Summary of Mercury Proposal for FY19/20 (Year 4 of Delta RMP Mercury Monitoring)

Continued monitoring of methylmercury in Delta fish and water is proposed to address the highest priority information needs related to revision and implementation of the Methylmercury TMDL (re-opening of the TMDL is scheduled for 2020). The window for inclusion of new data in the TMDL revision could close as soon as December 2019. Monitoring with the current design is proposed to continue through October 2019. During the second half of the fiscal year (January-June 2020) a transition to a second phase of monitoring is proposed. The second phase would address the critical need for continued monitoring of subregional trends in fish and water, and would add a monitoring element focused on assessing the subregional impact of habitat restoration projects on methylmercury impairment.

Three monitoring elements are proposed.

1. **Subregional trends in bass** - Continued annual monitoring of methylmercury in black bass at seven stations (distributed among the TMDL subregions) will firmly establish baseline concentrations and interannual variation in support of monitoring of long-term trends as a critical performance measure for the TMDL. This design will be re-evaluated after completion of a 10-year period (2014-2023).
2. **Subregional trends in water** - Continued monitoring of methylmercury in water at six stations on a near-monthly basis during the biologically-relevant time period (Mar-Oct) will further solidify the linkage analysis (the quantitative relationship between methylmercury in water and mercury in sport fish) in the TMDL and be valuable in verifying trends and patterns predicted by numerical models of methylmercury transport and cycling being developed for the Delta and Yolo Bypass by the California Department of Water Resources (DWR) and the USGS. These models will allow testing of various land and water management scenarios.
3. **Restoration monitoring** - Annual monitoring methylmercury in black bass and prey fish at new stations (seven for black bass and 16 for prey fish) located near habitat restoration projects will assess the subregional impact of the projects on impairment. The San Francisco Bay Regional Water Board has obtained $30,000 for monitoring methylmercury impacts of a restoration project on Winter Island in the West Delta and is interested in coordinating with the Delta RMP.

At the level of funding allocated in the Multi-Year Plan ($290,000), the design would include:

- Subregional trends in bass;
- Subregional trends in water (8 stations, 4 events from Jul – Oct 2019; 6 stations, 4 events from Mar-Jun 2020)
- An interpretive report on the 3.5 years of monitoring to date that would inform the TMDL revision

At an increased funding level (Multi-Year Plan amount plus 25%, or $360,000), the design would include:

- All elements from the $290,000 funding level; and
- Initiation of baseline restoration monitoring in three Delta tidal wetland restoration areas, with seven added black bass stations and 16 added prey fish stations.

At a decreased funding level (Multi-Year Plan amount minus 25%, or $220,000), the design would include:

- Subregional trends in bass;
- Subregional trends in water (reduced level) (8 stations, 4 events from Jul – Oct 2019; 6 stations, 2 events from Mar-Jun 2020); and
- No interpretive report on the 3.5 years of monitoring to date.

Management Drivers Addressed

Mercury monitoring addresses the Delta Methylmercury TMDL, which establishes goals for cleanup and calls for a variety of control studies and actions.

Management and Assessment Questions Addressed

The management and assessment questions addressed by each of the methylmercury monitoring elements are indicated in Table 1. In addition, the combination of water and fish monitoring addresses a critical data need for management that is not captured in the current set of questions for the Program: data to strengthen the linkage analysis that is a key component of the technical foundation for the TMDL.

Data Quality Objectives/Null Hypothesis

The initial and preliminary data quality objective (DQO) for subregional bass trend monitoring is the ability to detect a trend of mercury in fish tissue of 0.040 ppm/yr. This DQO can be refined when additional data are available. The null hypothesis is that there is no trend. MQOs are identical to those used in other mercury studies throughout the state and the country

for determinations of impairment and trend detection. These MQOs generally call for indices of accuracy and precision to be within 30% of expected values.

The subregional water monitoring is primarily being collected to solidify understanding of the correlation of fish methylmercury with aqueous methylmercury (i.e., the linkage analysis) and to provide essential input data for the models being developed by DWR and USGS. Hypothesis testing will not be a primary use of the water data.

The restoration monitoring with bass and prey fish will focus on the same kind of trend evaluation described for subregional bass trend monitoring above, and the same considerations apply.

Table 1. Delta RMP mercury management and assessment questions addressed by each mercury monitoring element. Questions highlighted in yellow were identified by the Steering Committee as the highest priority for initial studies.

Type	Core Management Questions	Assessment Questions	Sub-Questions	Subregional Trends in Bass	Subregional Trends in Water	Restoration Monitoring
Status and Trends	Is there a problem or are there signs of a problem ? a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? b. Which constituents may be impairing beneficial uses in subregions of the Delta? c. Are trends similar or different across different subregions of the Delta?	1. What are the status and trends in ambient concentrations of total mercury and methylmercury (MeHg) in fish, water, and sediment, particularly in subareas likely to be affected by major sources or new sources (e.g., large-scale restoration projects)?	A. Are trends over time in MeHg in sport fish similar or different among Delta subareas?	X		
			B. Are trends over time in MeHg in water similar or different among Delta subareas?		X	
Sources, Pathways, Loadings, and Processes	Which sources and processes are most important to understand and quantify? a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? b. What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition) c. What are the magnitudes of internal sources (e.g., benthic flux) and sinks in the Delta?	1. Which sources, pathways, and processes contribute most to observed levels of MeHg in fish?	A. What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)?		X	
			B. How do internal sources and processes influence MeHg levels in fish in the Delta?	X	X	X
			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 MeHg levels in fish in the Delta?			
Forecasting Scenarios	a. How do ambient water quality conditions respond to different management scenarios? b. What constituent loads can the Delta assimilate without impairment of beneficial uses? c. What is the likelihood that the Delta will be water quality-impaired in the future?	1. 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?		X	X	X
Effectiveness Tracking	a. Are water quality conditions improving as a result of management actions such that beneficial uses will be met? b. Are loadings changing as a result of management actions?	[none]		X	X	X

