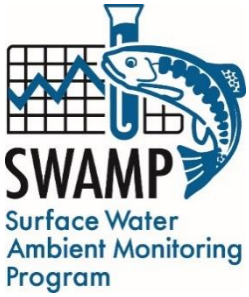

MONITORING AND ANALYSIS PLAN

Screening Study of Bioaccumulation in Rivers and Streams in California

Bioaccumulation Monitoring Program

Surface Water Ambient Monitoring Program

Version 2

April 2022

Table of Contents

Background

In 2011, the Surface Water Ambient Monitoring Program's (SWAMPs) Bioaccumulation Monitoring Program implemented a statewide river and stream screening survey for a set of 63 river and stream locations throughout California. A Sampling and Analysis Plan (also known as Monitoring Plan) was published in 2011 to document the objectives and design details of the study. A report and fact sheet on the study were published in 2013.

Monitoring Design Updates

The Safe to Eat Workgroup (formerly known as the Bioaccumulation Oversight Group) has provided valuable input and feedback to the Bioaccumulation Monitoring Program (BMP), which resulted in minor modifications to the monitoring design. This update to the original 2011 Monitoring Plan documents the modifications that have been made. All other details of the monitoring design match what was outlined in the 2011 Monitoring Plan.

The river and stream sampling locations for 2022 (Table A) were identified as priorities based on input from Central Valley Regional Water Quality Control Board (Central Valley Water Board). Sampling of these locations will support development of a control

program for mercury in Central Valley rivers. The Central Valley Water Board is contributing a significant portion of the funding for monitoring these locations.

The updated tables are provided below, following the numbering used in the original plan. Where changes were minor, revisions to the original tables are highlighted in yellow.

One significant difference from the 2011 survey is that prey fish monitoring is now a standard element of BMP mercury monitoring. This is driven by the establishment in 2017 of statewide objectives for mercury in both sport fish and prey fish, and recognition of the value of prey fish monitoring to supplement sport fish monitoring. Prey fish methods are presented below.

Prey Fish Collection and Analysis

Prey fish (25-100 mm) will be sampled using e-boat, traps, seines, and/or dip nets from shoreline areas adjacent to the locations where sport fish are collected. Ten individuals each from the three most common prey fish species will be sampled from each water body. We will target the following primary prey fish target species at each site: Mississippi silversides, young-of-the-year largemouth bass, young-of-the-year bluegill, and threadfin shad. Other species that are within the target size range may be collected if the primary targets are not available. Efforts will be made to sample the same species across all sites, and when not possible fish that overlap in trophic guild will be sampled. Prey fish will not be collected at Hatchery sites.

Prey fish will be composited whole-body by species from each site and analyzed for mercury and selenium.

Quality Assurance

Data collected for this project will be subject to quality assurance objectives set forth in the 2022 SWAMP Quality Assurance Program Plan (QAPrP).

Archiving

The BMP has long employed a short-term archive strategy for fish composites. Up to three aliquots (approximately 50-60 g) of each composite will be archived in either glass or plastic (polyethylene or polypropylene) jars for future analysis. Plastic containers are used to store sample that may be analyzed for perfluorinated compounds, while glass is used for other compounds. Archived samples are retained and available for analysis for five years in freezers located at the Marine Pollution Studies Laboratory (MPSL).

Table Updates

The updated tables and figures are provided below, following the numbering used in the 2011 Monitoring Plan. Where changes were minor, revisions to the original tables are highlighted in yellow.

Table 4. Target sport fish species, size ranges, and processing instructions

I - process as individuals. I* - process as individuals for mercury, also prepare a composite using middle of size range for selenium and if other species are not available for organics. C - process as composites. C* - process as composites, but as individuals for mercury if fish > 400 mm are collected. 1 - first choice; 2 - second choice. Revised elements are highlighted.

