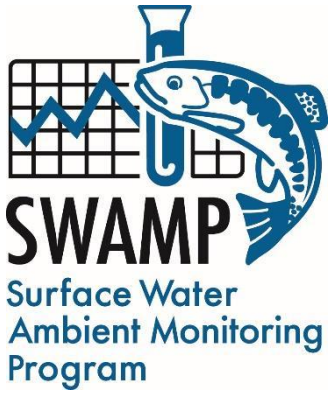

Surface Water Ambient Monitoring Program Bioaccumulation Monitoring Program Realignment

Monitoring and Analysis Workplan for the San Diego Region

December 2021

Acknowledgements

This Monitoring and Analysis Workplan was prepared by the Surface Water Ambient Monitoring Program (SWAMP) and the San Diego Regional Water Quality Control Board (R9) as part of the SWAMP Bioaccumulation Monitoring Program's Realignment efforts in the San Diego Region. The development of this Plan was guided by the San Diego Realignment Advisory Committee.

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Table of Contents

Acronyms and Abbreviations

The below table defines acronyms and abbreviations that are used throughout this document.

Acronym or Abbreviation	Definition
Committee	San Diego Realignment Advisory Committee
OC pesticides	Organochlorine (OC) pesticides
OEHHA	California Office of Environmental Health Hazard Assessment
PBDEs	Polybrominated Diphenyl Ethers
PCBs	polychlorinated biphenyls
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
Program	SWAMP Bioaccumulation Monitoring Program
QAPP	Quality Assurance Project Plan
SWAMP	Surface Water Ambient Monitoring Program
SWAMP IQ	SWAMP Information Management and Quality Assurance Center

Introduction

A key component of the Surface Water Ambient Monitoring Program (SWAMP) Bioaccumulation Monitoring Program Realignment Plan involves conducting targeted sampling in 2022 according to the recommendations of the San Diego Realignment Advisory Committee (Committee). This document presents a plan for sampling and analysis of fish and shellfish in a one-year effort (in 2022) to get a better understanding of contaminant levels in areas and species that are important for consumption, subsistence, and sustenance by traditionally underrepresented communities, as well as Tribal traditions, culture, and subsistence in the San Diego Region. The development of this Plan was guided by the Committee, and the work will be performed as part of the SWAMP Bioaccumulation Monitoring Program (Program).

Statewide SWAMP Bioaccumulation Monitoring

Since 2007, the Program and the Safe to Eat Workgroup have partnered to conduct surveys focused on collecting and analyzing fish tissue for mercury, legacy pesticides, and other bioaccumulated pollutants, such as PCBs (polychlorinated biphenyls), and assessing these data to provide insight into the safety of eating fish. These surveys have been conducted in lakes and reservoirs, rivers and streams, and coastal waters of California. The sampling and analysis conducted as part of the realignment effort in the San Diego region, as described in this Workplan, is intended to complement surveys that have already been conducted or are scheduled to be conducted by the Program on a statewide basis (Figure 1).