Monitoring to Support Implementation of the Methylmercury TMDL

Background and Motivation

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

The TMDL established three water quality objectives for methylmercury in fish tissue: 0.24 ppm in muscle of large, trophic level four (TL4) fish such as black bass ("black bass" includes largemouth, smallmouth, and spotted bass); 0.08 ppm in muscle of large TL3 fish such as carp; and 0.03 ppm in whole TL2 and TL3 fish less than 50 mm in length. Furthermore, the TMDL established an implementation goal of 0.24 ppm in largemouth bass 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 for largemouth bass were a foundation for the development of the TMDL, including the division of the Delta into eight subregions. Monitoring of largemouth bass in these subregions therefore provides the most critical performance measure of progress in addressing methylmercury impairment in the Delta.

The TMDL describes a statistically significant relationship between the annual average concentration of methylmercury in unfiltered water and average mercury in 350 mm largemouth bass when data are organized by subregion. This linkage provides a connection, essential for management, between methylmercury inputs from various pathways (e.g., municipal wastewater, municipal stormwater, agricultural drainage, sediment flux in open waters, and wetland restoration projects) and impairment of beneficial uses. Because of this linkage, the TMDL established an implementation goal of 0.06 ng/L of unfiltered aqueous methylmercury. In response to TMDL control study requirements, the Department of Water Resources (DWR) is leading development of numerical methylmercury transport and cycling simulation models for the Delta and Yolo Bypass. Monitoring of aqueous methylmercury 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 methylmercury 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.

In FY 2016/2017 the Delta RMP initiated a methylmercury monitoring program for fish and water. Largemouth bass were collected in late summer 2016 (September) from six stations distributed across the subregions. Quarterly sampling of methylmercury and mercury (and ancillary parameters) in water at five stations began in August 2016.

In FY 2017/2018, methylmercury monitoring of fish and water continued. Funding was allocated to sample fish at six stations and water at six stations for eight months. The eight months to be sampled were to be the March-October period used for the linkage analysis in the TMDL. In late 2017, the Mercury Subcommittee decided, based on data needs related to a Regional Board decision to revise the TMDL in 2020, that a more optimal use of the available funds would be to shift to sampling water at eight stations (adding stations in the West Delta and at the export pumps) and to add sampling in January and February (Table 2). This design would provide information to update the methylmercury mass balance for the Delta by sampling two export stations (in the West Delta and at the pumps) and sampling during high flows in the winter. The FY 2017/2018 plan also included funds for quarterly sediment sampling to support the DWR methylmercury modeling effort, and any future methylmercury modeling.

In FY 2018/2019, the design that was established in the latter part of FY 2017/2018 was continued, with sampling of fish at seven stations in August/September and sampling of water at eight stations monthly during the biologically-relevant period (March-October) plus two high flow months (January and February of 2019) to inform the loads assessment (Table 2). Sediment sampling was discontinued due to funding limitations.

Proposed Approach for FY 2019/2020

The window for inclusion of new data in the TMDL revision is planned to close in December 2019. Monitoring with the current design is proposed to continue through October 2019. An interpretive report covering the first 3.5 years of monitoring (from August 2016 to October 2019) will be prepared in December 2019 to inform the TMDL deliberations. During the second half of the fiscal year (January-June 2020) a transition to a second phase of monitoring is proposed. The second phase would add a monitoring element focused on assessing the subregional impact of habitat restoration projects on methylmercury impairment.

Three monitoring elements are proposed for the second phase of Delta RMP methylmercury monitoring.

1. **Subregional trends in bass** - Continued annual monitoring of methylmercury in black bass at seven stations will firmly establish baseline concentrations and interannual variation in support of monitoring of long-term trends as a critical performance measure for the TMDL. This design will be re-evaluated after establishment of a 10-year time series.
2. **Subregional trends in water** - Continued monitoring of methylmercury in water on a near-monthly basis will further solidify the linkage analysis (the quantitative relationship between methylmercury in water and mercury in sport fish) in the TMDL. It will also be valuable in verifying trends and patterns predicted by a numerical model of methylmercury transport and cycling being developed for the Delta and Yolo Bypass by the California Department of Water Resources (DWR). This model will allow testing of various land and water management scenarios. The need for continuation of this monitoring, including the duration and the level of effort, will be assessed as part the interpretive report on phase 1 of the monitoring.
3. **Restoration monitoring** - A new element of annual monitoring methylmercury in black bass and prey fish at new stations located near habitat restoration projects will assess the subregional impact of the projects on impairment. The San Francisco Bay Regional Water Board (Region 2) has obtained $30,000 for monitoring methylmercury impacts of a restoration project on Winter Island in the West Delta and is interested in coordinating with the proposed Delta RMP monitoring. This monitoring should begin with a level of effort that is sufficient to detect the potential subregional impact of restoration projects, and could be tapered off over time if the results indicate a lack of impact.

Applicable Management Decisions and Assessment Questions

The Delta Methylmercury TMDL is the embodiment of management decisions for methylmercury in the Delta, establishing goals for cleanup and calling for a variety of control studies and actions. With providing information to support TMDL implementation in mind, the Mercury Subcommittee carefully considered the assessment questions articulated by the Steering Committee and Technical Advisory Committee for mercury.

The Delta RMP management and assessment questions addressed by each of the methylmercury monitoring elements are indicated in Table 1. In addition, the combination of water and fish monitoring addresses a critical data need for management that is not captured in

the current set of questions for the Program: data to strengthen the linkage analysis that is a key component of the technical foundation for the TMDL.