	Process for Mercury	Process for Organics and Selenium	Numbers and Size Ranges (mm)
Primary Targets: stay on location until one of the targets from both Group 1 and 2 is obtained, or collect secondary targets if primary targets are not available			
Group 1) Pelagic Predators			
Black bass	I*	2	2X(200-249), 2X(250-304), 7X(305-406), 3X(407-500)
Sacramento pikeminnow	I*	2	3X(200-299), 7X(300-399), 3X(400-500)
Striped bass	I*	2	2X(250-349), 2X(350-449), 7X(450-599), 3X(>600)
Rainbow trout	C*	2	5X(300-400)
Brown trout	C*	2	5X(300-400), and keep up to five fish > 400 if present
Brook trout	C*	2	5X(300-400), and keep up to five fish > 400 if present

	Process for Mercury	Process for Organics and Selenium	Numbers and Size Ranges (mm)
Group 2) Bottom feeder			
White catfish	C	1	5X(229-305)
Channel catfish	C	1	5X(375-500)
Common carp	C	1	5X(450-600)
Brown bullhead	C	1	5X(262-350)
Sacramento sucker	C	1	5X(375-500)
Secondary Targets: collect these if primary targets are not available			
Bluegill	C	2	5X(127-170)
Redear sunfish	C	2	5X(165-220)
Black crappie	C	2	5X(187-250)
Tilapia	C	2	5X(235-314)
Green sunfish	C	2	5X(119-159)
Kokanee	C	2	5X(300-400)

Table 5. Summary of analytes included in the monitoring

Prey fish were not included in the 2011 survey but are now a standard element of BMP mercury monitoring. PCBs and legacy pesticides are analyzed in selected water bodies where the information is needed for advisory development or tracking trends for management. Revised elements are highlighted.

Fish Type	Analyte	Included in Study?
Sport fish	Methylmercury[1]	All individuals and composites
Sport fish	Selenium	All composites
Sport fish	PCBs	Selected composites
Sport fish	OCHs[2]	Selected composites
Prey fish	Methylmercury[1]	All composites
Prey fish	Selenium	All composites

[1]Measured as total mercury, which provides a direct estimate of methylmercury in fish muscle.

[2]OCHs include DDTs, Dieldrin, Aldrin, and Chlordanes

Table 6. Parameters to be measured

Fish attributes to be measure in prey fish have an asterisk. Revised elements are highlighted.

Table 6a. Fish Attributes

Fish Attributes
Total length (mm)*
Fork Length (mm)*
Standard Length (mm; prey fish only)*
Weight (g)*
Sex (sport fish only)
Moisture (%)*
Lipid (%; only when organics are analyzed)

Fish attributes are physical measurements or observations.

Table 6b. Metals and Metalloids in Tissue

Analyte	Matrix Type
Total Mercury	whole body small fish and sport fish muscle fillet
Total Selenium	whole body small fish and sport fish muscle fillet

Table 6c. Organochlorine (OC) Pesticides in Tissue

Analyte Group	Analyte	Matrix Type
Chlordanes	Chlordane, cis-	sport fish muscle fillet
	Chlordane, trans-	sport fish muscle fillet
	Heptachlor	sport fish muscle fillet
	Heptachlor epoxide	sport fish muscle fillet
	Nonachlor, cis-	sport fish muscle fillet
	Nonachlor, trans-	sport fish muscle fillet
	Oxychlordane	sport fish muscle fillet
DDTs	DDD(o,p')	sport fish muscle fillet
	DDD(p,p')	sport fish muscle fillet
	DDE(o,p')	sport fish muscle fillet
	DDE(p,p')	sport fish muscle fillet
	DDMU(p,p')	sport fish muscle fillet
	DDT(o,p')	sport fish muscle fillet
	DDT(p,p')	sport fish muscle fillet
Cyclodienes	Aldrin	sport fish muscle fillet
	Dieldrin	sport fish muscle fillet
	Endrin	sport fish muscle fillet
HCHs	HCH, alpha	sport fish muscle fillet
	HCH, beta	sport fish muscle fillet
Others	Dacthal	sport fish muscle fillet
	Endosulfan I	sport fish muscle fillet
	Hexachlorobenzene	sport fish muscle fillet
	Methoxychlor	sport fish muscle fillet
	Mirex	sport fish muscle fillet
	Oxadiazon	sport fish muscle fillet

Table 6d. Polychlorinated biphenyls (PCB) in Tissue

Coeluted congeners are reported inline together. (Example: PCB-12/13.)