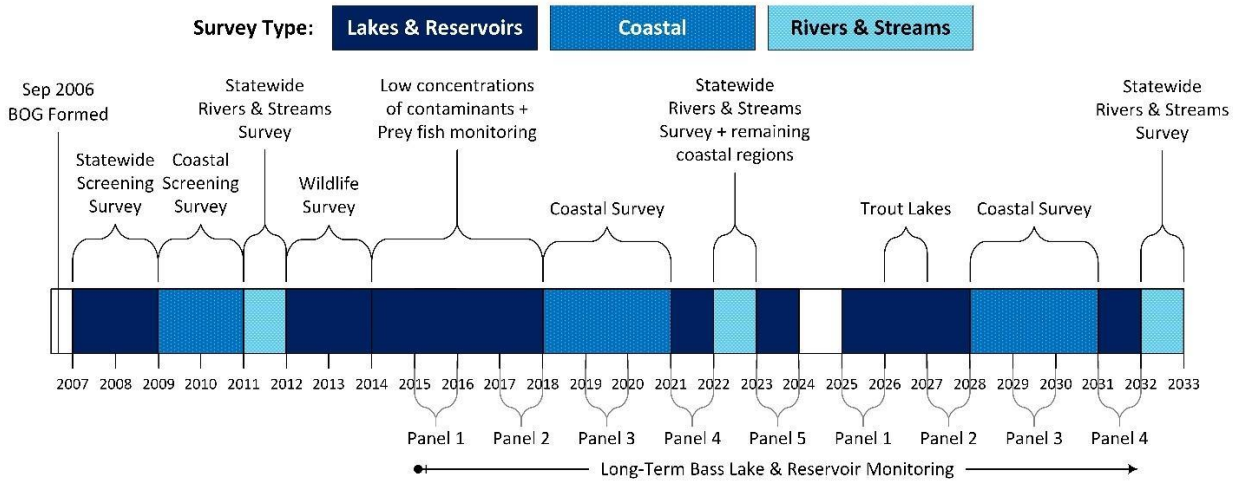


Figure 1. Statewide SWAMP Bioaccumulation Monitoring Schedule. Timeline of bioaccumulation monitoring surveys that have been and plan to be conducted by the Program and the Safe to Eat Workgroup in lakes and reservoirs, rivers and streams, and coastal waters of California.

Coordination

The Statewide Program regularly coordinates with other efforts to significantly leverage the monitoring and analysis funds and achieve a more thorough evaluation of bioaccumulation within California water bodies. For example, in 2022 the Central Valley Regional Water Quality Control Board has contributed funds to support monitoring of rivers and streams in their region and plan to use the data collected to inform the development of their river and stream Total Maximum Daily Loads (TMDL) and Impaired Water Bodies 303(d) Lists. Similar coordination will take place within the San Diego Region in 2022 whenever possible.

Sampling Design

Before each sampling season, the Program and the Safe to Eat Workgroup develop the sampling design by selecting the sampling sites, the types and size of fish, and the analyses to be conducted.

In 2022, the Program will focus its regularly scheduled statewide monitoring on completing the current coastal survey (focusing on the Central and North Coast regions) and initiating a second round of river and stream monitoring (focusing on the Central Valley). Quality Assurance Project Plans (QAPPs) have been developed for both the coastal survey (completed in 2018) and the statewide river and stream survey (completed in 2011). Each QAPP defines procedures and criteria that will be used for each respective project, such as criteria for data quality acceptability, procedures for sampling, testing (including deviations) and calibration, as well as preventative and corrective measures. The responsibilities of each agency or laboratory involved in each project are also defined.

Locations

Between 2007 and 2017, the Program conducted sampling of lakes, reservoirs, and coastal areas in the San Diego Region (Figure 2). During those years, no river or stream locations were sampled by the Statewide Program in the region, though the San Diego Regional SWAMP did targeted sampling along the San Diego River from 2013-2015. See Appendix 1 for results for the species with the highest average concentration of mercury in water bodies sampled by the Program in the San Diego region between 2007 and 2017. See Appendix 2 for results from the San Diego Regional SWAMP targeted sampling effort along the San Diego River between 2013-2015.

The Program has plans to sample five lakes in the San Diego Region in 2023 as part of the fifth set of lakes included in the Long-term Monitoring Survey: Cuyamaca Reservoir, Lake Henshaw, Lower Otay Reservoir, Miramar Reservoir, and Lake Murray. Cuyamaca Reservoir is one of the water bodies prioritized by the Committee (see the below Locations Section). Sampling for Cuyamaca Reservoir will be moved to 2022 so the results can be reported along with the other results of the Realignment sampling outlined in this document.

Figure 2. Water bodies sampled by the Program in the San Diego region between 2007 and 2017 (dark blue points). San Diego Regional Water Board boundary indicated by dashed line. Regions of the coastal zone sampled are highlighted in blue. Reservoirs scheduled for sampling in 2023 are indicated with an asterisk.

Species and Tissue Types

The Program has collected close to 100 different species during sampling of lakes, reservoirs, and coastal areas across the state. In the San Diego Region, species that are collected can be broken down by region and categorized into broad categories, as described in Table 1 below.

Table 1. Species regularly sampled in the San Diego Region.

Lakes	Bays	Ocean
Largemouth Bass	Spotted Bay Bass	Kelp/Sand Bass
Catfish species	Perch species	Rockfish species
Carp	Topsmelt	Mackerel species

During regular monitoring across the state, including in the San Diego Region, tissue samples are collected and analyzed in a manner that allows the Program's data to be used by the California Office of Environmental Health Hazard Assessment (OEHHA) to develop fish consumption advisories with the following assumptions:

- Consumption of fish and shellfish is at a rate consistent with recreation. This equates to approximately 1 - 4 servings per week depending on the person and the species they are consuming.
- Those consuming the fish are only eating the skinless fillet.
- Those consuming crustaceans are only eating the meat.
- Those consuming bivalves are eating all animal tissue.