Monitoring of subregional trends in bass is addressing questions relating to Status and Trends, Forecasting, and Effectiveness Tracking. Status and Trends Question 1A is a high priority for managers that relates to the TMDL, and is a primary driver of the sampling design for subregional bass trend monitoring. Annual monitoring of bass mercury is urgently needed to 1) firmly establish a baseline for each Delta subregion 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 provide an essential foundation for Forecasting Scenarios (past trends are a starting point for projecting future conditions) and Effectiveness Tracking (evaluating whether water quality is improving at the subregional scale as a result of management actions).

Monitoring of subregional trends in water is addressing all of the major categories of Delta RMP management questions (Status and Trends; Sources, Pathways, Loadings, and Processes [SPLP]; Forecasting Scenarios; and Effectiveness Tracking). Data on concentrations of methylmercury in water are valuable as an indicator of Status and Trends as they can be compared to the TMDL implementation goal of 0.06 ng/L of unfiltered aqueous methylmercury. The use of water data to update the mass budget addresses SPLP Question 1A and is a key element of the TMDL. Aqueous methylmercury concentrations are essential input and validation data for the models that DWR and USGS are developing for the Delta that will elucidate the processes affecting methylmercury patterns and allow forecasting and testing of various water management scenarios (DiGiorgio et al. 2016; Windham-Myers et al., 2016). Water concentration data will also be valuable in Effectiveness Tracking, allowing assessment of status relative to the implementation goal and of changes in loading in the context of the overall mass budget for the Delta.

Monitoring of subregional trends in bass and water will also provide information on the influence of climate, hydrology, and ecology. For example, the first two years of monitoring have already spanned the end of a prolonged drought and a high flow year, providing an opportunity to examine the impact of extreme variation in flow on methylmercury concentrations in fish and water.

Restoration monitoring will address questions relating to SPLP, Forecasting Scenarios, and Effectiveness Tracking. The basic concern with restoration projects is that they may enhance net methylmercury production within the Delta ecosystem, and represent an internal source that increases as the projects proceed (SPLP Question 1B) – restoration monitoring will track

whether this occurs or not. Restoration monitoring will yield insights into which types of projects, if any, impact net methylmercury production and food web accumulation (Forecasting Scenarios Question 1) and whether internal loadings change and ambient water quality shows net improvement as a result of restoration projects (Effectiveness Tracking).

Approach

Subregional Trends in Bass

Design	7 fixed stations (Figure 1), largemouth bass only
Key Indicator	Annual average methylmercury in muscle fillet of 350 mm largemouth bass (or similar predator species), derived through analysis of 16 individual bass or other predator species at each station
Parameters	Total mercury*, Total length, Fork length, Weight, Sex, Moisture, Estimated age
Frequency	Annual
Schedule	Sample in August and September
Duration	Monitor through 2025 and then re-evaluate
Co-location	Water MeHg and Hg Other water parameters
Contractors	SFEI (design, data management, reporting), MLML (sample collection, chemical analysis, reporting)
Coordination	DWR, USGS (sampling of flow monitoring stations)
Cost	$61,000

* Total mercury measured as proxy of methylmercury because methylmercury comprises more than 90% of the total mercury in sport fish.

Summary of Results to Date

Results from the first year of DRMP methylmercury monitoring are presented in the Year One Data Report (Davis et al. 2018) and the Year Two Data Report (in prep). The reports provide details on the sample collection and processing, chemical analysis, quality assurance, and the results. Highlights of the results are briefly discussed here.

Results from the first two rounds of DRMP fish monitoring are presented in **Figure 2**, with data from prior fish sampling in or near these stations provided for context. Time series

with more than three observations are available for four of the six stations. 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. The data do suggest a preliminary answer to management question 1A, and a possible effect of the very high flows in 2017. Up through 2016, the data suggested a decline in concentrations at the San Joaquin River at Vernalis over the period of record, while concentrations appeared to be stable at the other three stations. Therefore, the data give a preliminary indication that trends do vary among the Delta subregions. In 2017, concentrations were significantly higher than 2016 at four of the six stations, most markedly at the Mokelumne River station, suggesting a possible effect of the high flows in that year, again with variation among the subregions in the degree of elevation. Additional rounds of consistent sampling are needed to confirm the long-term patterns and the potential influence of hydrology in 2017.

Subregional Trends in Water

Design	8 fixed stations through October 2019; 6 stations after that (dropping the Mallard Island and Mendota Canal stations (**Figure 1**)
Key Indicator	March-October average total (unfiltered) methylmercury at each station
Parameters	Total (unfiltered) methylmercury, filtered methylmercury, unfiltered total mercury, filtered total mercury, total suspended solids (TSS), chlorophyll a, dissolved organic carbon, volatile suspended solids. Field measurements will include dissolved oxygen, pH, and specific conductance.
Frequency	8 events per year
Schedule	Two 4-month blocks (Jul-Oct; Mar-Jun) of monthly samples
Duration	Monitor through FY 19/20 and then re-evaluate
Co-location	Sport fish sampling Other water parameters
Coordination	DWR, USGS (sampling of flow monitoring stations)
Cost	$187,000

Summary of Results to Date

In this section, we briefly summarize results for March through October average total (unfiltered) methylmercury at each station for the first year of sampling. Data for the other water quality parameters are presented in the Year One Data Report (Davis et al. 2018) and the Year Two Data Report (in preparation-).

Concentration of MeHg in unfiltered water ranged from 0.044 – 0.385 ng/L. **Figure 3** presents long-term time series of March to October annual averages of unfiltered MeHg concentrations for Delta RMP stations. 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 results 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 values 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 values.

