth	19-Mar-2018	2.43	1.56	4.10	<MDL	2.44	1.10	0.088	0.068
510ADVLIM	Cache Sl @ Liberty Island Mouth	17-Apr-2018	3.06	1.32	3.74	1.25	3.18	1.76	0.131	0.099
510ADVLIM	Cache Sl @ Liberty Island Mouth	15-May-2018	2.10	1.00	4.58	<MDL	1.84	0.752	0.110	0.074
510ADVLIM	Cache Sl @ Liberty Island Mouth	20-Jun-2018	1.59	1.05	8.70	<MDL	2.13	0.590	0.088	0.050
207SRD10A	Sacramento R @ Mallard Island	Not Collected								
207SRD10A	Sacramento R @ Mallard Island	30-Jan-2018	<MDL	2.06	17.5	5.00	6.66	1.41	0.069	0.032
207SRD10A	Sacramento R @ Mallard Island	27-Feb-2018	2.99	3.16	47.7	7.24	8.76	0.763	0.086	0.028
207SRD10A	Sacramento R @ Mallard Island	20-Mar-2018	2.59	5.30	26.1	<MDL	9.55	0.931	0.064	0.030
207SRD10A	Sacramento R @ Mallard Island	18-Apr-2018	2.42	1.72	40.4	10.3	12.2	2.04	0.101	0.064
207SRD10A	Sacramento R @ Mallard Island	16-May-2018	2.32	3.15	47.0	5.33	11.6	0.937	0.060	0.021
207SRD10A	Sacramento R @ Mallard Island	20-Jun-2018	2.16	1.71	52.4	7.07	13.2	0.647	0.078	0.021
510ST1317	Sacramento R @ Freeport	18-Oct-2017	1.24	0.60	13.8	8.66	1.99	0.482	0.071	0.019
510ST1317	Sacramento R @ Freeport	29-Jan-2018	8.10	2.17	28.5	8.00	4.73	1.18	0.098	0.044
510ST1317	Sacramento R @ Freeport	26-Feb-2018	2.12	3.73	12.2	5.02	1.85	0.427	0.061	0.042
510ST1317	Sacramento R @ Freeport	19-Mar-2018	2.36	2.82	15.7	<MDL	7.23	2.15	0.115	0.047
510ST1317	Sacramento R @ Freeport	17-Apr-2018	1.45	3.08	40.7	7.54	11.1	1.47	0.126	0.056
510ST1317	Sacramento R @ Freeport	15-May-2018	1.16	3.32	6.69	1.27	2.61	0.709	0.072	0.040
510ST1317	Sacramento R @ Freeport	20-Jun-2018	1.18	1.65	15.1	1.29	3.33	0.615	0.088	0.053
541SJC501	SanJoaquin R @ Vernalis/Airport Way	19-Oct-2017	2.48	3.36	27.7	6.25	4.85	0.897	0.110	0.056
541SJC501	SanJoaquin R @ Vernalis/Airport Way	30-Jan-2018	<MDL	5.32	16.5	7.00	3.01	1.35	0.093	0.049
541SJC501	SanJoaquin R @ Vernalis/Airport Way	27-Feb-2018	2.12	7.85	29.8	5.42	3.22	0.846	0.091	0.042
541SJC501	SanJoaquin R @ Vernalis/Airport Way	20-Mar-2018	3.45	17.8	44.0	4.43	6.89	1.29	0.136	0.060
541SJC501	SanJoaquin R @ Vernalis/Airport Way	18-Apr-2018	2.40	5.23	136	13.3	15.9	1.46	0.163	0.061
541SJC501	SanJoaquin R @ Vernalis/Airport Way	16-May-2018	1.80	6.12	18.4	2.53	4.76	0.805	0.089	0.048
541SJC501	SanJoaquin R @ Vernalis/Airport Way	21-Jun-2018	2.21	37.2	29.1	6.78	4.64	0.631	0.139	0.028
544ADVLM6	Low er Mokelumne R. 6	18-Oct-2017	1.65	0.39	6.86	5.65	1.89	0.494	0.044	0.026
544ADVLM6	Low er Mokelumne R. 6	29-Jan-2018	<MDL	1.98	3.55	5.16	2.80	1.49	0.155	0.105
544ADVLM6	Low er Mokelumne R. 6	26-Feb-2018	1.31	1.81	4.44	2.28	1.64	0.453	0.075	0.043
544ADVLM6	Low er Mokelumne R. 6	19-Mar-2018	4.12	2.60	7.40	<MDL	10.8	5.36	0.271	0.159
544ADVLM6	Low er Mokelumne R. 6	17-Apr-2018	2.01	1.45	15.2	3.88	8.12	2.35	0.385	0.256
544ADVLM6	Low er Mokelumne R. 6	15-May-2018	1.30	1.22	23.5	3.03	4.82	0.991	0.164	0.091