Analytes

A suite of physical measurements or observations of fish that are collected at each sampling location are recorded, including:

- Total Length (mm; the length of a fish measured from the tip of the snout to the tip of the longer lobe of the caudal fin)
- Fork Length (mm; the length of a fish measured from the tip of the snout to the end of the middle caudal fin rays)
- Standard Length (mm; the length of a fish measured from the tip of the snout to the posterior end of the last vertebra; measurement for prey sized fish in the lakes studies only)
- Weight (g)
- Sex (sport fish only)
- Moisture (%)
- Lipid Content (%; when organics are analyzed)
- Collection Location (latitude/longitude)

The type of pollutant (henceforth referred to as analyte) selected for analysis during regularly scheduled statewide monitoring varies slightly for each survey and location. The general classes of analytes that are analyzed at each survey type are provided in Table 2.

Table 2. List of analytes analyzed during each type of survey, according to the most recent QAPP for the corresponding survey type. Not all pollutants listed below are measured in all surveys or in all locations. Rather, a suite of analytes is selected for each survey and location. Organochlorine pesticides are measured very infrequently.

		Survey Type		
Analyte Groups	**Analyte Class**	**Lake and Reservoir**	**Coastal**	**River and Stream**
Metals and metalloids	Total Mercury	X	X	X
	Total Selenium	X	X	X
	Total Arsenic	-	X[1]	-
PCBs	PCBs (polychlorinated biphenyls)	X	X	X
Organochlorine (OC) pesticides	Chlordanes	X	X	X
	Cyclodienes[2]	X	X	X
	DDTs (dichlorodiphenyltrichloroethane)	X	X	X
	HCHs (hexachlorocyclohexane)	X	X	X
	Other Pesticides[3]	X	X	X
PBDE	PBDEs (Polybrominated Diphenyl Ethers)	-	X[4]	-
Algal Toxins	Total Microcystins	-	-	X
	Anatoxin-a	-	-	X
	Cylindrospermopsin	-	-	X
	Saxitoxins	-	-	X
	BMAA (beta-N-methylamino-L-alanine)	-	-	-

1) The only Program samples analyzed for total arsenic were measured by Southern California Bight laboratories as part of the 2018 collaborative effort
2) Cyclodienes include: Aldrin, Dieldrin, Endrin
3) Other pesticides include: Dacthal, Endosulfan I, Hexachlorobenzene, Methoxychlor, Mirex, and Oxadiazon
4) The Program rarely analyzes samples for PBDEs

San Diego Region Realignment Sampling

In addition to the regularly scheduled statewide monitoring described above, the Committee has recommended and prioritized additional locations, species, tissue types, and analytes to be sampled in 2022. The Committee prioritized developing a better understanding of contaminant levels in areas and species that are important for consumption, subsistence, and sustenance by traditionally underrepresented communities, as well as Tribal traditions, culture, and subsistence within the San Diego Region.

Sampling Design

Locations

In addition to the locations that are planned to be sampled during regular statewide monitoring, the Committee has identified and prioritized ten locations that they would like to be sampled in 2022 (Table 3; Figure 3). More generally, the Committee requested sampling be prioritized in:

- Locations that do not require a license to fish (e.g. piers/jetties along the coast or in lagoons)
- Locations that represent urban rivers in lower portions of watersheds
- Areas of importance for environmental justice and equity

The Committee has also noted seven locations that are regularly sampled that are of high importance for consumption, subsistence, and sustenance in the region and should continue to be prioritized in future sampling (Figure 3). Finally, the Committee recommended sampling at the Salton Sea when the Realignment process is being conducted in the Colorado River Region.

Table 3. Priority classification for each of the locations that the San Diego Realignment Advisory Committee has identified as being important to sample in 2022.

Sampling Priority	High priority for sampling in 2022	Would like to be sampled but can be skipped if limited by budget or logistics
Lakes and Reservoirs	Cuyamaca Reservoir	Chollas Lake
Coastal Locations	Dana Point Harbor and Jetty Imperial Beach Pier Mission Bay Jetties Oceanside Harbor Oceanside Pier San Diego Bay	Agua Hedionda Effluent Jetties Agua Hedionda Lagoon Batiquitos Lagoon/Jetties Ocean Beach Pier Pacific Beach Pier San Clemente Pier Tijuana River Mouth

Sampling Priority	High priority for sampling in 2022	Would like to be sampled but can be skipped if limited by budget or logistics
River and Stream Locations	San Diego River Sweetwater River	Otay River Pine Valley Creek San Luis Rey River San Mateo Creek Trabuco Creek