Restoration Monitoring

Design (Preliminary)	7 new black bass fixed stations and 16 new prey fish fixed stations (Figures 4-6)
Key Indicator	Bass: annual average methylmercury in muscle fillet of 350 mm largemouth bass (or similar predator species), derived through analysis of 16 individuals at each station Prey fish: Annual average methylmercury in whole fish, based on 6 composites of 10 individuals of the indicator species at each station
Parameters	Total mercury, Total length, Fork length, Weight, Sex, Moisture, Estimated age*
Frequency	Annual
Schedule	Bass: sample in August-September Prey fish: sample in April – June
Duration	Monitor through 2023 and then re-evaluate
Co-Location	None
Contractors	SFEI (design, data management, reporting), MLML (sample collection, chemical analysis, reporting)
Coordination	Coordinated with Region 2 monitoring in the West Delta ($30K over 2 years in funds from Region 2)
Cost	$122,000 total for the year**: $108,000 from Delta RMP**; $14,000 from Region 2 to cover 4 prey fish sites in and around Winter Island

* for bass only

Restoration monitoring will focus on three areas in the Delta where restoration activity is concentrated (Figures 4-6). In each of these areas, bass stations and prey fish stations will be strategically located. The bass station locations will be selected to detect the potential aggregate impact of restoration projects at the subregional scale. Prey fish station locations will be selected to a) link specific restoration projects to the trends that are observed in the bass, and b) track trends in reference tidal wetlands to aid in the interpretation of the prey fish data from the project-specific stations. The time series obtained for the bass and prey fish at these stations will be compared to each other, to the Subregional Bass Trend stations, and to historic data to evaluate whether restoration causes an increase in methylmercury in fish.

The San Francisco Bay Regional Water Board (Region 2) has obtained $30,000 for monitoring methylmercury impacts of a restoration project on Winter Island in the West Delta and is interested in coordinating and fitting in with the proposed Delta RMP monitoring. The

Region 2 funds can help allow for monitoring in the West Delta, and for more intensive sampling in and around the Winter Island project.

The sampling station locations shown in Figures 4-6 are preliminary. The allocation and placement of stations will be refined by the Mercury Subcommittee if the Steering Committee approves the mercury monitoring at the higher funding level.

The sooner these restoration monitoring time series are initiated, the more valuable they will be for detecting the impacts of restoration projects. Some of the restoration projects have not yet been implemented, and some have been implemented recently.

Other biosentinel restoration monitoring projects in the region have shown that restoration in some instances does not lead to methylmercury increases (e.g., Robinson et al. 2018). If prey fish stations are yielding results that indicate a lack of change from baseline conditions, they can be phased out. Results from the first three years of this monitoring can be evaluated in 2024 to determine whether monitoring can be tapered back.

Data Quality

The measurement quality objectives (MQOs) for measurements of methylmercury and mercury in fish and water are shown in Appendix 1. These MQOs are the same as MQOs used in mercury studies throughout California, with statewide fish monitoring by the Surface Water Ambient Monitoring Program as a prominent example. The MQOs generally call for indices of accuracy and precision to be within 30% of expected values. Data of this quality are routinely used for determinations of impairment and trend detection throughout the state and the country. The variance attributable to the analytical process is one of the contributors to the overall variance observed in the data. This variance is therefore accounted for in the power estimates provided in the next section.

Power to Detect Long-term Trends - Bass Sampling

The power to detect interannual trends in largemouth bass mercury on a per station basis was evaluated using existing data. Even the best existing time series for the Delta have low statistical power to detect trends due to infrequent sampling and varying sampling designs of studies performed over the years (**Figure 2**). One of the goals of the initial phase of Delta RMP fish mercury monitoring is to obtain robust information on interannual variation to support future power analysis. As part of the mercury proposal for FY 2017/2018 we conducted a power analysis on the small amount of information presently on hand. Appendix 2 provides

the methods and details on the results. This analysis will be updated after a few years of new data have accumulated.

Power analysis summary

Power for trend detection at a single station based on grand mean estimates of observed variance across stations. Pink shading indicates scenarios with greater than 80% power.

		10 Years		20 Years		30 Years	
Trend	N Fish/Yr	Annual	Biennial	Annual	Biennial	Annual	Biennial
0.010 ppm/yr	12	0.11	0.09	0.20	0.15	0.40	0.27
0.020 ppm/yr	12	0.13	0.13	0.44	0.27	0.81	0.60
0.030 ppm/yr	12	0.21	0.17	0.69	0.45	0.99	0.85
0.040 ppm/yr	12	0.29	0.19	0.88	0.61	1.00	0.98
0.010 ppm/yr	16	0.21	0.19	0.33	0.27	0.55	0.44
0.020 ppm/yr	16	0.27	0.24	0.65	0.46	0.93	0.77
0.030 ppm/yr	16	0.36	0.32	0.86	0.64	1.00	0.96
0.040 ppm/yr	16	0.47	0.36	0.97	0.82	1.00	1.00

These preliminary results indicated that increasing the number of fish per station would be effective in increasing power. With 16 fish per station and annual sampling, 80% power would be expected for several of the 20-year scenarios. Beginning with year 2 (FY 2017/2018) the design for fish monitoring was therefore modified to include 16 fish per station. The monitoring results for the San Joaquin at Vernalis suggest that trends of up to 0.040 ppm/yr are possible. The results highlight the importance of initiating consistent time series.

Power Analysis - Water Sampling

Not applicable. The primary objectives of the water sampling are to strengthen the linkage analysis and support model development. The water monitoring is not intended as a primary tool for long-term trend monitoring.

Reporting and Deliverables

With three years of monitoring completed, and an opportunity to inform the revision of the TMDL, the fall of 2019 will be an opportune time to prepare an interpretive report that provides a more thorough assessment of the dataset generated by this program and a comparison to data from other studies. This report will be drafted by December 2019 so the findings can be considered in the process of TMDL revision.