Analyte	Matrix Type
PCB-1	sport fish muscle fillet
PCB-2	sport fish muscle fillet
PCB-3	sport fish muscle fillet
PCB-4	sport fish muscle fillet
PCB-5	sport fish muscle fillet
PCB-6	sport fish muscle fillet
PCB-7	sport fish muscle fillet
PCB-8	sport fish muscle fillet
PCB-9	sport fish muscle fillet
PCB-10	sport fish muscle fillet
PCB-11	sport fish muscle fillet
PCB-12/13	sport fish muscle fillet
PCB-14	sport fish muscle fillet
PCB-15	sport fish muscle fillet
PCB-16	sport fish muscle fillet
PCB-17	sport fish muscle fillet
PCB-19	sport fish muscle fillet
PCB-21/33	sport fish muscle fillet
PCB-22	sport fish muscle fillet
PCB-23	sport fish muscle fillet
PCB-24	sport fish muscle fillet
PCB-25	sport fish muscle fillet
PCB-26/29	sport fish muscle fillet
PCB-27	sport fish muscle fillet
PCB-28/20	sport fish muscle fillet
PCB-30/18	sport fish muscle fillet
PCB-31	sport fish muscle fillet
PCB-32	sport fish muscle fillet
PCB-34	sport fish muscle fillet
PCB-35	sport fish muscle fillet
PCB-36	sport fish muscle fillet
PCB-37	sport fish muscle fillet

Analyte	Matrix Type
PCB-38	sport fish muscle fillet
PCB-39	sport fish muscle fillet
PCB-41/40/71	sport fish muscle fillet
PCB-42	sport fish muscle fillet
PCB-43	sport fish muscle fillet
PCB-44/47/65	sport fish muscle fillet
PCB-45/51	sport fish muscle fillet
PCB-46	sport fish muscle fillet
PCB-48	sport fish muscle fillet
PCB-50/53	sport fish muscle fillet
PCB-52	sport fish muscle fillet
PCB-54	sport fish muscle fillet
PCB-55	sport fish muscle fillet
PCB-56	sport fish muscle fillet
PCB-57	sport fish muscle fillet
PCB-58	sport fish muscle fillet
PCB-59/62/75	sport fish muscle fillet
PCB-60	sport fish muscle fillet
PCB-61/70/74/76	sport fish muscle fillet
PCB-63	sport fish muscle fillet
PCB-64	sport fish muscle fillet
PCB-66	sport fish muscle fillet
PCB-67	sport fish muscle fillet
PCB-68	sport fish muscle fillet
PCB-69/49	sport fish muscle fillet
PCB-72	sport fish muscle fillet
PCB-73	sport fish muscle fillet
PCB-77	sport fish muscle fillet
PCB-78	sport fish muscle fillet
PCB-79	sport fish muscle fillet
PCB-80	sport fish muscle fillet
PCB-81	sport fish muscle fillet
PCB-82	sport fish muscle fillet
PCB-83/99	sport fish muscle fillet
PCB-84	sport fish muscle fillet

Analyte	Matrix Type
PCB-88/91	sport fish muscle fillet
PCB-89	sport fish muscle fillet
PCB-92	sport fish muscle fillet
PCB-94	sport fish muscle fillet
PCB-95/100/93/102/98	sport fish muscle fillet
PCB-96	sport fish muscle fillet
PCB-103	sport fish muscle fillet
PCB-104	sport fish muscle fillet
PCB-105	sport fish muscle fillet
PCB-106	sport fish muscle fillet
PCB-107/124	sport fish muscle fillet
PCB-108/119/86/97/125/87	sport fish muscle fillet
PCB-109	sport fish muscle fillet
PCB-110/115	sport fish muscle fillet
PCB-111	sport fish muscle fillet
PCB-112	sport fish muscle fillet
PCB-113/90/101	sport fish muscle fillet
PCB-114	sport fish muscle fillet
PCB-117/116/85	sport fish muscle fillet
PCB-118	sport fish muscle fillet
PCB-120	sport fish muscle fillet
PCB-121	sport fish muscle fillet
PCB-122	sport fish muscle fillet
PCB-123	sport fish muscle fillet
PCB-126	sport fish muscle fillet
PCB-127	sport fish muscle fillet
PCB-128/166	sport fish muscle fillet
PCB-130	sport fish muscle fillet
PCB-131	sport fish muscle fillet
PCB-132	sport fish muscle fillet
PCB-133	sport fish muscle fillet
PCB-134/143	sport fish muscle fillet
PCB-136	sport fish muscle fillet
PCB-137	sport fish muscle fillet
PCB-138/163/129/160	sport fish muscle fillet