544ADVLM6	Low er Mokelumne R. 6	21-Jun-2018	1.51	1.50	24.6	4.06	7.46	1.13	0.146	0.078
544DMC020	DMC off HWY 4	Not Collected								
544DMC020	DMC off HWY 4	30-Jan-2018	<MDL	1.48	2.94	3.92	1.59	0.963	0.091	0.073
544DMC020	DMC off HWY 4	27-Feb-2018	2.52	1.18	2.99	1.54	1.20	0.633	0.058	0.044
544DMC020	DMC off HWY 4	20-Mar-2018	4.15	1.45	1.34	<MDL	1.21	0.798	0.079	0.068
544DMC020	DMC off HWY 4	18-Apr-2018	2.60	1.28	5.49	2.49	3.05	1.69	0.105	0.079
544DMC020	DMC off HWY 4	16-May-2018	2.63	0.875	4.85	<MDL	2.26	1.08	0.067	0.049
544DMC020	DMC off HWY 4	21-Jun-2018	2.94	1.72	8.29	1.09	1.65	0.743	0.084	0.058
544LILPSL	Little Potato Slough	18-Oct-2017	1.63	0.581	15.2	13.3	1.00	0.385	0.056	0.021
544LILPSL	Little Potato Slough	29-Jan-2018	4.77	0.407	2.18	1.19	2.10	1.41	0.174	0.138
544LILPSL	Little Potato Slough	26-Feb-2018	3.93	0.839	2.29	1.33	1.47	0.946	0.155	0.117
544LILPSL	Little Potato Slough	19-Mar-2018	4.48	0.970	5.88	<MDL	8.67	4.49	0.149	0.116
544LILPSL	Little Potato Slough	17-Apr-2018	2.68	0.947	5.00	2.40	3.62	2.16	0.177	0.141
544LILPSL	Little Potato Slough	15-May-2018	1.97	0.939	4.86	<MDL	1.80	0.770	0.084	0.059
544LILPSL	Little Potato Slough	20-Jun-2018	1.52	2.29	7.43	1.67	1.64	0.651	0.071	0.036
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	19-Oct-2017	2.32	0.795	7.60	6.40	0.73	0.310	0.062	0.042
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	30-Jan-2018	<MDL	0.832	3.52	2.96	1.35	1.47	0.119	0.099
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	27-Feb-2018	5.17	1.40	2.77	2.25	1.24	0.905	0.126	0.100
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	20-Mar-2018	3.78	0.883	1.77	<MDL	1.24	0.729	0.065	0.061
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	18-Apr-2018	3.29	1.12	3.98	1.99	2.50	1.55	0.091	0.073
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	16-May-2018	3.99	1.09	5.20	<MDL	1.22	0.635	0.071	0.049
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	21-Jun-2018	2.68	2.00	8.71	1.88	1.33	0.460	0.068	0.036
		Method Detection Limit	0.24	0.045	1.00	1.00	0.200	0.200	0.011	0.011
		Reporting Limit	1.00	0.045	3.00	3.00	0.200	0.200	0.031	0.031

Appendix 7: Mercury and Ancillary Concentrations in Sediment

StationCode	Station	Sample Date dd/mmm/yyyy	Thalweg Percent Clay <0.0039 mm	Thalweg Percent Silt 0.0039 to <0.0625 mm	Thalweg Percent Sand 0.0625 to <2.0 mm	Thalweg TOC (% dw)	Thalweg Moisture (%)	Thalweg THg (ug/g dw)	Thalweg MeHg (ng/g dw)	Bank Percent Clay <0.0039 mm	Bank Percent Silt 0.0039 to <0.0625 mm	Bank Percent Sand 0.0625 to <2.0 mm	Bank TOC (% dw)	Bank Moisture (%)	Bank THg (ug/g dw)	Bank MeHg (ng/g dw)
510ADVLIM	Cache Sl @ Liberty Island Mouth	18-Oct-2017	17.2	78.1	4.8	1.91	64.26	0.148	1.74	11.0	67.9	21.1	1.91	48.16	0.089	3.09
510ADVLIM	Cache Sl @ Liberty Island Mouth	29-Jan-2018	37.4	62.6	<MDL	1.99	38.55	0.065	0.17	16.1	66.8	17.1	2.06	53.62	0.125	0.43