Deliverable	**Due Date**
Draft Interpretive Report on Years 1-3	December 2019
Final Interpretive Report on Years 1-3	March 2020
Draft Data Report on Year 4 (FY 19/20)	December 2020
Final Data Report on Year 4 (FY 19/20)	March 2021

Budget

	Levels specified by the SC		
OPTIONS FOR 19/20	220	290	360
	19/20	**19/20**	**19/20**
Core Bass (7 sites from 18/19 on)	61	61	61
Water (6 sites, 8 events after Jan 20)	146	186	186
Sediment			
Oversight, Coord., Data Mgt, Reporting	35	60	60
Restoration	0	0	122
Total	242	307	429
Region 2			15
MLML In-Kind	25	25	25
Delta RMP	217	282	389
Over SC Level	-3	-8	29

Proposed Multi-Year Plan With Restoration	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Core Bass (7 sites from 18/19 on)	45	52	61	61	63	65	67
Water (6 sites, 8 events after Jan 20)	65	153	259	186	164	169	174
Sediment		29					
Oversight, Coord., Data Mgt, Reporting	18	25	35	60	35	35	35
Restoration				122	122	122	122
Total	128	259	355	429	384	391	398
Region 2 In-Kind				15	15		
MLML In-Kind	21	25	30	25	25	25	25
Delta RMP	107	234	325	389	344	366	373

Table 2. *Sampling schedule for Delta RMP mercury monitoring. The March-October period used for the linkage analysis in the TMDL is indicated with gray shading.*

Year →	2016						2017												2018												2019												2020					
Fiscal Yr →	FY 16/17												FY17/18												FY18/19												FY19/20											
Month →	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Monitoring element (# of sites sampled)																																																
Fish		6												6													7											7										
Water		5			5			5		5						6			8	8	8	8	8	8	8	8	8	8					8	8	8	8	8	8	8	8					6	6	6	6
Sediment																6			6			6		6																								

This proposal

Figure 1. Planned subregional bass and water sampling stations for methylmercury in FY19-20. Note: Water will not be sampled at Mallard Island or Mendota Canal after Oct 2019.

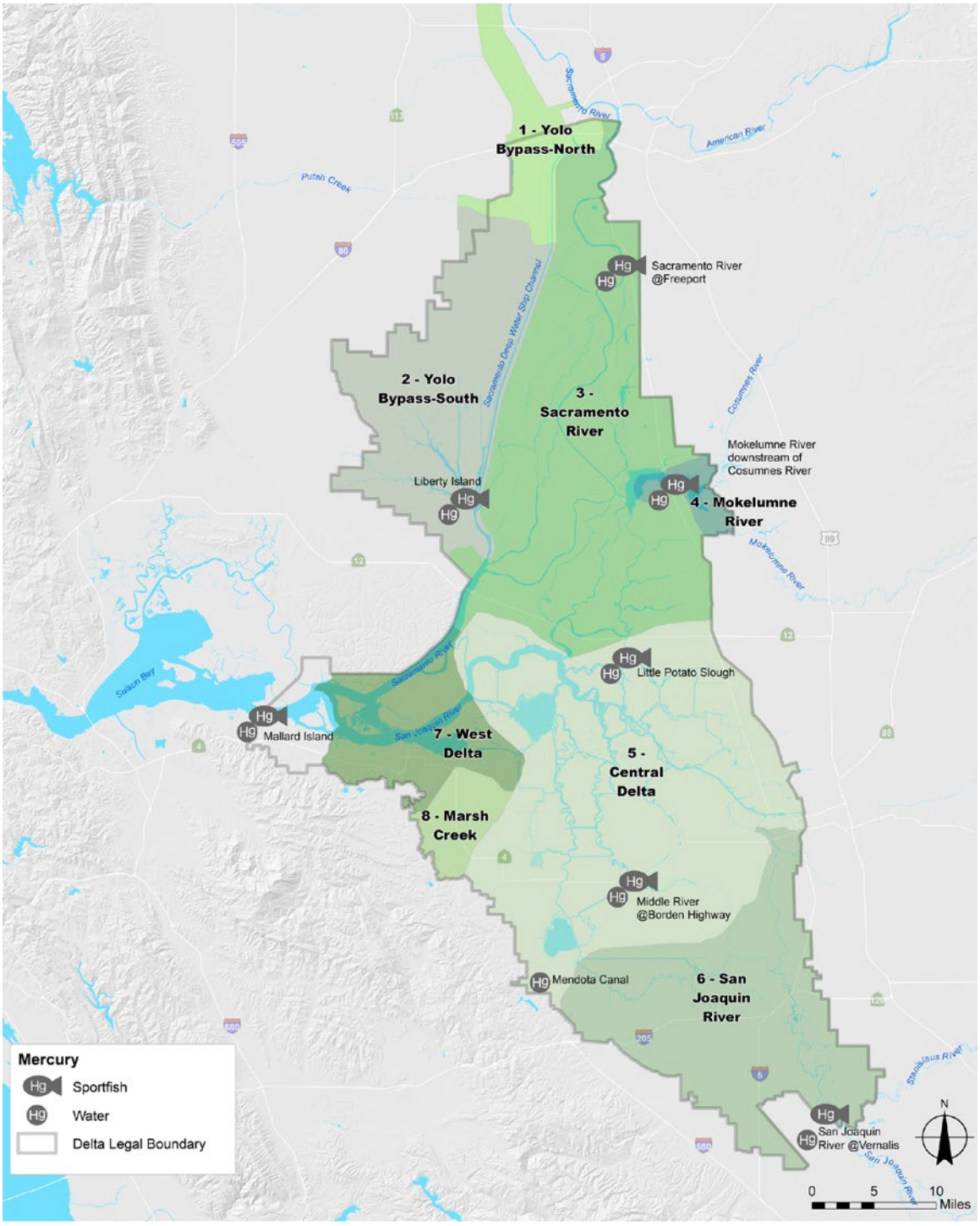

Figure 2. *Long-term time series of mean mercury (ppm wet weight) in black bass for Delta RMP stations and nearby stations sampled historically. Details on following page.*