Analyte	Matrix Type
PCB-139/140	sport fish muscle fillet
PCB-141	sport fish muscle fillet
PCB-142	sport fish muscle fillet
PCB-144	sport fish muscle fillet
PCB-145	sport fish muscle fillet
PCB-146	sport fish muscle fillet
PCB-147/149	sport fish muscle fillet
PCB-148	sport fish muscle fillet
PCB-150	sport fish muscle fillet
PCB-151/135/154	sport fish muscle fillet
PCB-152	sport fish muscle fillet
PCB-153/168	sport fish muscle fillet
PCB-155	sport fish muscle fillet
PCB-156/157	sport fish muscle fillet
PCB-158	sport fish muscle fillet
PCB-159	sport fish muscle fillet
PCB-161	sport fish muscle fillet
PCB-162	sport fish muscle fillet
PCB-164	sport fish muscle fillet
PCB-165	sport fish muscle fillet
PCB-167	sport fish muscle fillet
PCB-169	sport fish muscle fillet
PCB-170	sport fish muscle fillet
PCB-171/173	sport fish muscle fillet
PCB-172	sport fish muscle fillet
PCB-174	sport fish muscle fillet
PCB-175	sport fish muscle fillet
PCB-176	sport fish muscle fillet
PCB-177	sport fish muscle fillet
PCB-178	sport fish muscle fillet
PCB-179	sport fish muscle fillet
PCB-180/193	sport fish muscle fillet
PCB-181	sport fish muscle fillet
PCB-182	sport fish muscle fillet
PCB-183/185	sport fish muscle fillet

Analyte	Matrix Type
PCB-184	sport fish muscle fillet
PCB-186	sport fish muscle fillet
PCB-187	sport fish muscle fillet
PCB-188	sport fish muscle fillet
PCB-189	sport fish muscle fillet
PCB-190	sport fish muscle fillet
PCB-191	sport fish muscle fillet
PCB-192	sport fish muscle fillet
PCB-194	sport fish muscle fillet
PCB-195	sport fish muscle fillet
PCB-196	sport fish muscle fillet
PCB-197/200	sport fish muscle fillet
PCB-198/199	sport fish muscle fillet
PCB-201	sport fish muscle fillet
PCB-202	sport fish muscle fillet
PCB-203	sport fish muscle fillet
PCB-204	sport fish muscle fillet
PCB-205	sport fish muscle fillet
PCB-206	sport fish muscle fillet
PCB-207	sport fish muscle fillet
PCB-208	sport fish muscle fillet
PCB-209	sport fish muscle fillet

There are some details worth noting on the reporting of data on PCB congeners. The number of congeners analyzed has been increasing over the years. In 2022 the full suite of 209 congeners will be analyzed. The sums of PCBs reported will include all 209 congeners, with “not detected” values for individual congeners set to zero. For rigorous comparisons with past data a subset of common congeners can be used.

Table A. River stations to be sampled in 2022

Table A includes information on station locations, sampling history, and desired monitoring by the Central Valley Water Board, the Bioaccumulation Monitoring Program, and OEHHA.

Note Table A is split into two parts below: Station information and history and Desired monitoring. See the spreadsheet source file for full notations. Email Jay Davis (jay@sfei.org) to request a copy of the spreadsheet.