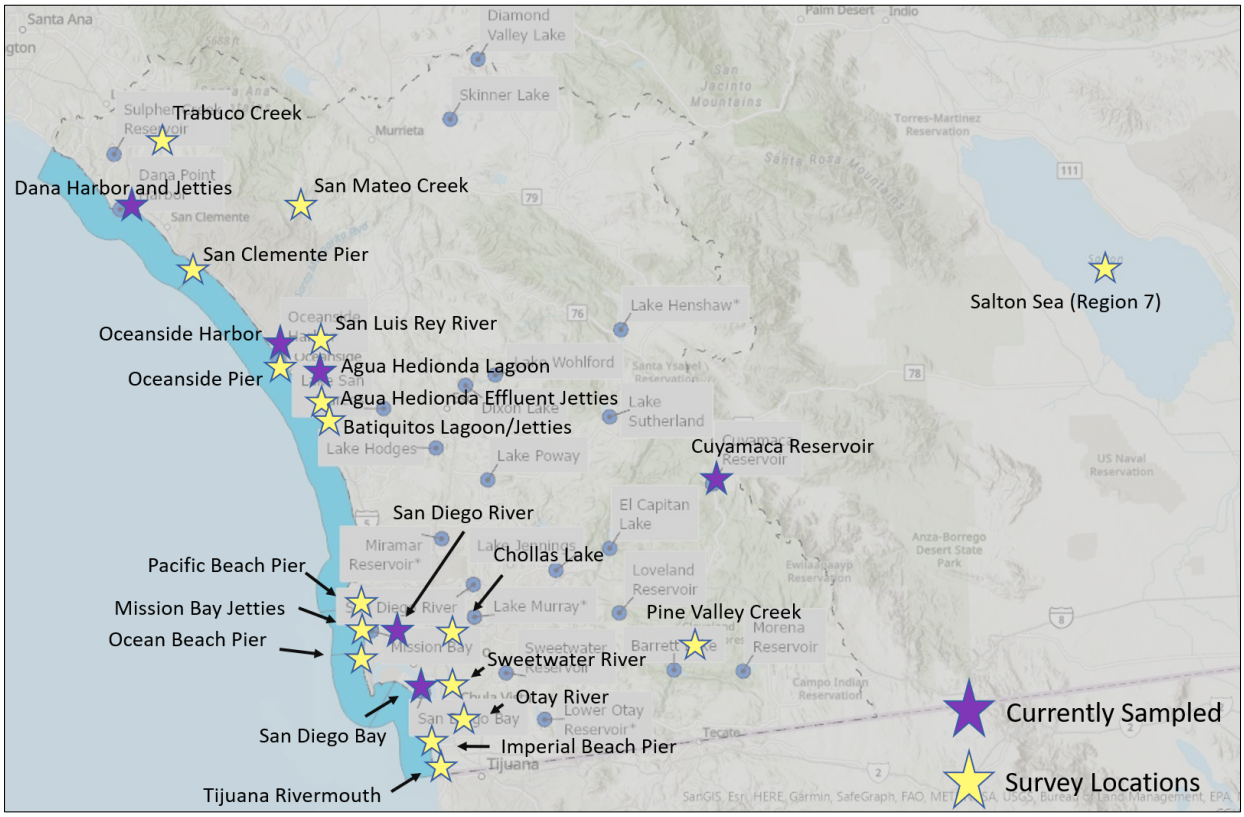


Figure 3. Water bodies identified by the San Diego Realignment Advisory Committee as being of importance for consumption, subsistence, and sustenance within the region. Yellow stars indicate locations that should be considered for sampling in 2022 (16 locations within the San Diego Region; one additional location in the Salton Sea). Purple stars indicate locations that should continue to be prioritized for longer term sampling in the region under the statewide program (6 locations). San Diego Regional Water Board boundary indicated by dashed line.

Species and Tissue Types

In addition to the species that are planned to be sampled during regular statewide monitoring, the Committee has identified and prioritized a number of additional species that they would like to be sampled in 2022 or some other time in the future as budgets allow (Table 4).

Additional species were identified as being of interest, but not recommended to be sampled for a multitude of reasons including: the species is not consumed, or it is threatened or endangered. These species included: Arroyo Chub, Rainbow trout, Southern California steelhead, Arroyo toad, and California coast range newt.

Table 4. Priority classification for each species that the San Diego Realignment Advisory Committee has identified as being important to sample in 2022.