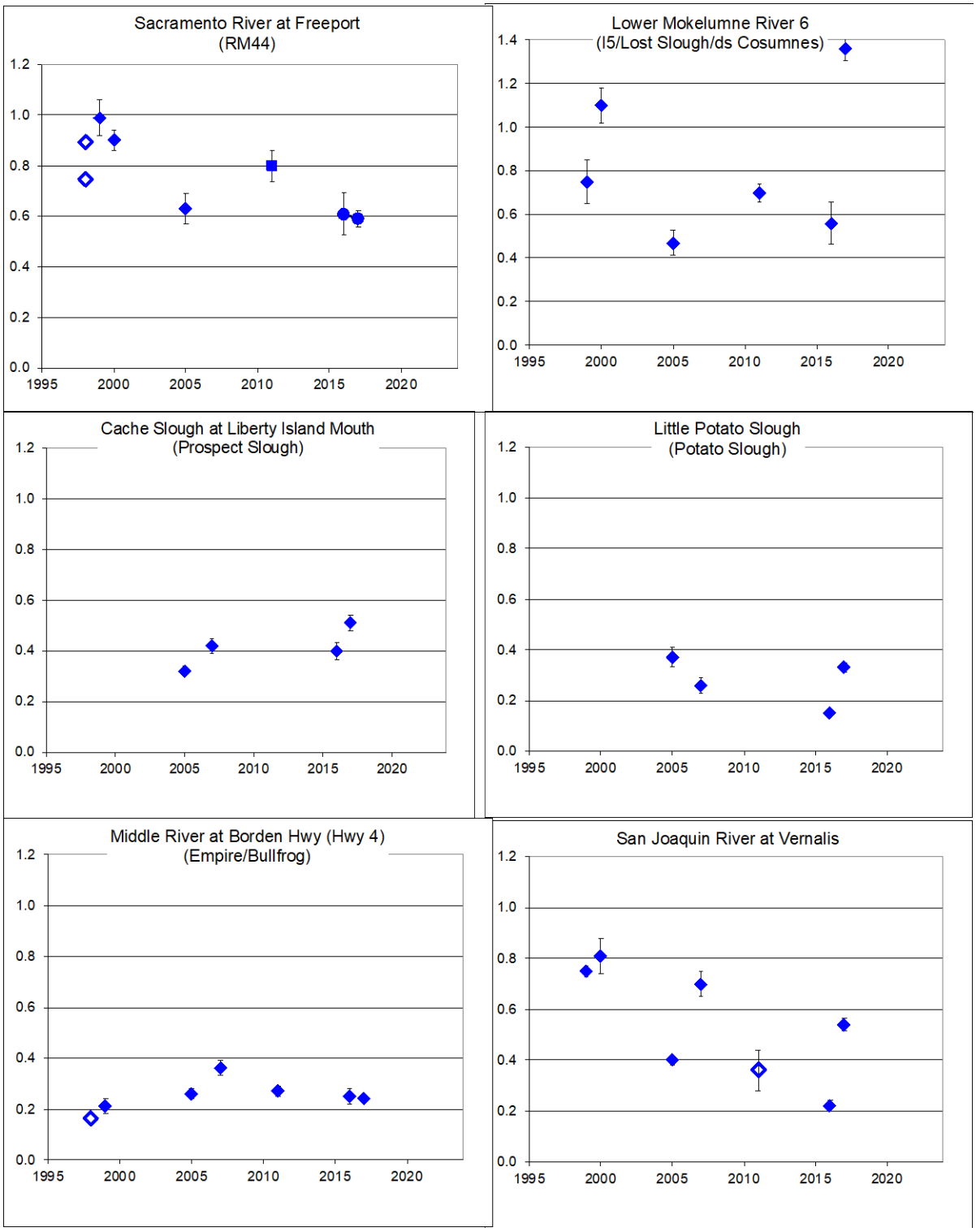

Figure 2 Details

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:mercury 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; 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; 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; Prospect Slough: 2005, 2007

Little Potato Slough
Stations - Little Potato Slough: 2016; 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; 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

Figure 3. *Annual mean aqueous unfiltered methylmercury concentration at each Delta RMP monitoring station sampled from October 2017 through June 2018. Plots based on March-October data.*