510ADVLIM	Cache Sl @ Liberty Island Mouth	17-Apr-2018	18.3	68.5	13.2	5.93	59.68	0.141	1.26	14.6	65.9	19.4	2.50	60.24	0.171	2.62
510ADVLIM	Cache Sl @ Liberty Island Mouth	20-Jun-2018	28.8	71.2	0.0	3.50	52.24	0.096	0.73	15.7	77.6	6.7	2.90	60.45	0.134	0.83
510ST1317	Sacramento R @ Freeport	18-Oct-2017	1.5	5.8	92.8	0.16	27.19	0.011	0.04	15.7	72.1	12.3	0.97	45.80	0.101	0.68
510ST1317	Sacramento R @ Freeport	29-Jan-2018	0.1	1.5	98.3	0.06	23.00	0.010	0.02	24.6	71.9	3.5	1.09	36.77	0.081	0.26
510ST1317	Sacramento R @ Freeport	17-Apr-2018	0.7	1.2	98.1	0.10	27.95	0.012	0.02	6.2	21.6	72.2	0.21	36.41	0.102	0.33
510ST1317	Sacramento R @ Freeport	20-Jun-2018	1.7	6.0	92.3	0.08	26.37	0.019	0.09	2.4	9.6	88.0	0.48	32.79	0.048	0.30
541SJC501	SanJoaquin R @ Vernalis/Airport Way	19-Oct-2017	0.2	0.9	98.9	0.04	25.49	0.004	0.01	0.7	4.4	94.9	0.07	25.20	0.007	0.01
541SJC501	SanJoaquin R @ Vernalis/Airport Way	30-Jan-2018	0.1	1.8	98.1	0.04	22.35	0.003	0.01	10.4	74.9	14.7	0.87	32.58	0.024	0.22
541SJC501	SanJoaquin R @ Vernalis/Airport Way	18-Apr-2018	20.8	61.2	18.0	0.14	29.80	0.081	0.09	13.5	57.0	29.5	0.30	29.29	0.031	0.04
541SJC501	SanJoaquin R @ Vernalis/Airport Way	21-Jun-2018	9.0	52.2	38.8	0.41	27.96	0.014	0.06	3.8	20.7	75.4	0.18	30.79	0.023	0.20
544ADVLM6	Lower Mokelumne R. 6	18-Oct-2017	0.4	1.8	97.8	0.05	14.84	0.004	0.01	1.4	5.6	92.9	0.09	29.22	0.027	0.05
544ADVLM6	Lower Mokelumne R. 6	29-Jan-2018	0.1	1.8	98.1	0.04	22.27	0.006	0.02	4.0	15.0	81.0	0.22	31.36	0.047	0.26
544ADVLM6	Lower Mokelumne R. 6	17-Apr-2018	0.8	2.3	96.9	0.05	29.77	0.009	0.02	1.1	2.6	96.3	0.11	27.67	0.012	0.04
544ADVLM6	Lower Mokelumne R. 6	21-Jun-2018	0.7	2.3	97.0	0.08	25.70	0.008	0.02	13.5	77.9	8.6	0.10	29.96	0.017	0.10
544LILPSL	Little Potato Slough	18-Oct-2017	22.3	75.6	2.2	2.24	65.66	0.157	0.63	14.4	73.7	12.0	2.63	61.69	0.089	0.70
544LILPSL	Little Potato Slough	29-Jan-2018	13.2	74.6	12.2	1.93	54.28	0.050	0.46	15.0	75.0	10.0	2.93	56.48	0.179	0.28
544LILPSL	Little Potato Slough	17-Apr-2018	29.7	70.2	0.0	2.88	45.65	0.107	0.43	12.1	74.9	13.0	2.72	52.36	0.134	0.25
544LILPSL	Little Potato Slough	20-Jun-2018	15.5	70.8	13.6	5.10	70.99	0.172	1.55	8.2	64.8	26.9	5.20	71.98	0.121	0.98
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	19-Oct-2017	4.3	19.3	76.4	0.33	26.08	0.014	0.07	2.9	19.3	77.9	0.39	23.68	0.010	0.21
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	30-Jan-2018	2.6	8.0	89.4	0.14	24.08	0.012	0.03	6.1	48.4	45.5	0.64	31.62	0.020	0.16
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	18-Apr-2018	2.3	5.8	92.0	0.94	27.32	0.007	0.05	6.3	39.7	54.0	0.74	26.09	0.012	0.10
544MDRBH4	Middle R. @ Borden Hwy (Hwy4)	21-Jun-2018	8.6	45.3	46.1	0.14	45.04	0.031	0.32	22.5	68.2	9.3	0.46	40.37	0.047	0.24
					Method Detection Limit	0.01		0.002	0.004				0.01		0.002	0.004
					Reporting Limit	0.10		0.006	0.011				0.10		0.006	0.011