Station information and history

2011 Site No.	Station Code	Site Name	Site Notes	Site Latitude	Site Longitude	2011 Target Species	2011 Catch
14	508ADVSBB	Sacramento River at Bend Bridge Near Red Bluff	ranked high by Stienstra	40.25283	-122.2267	trout, pikeminnow, sucker	Rainbow Trout; Sacramento Sucker (TL3)
25	515FRUPYC	Feather River upstream Yuba City	important site for future Hg control program compliance	39.33486	-121.6323	largemouth bass, trout, striped bass	LMB
30	514ARSFCL	American River, South Fork at Coloma	ranked high by Stienstra	38.80123	-120.8898	trout	Sacramento Pikeminnow (TL4); Sacramento Sucker (TL3)
44	531ADVMOK	Mokelumne River (Mokelumne River FH)	Representative of steelhead/salmon in rivers.	38.2254	-121.0256	steelhead/ salmon	Chinook Salmon; Steelhead Rainbow Trout

2011 Site No.	Station Code	Site Name	Site Notes	Site Latitude	Site Longitude	2011 Target Species	2011 Catch
56	541MER522	San Joaquin River at Lander Avenue	ranked high by Stienstra	37.29528	-120.8503	trout, largemouth bass	LMB; Common Carp

Desired monitoring

2011 Site No.	Station Code	Central Valley Water Board Desired Catch	Central Valley Water Board Desired Analysis	BMP Desired Catch and Analysis	OEHHA Desired Analysis
14	508ADVSBB	Highest Waterbody Trophic Level Count: 8 Size: Legal Size or TL4 200-500 mm/TL3 150-500 mm	THg wet weight; individual or composite; skinless fillet	Follow BMP Table 4. Collect fish monitored previously; if present (pikeminnow [2006]; rainbow trout [2006, 2011]; Sacramento sucker [2006, 2011])	*Advisory is new, with a lot of species. Limited need for additional data.* Goldfish (n= 16, include PCBs), Hitch (n=13), Sacramento Perch (n=14), Splittail (n=16), Tule Perch (n=13)
25	515FRUPYC	Highest Waterbody Trophic Level Count: 8 Size: Legal Size or TL4 200-500 mm/TL3 150-500 mm	THg wet weight; individual or composite; skinless fillet	Follow BMP Table 4. Collect fish monitored previously; if present (largemouth [2011]; Sacramento sucker [2011])	Crappie (n=15), Carp (n=10. Include PCBs), Hardhead (n=15. Include PCBs), White Catfish (n=13. Include PCBs), Channel Catfish (n=11. Include PCBs), Any other species (but NOT Black Bass, Pikeminnow, Sucker, Sunfish) (n=20)

2011 Site No.	Station Code	Central Valley Water Board Desired Catch	Central Valley Water Board Desired Analysis	BMP Desired Catch and Analysis	OEHHA Desired Analysis
30	514ARSFCL	Highest Waterbody Trophic Level Count: 8 Size: Legal Size or TL4 200-500 mm/TL3 150-500 mm	THg wet weight; individual or composite; skinless fillet	Follow BMP Table 4. Collect fish monitored previously; if present (pikeminnow [2011]; Sacramento sucker [2011]). Include PCBs in sucker (10 ppb in 2011).	*No advisory. Ideal to sample at least 2 sites over 25 miles apart. Minimum of 3 species with n=20 needed.* Pikeminnow (n=15), Sucker (n=15. Include PCBs), Any other species (n=20)
44	531ADVMOK	Highest Waterbody Trophic Level Count: 8 Size: Legal Size or TL4 200-500 mm/TL3 150-500 mm	THg wet weight; individual or composite; skinless fillet	Follow BMP Table 4. Collect fish monitored previously; if present (Chinook [2011]; steelhead/rainbow [2012]). Include PCBs in chinook and steelhead (8 and 5 ppb in 2011 and 2012, respectively.	
56	541MER522	Highest Waterbody Trophic Level Count: 8 Size: Legal Size or TL4 200-500 mm/TL3 150-500 mm	THg wet weight; individual or composite; skinless fillet Selenium	Follow BMP Table 4. Collect fish monitored previously; if present (largemouth [2011]; carp [2011])	Bullhead (n=2), Pikeminnow (n=15), Striped Bass (n=16), Any other species (but NOT black bass, catfish, carp, sunfish, sucker;