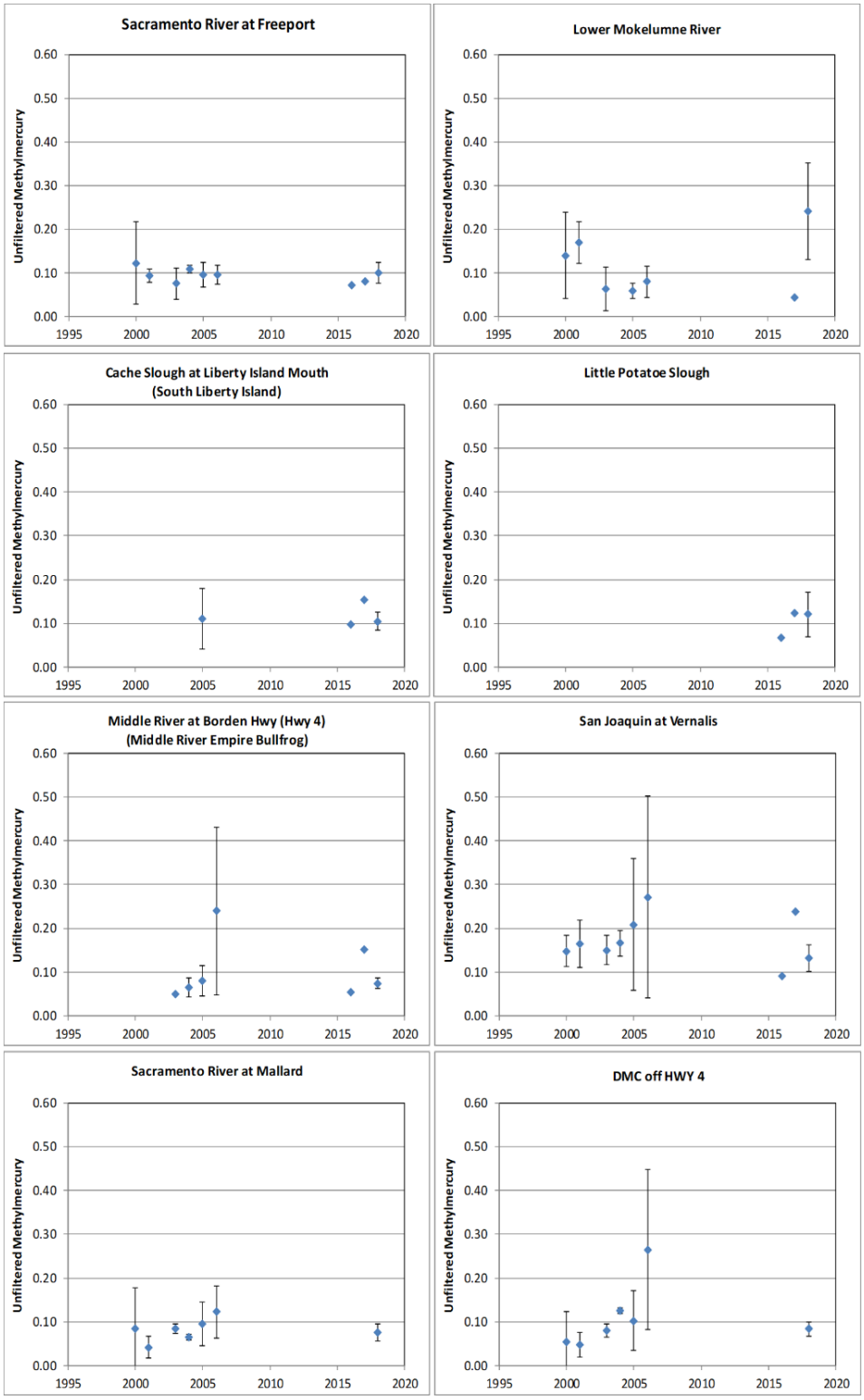

Figure 4. Preliminary design for restoration monitoring in the northwest Delta.

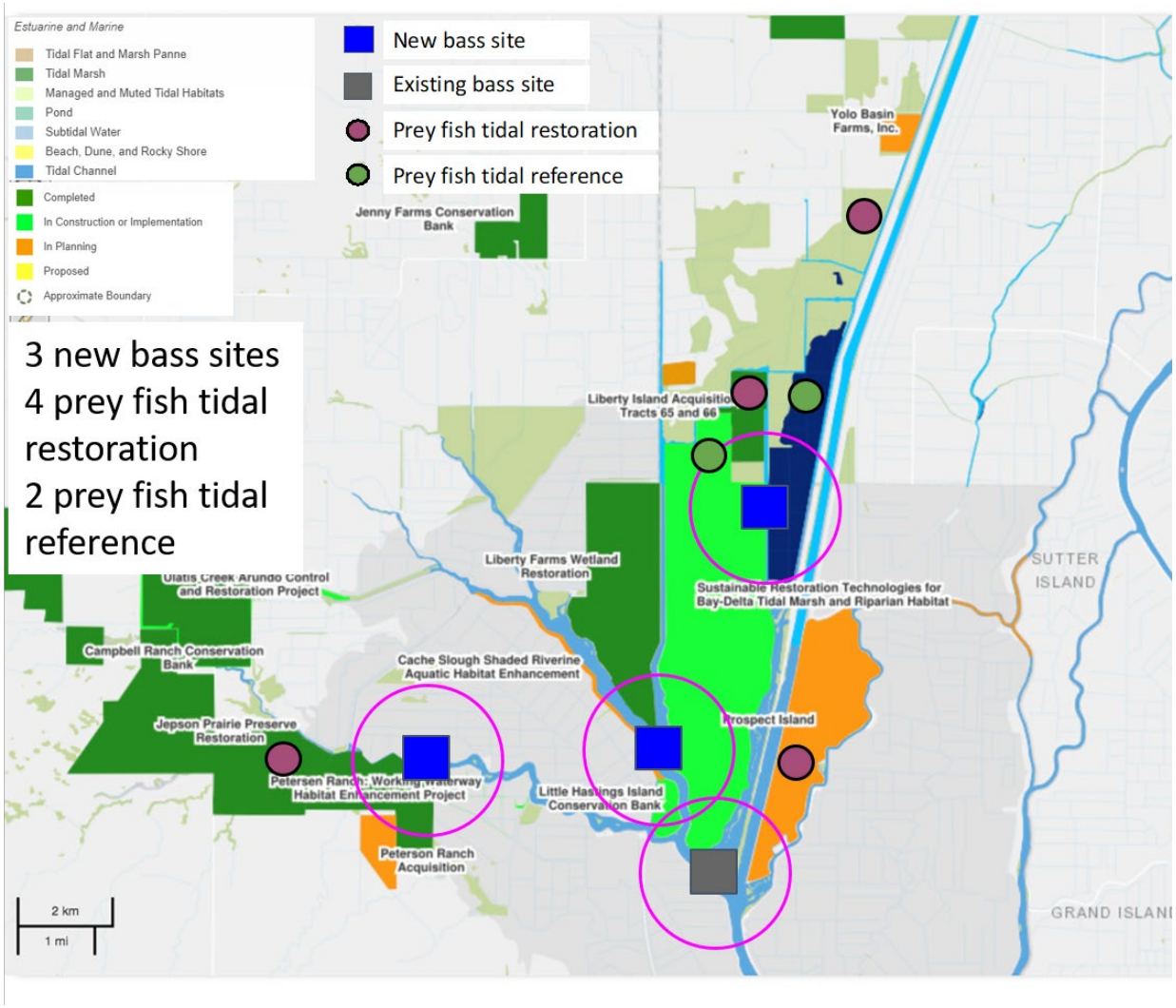

Figure 5. Preliminary design for restoration monitoring in the northeast Delta.

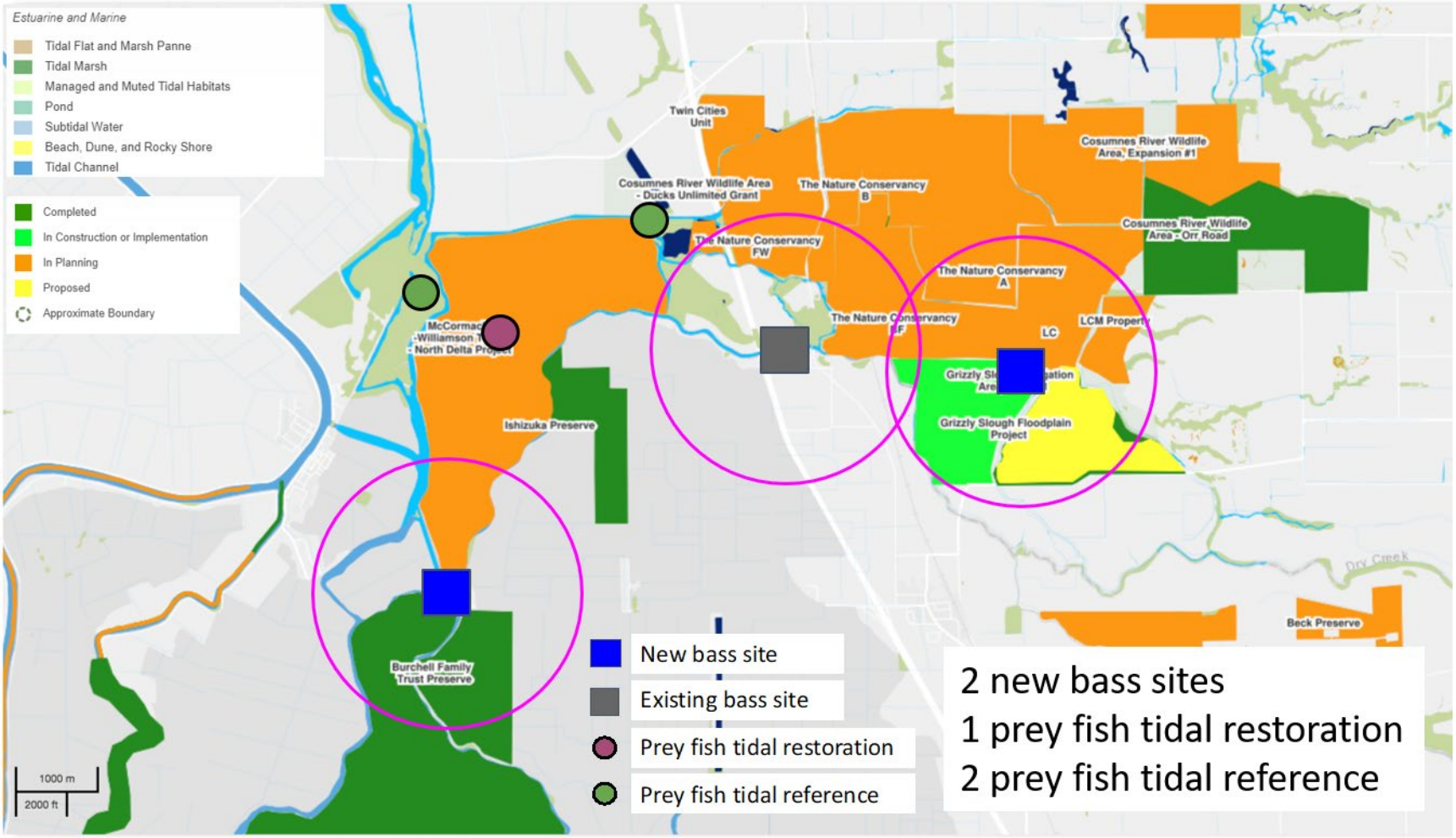

Figure 6. Preliminary design for restoration monitoring in the west Delta.

References

DiGiorgio, C., H. Amos, J. Anderson, M. Bahia, C. Beals, D. Beals, D. Bosworth, G. Gill, R. Harris, W. Heim, E. Hsu, and D. Hutchinson. "Creation of Mercury Models for the Delta and Yolo Bypass: Linking Modeling and Delta Regulatory Decisions." Sacramento, California, 2016. http://scienceconf2016.deltacouncil.ca.gov/content/creation-mercury-models-delta-and-yolo-bypass-linking-modeling-and-delta-regulatory

Robinson, A., A. Richey, D. Slotton, J. Collins, and J.A. Davis. 2018. *North Bay Mercury Biosentinel Project 2016-2017*. Contribution #868. San Francisco Estuary Institute and the Aquatic Science Center. Richmond, CA. https://www.sfei.org/documents/north-bay-mercury-biosentinel-project

Windham-Myers, L., L. Lucas, J.A. Fleck, A.R. Stewart, R.C. Martyr, and M. Marvin-DiPasquale. 2016. *The Delta doughnut: A persistent pattern for methylmercury metrics. Presentation at the Bay-Delta Science Conference*, November 15-17, 2016. http://scienceconf2016.deltacouncil.ca.gov/content/delta-doughnut-persistent-pattern-methylmercury-metrics

Wood, M.L., C.G. Foe, J. Cooke, and S.J. Louie. "Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury: Staff Report." Sacramento, California: Central Valley Regional Water Quality Control Board, 2010. http://www.waterboards.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_tmdl_staffrpt_final.pdf.