Sampling Priority	**High priority for sampling in 2022**	**Would like to be sampled but can be skipped if limited by budget or logistics**
Species already included in statewide monitoring	Largemouth Bass Spotted Bay/Sand Bass Perch Species Topsmelt Kelp/Sand Bass Mackerel Species	Catfish Species Carp Rockfish Species
New species to be added to monitoring	Mussels Oyster Lobster	Sharks Sunfish species Bonito Crayfish

Moreover, the Committee recommends the Program work with OEHHA to determine the extent to which consumption advisories can be adapted or developed to include advisories for those who consume fish and shellfish at a rate and manner consistent with subsistence and sustenance by traditionally underrepresented communities, as well as Tribal traditions, culture, and subsistence (i.e., a rate that can be much greater than four servings per week for some communities). This will likely include future monitoring methods where tissue samples are collected and analyzed in a manner that represents consumption of tissue, skin, and organs (i.e., more than just a skinless filet).

Analytes

In addition to the analytes that are selected for analysis during regular statewide monitoring, the Committee has identified and prioritized a number of additional analytes that they would like to be sampled in 2022 or some other time in the future as budgets allow (Table 5).

The specifics regarding target species, size ranges, and processing instructions are provided as appendices for each survey type; see Appendix 3 for lake and reservoir locations, Appendix 4 for coastal locations, and Appendix 5 for river and stream locations.

Table 5. Priority classification for each analyte that the San Diego Realignment Advisory Committee has identified as being important to sample in 2022.

Sampling Priority	**High priority for sampling in 2022**	**Would like to be sampled but can be skipped if limited by budget or logistics**
Analytes already included in statewide monitoring	Mercury Selenium PCBs OC Pesticides Algal Toxins[1]	Arsenic PBDEs (rarely included in statewide monitoring)
New analytes to be added to monitoring	PFAS (Perfluoroalkyl and polyfluoroalkyl substances)[2]	Microplastics E. coli (Escherichia coli) Industrial waste products Solvents, household chemicals Motor oil, brake dust

1) Collect water samples and visual observations in combination with existing monitoring (See Appendix 7 for more details)
2) To be sampled at select locations as logistics and budget allow (i.e. not required at all locations in 2022)

It is important to note that fish species may have variable distributions within the region. To cope with this, the sampling crew will have a prioritized menu of several potential target species (Appendix 6). Primary target species will be given the highest priority. If primary targets are not available in sufficient numbers, secondary targets have been identified. Other species will also be observed in the process of fish collection. This "bycatch" will not be collected, but the sampling crew will record estimates of the numbers of each species observed. This information may be useful if follow up studies are needed at any of the sampled locations.

Quality Assurance

Wherever possible, the Program will follow sampling, analysis, and quality assurance procedures already defined in existing QAPPs. Coastal areas that are sampled as part of the realignment effort will follow the coastal survey QAPP (completed in 2018, and amended in 2020). Similarly, samples collected at rivers and streams will follow the river and stream QAPP (completed in 2011), and samples collected at lakes and reservoirs will follow the lake and reservoir QAPP (in development; to be completed in Oct 2021). Samples collected for cyanobacteria and algal toxins in lakes, estuaries, and streams will follow the SWAMP QAPP (2020) and the SWAMP standard operating procedure for collecting cyanobacteria and water for cyanotoxin measurements (2017). When different sampling or analysis procedures are needed for the 2022 realignment efforts, they will be described or referenced below.

Sample and Analysis Timing

Sampling will be conducted from approximately April through October 2022. Field crews will do their best to collect the targeted samples at all recommended sites, however low water levels in certain water bodies, fire and smoke in or near sampling locations, or other unforeseen circumstances may prevent field crews from collecting all samples in this plan.

After tissue samples are collected in the field, they will be sent to a laboratory (as defined in the appropriate QAPP) for analysis. It can take laboratories many months to process samples and send the results back to the Program; the exact amount of time this process takes depends on the pollutant to be analyzed. Once results are received from the laboratory, the SWAMP Information Management and Quality Assurance Center (SWAMP IQ) will conduct quality assurance and quality control checks of the data before submitting it into the SWAMP database. Data in the SWAMP database are publicly available via the California Environmental Data Exchange Network (CEDEN) database and the California Open Data Portal.

Products and Timeline

An interpretive report summarizing the 2022 sampling efforts and resultant data will be drafted by October 2023. The final report, incorporating revisions in response to Committee and reviewer comments, will be completed and released in December 2023.

Additional Recommendations

In addition to the recommended and prioritized locations, species, tissue types, and analytes listed above, the Committee has recommended the following for longer term discussion and consideration:

- The Committee requested a Native Monitor be present when sampling near creeks so they can ensure sampling is sensitive to cultural resources.
- In addition to the species considered in Table 4, Appendix 3, Appendix 4, Appendix 5, and Appendix 6, the Committee recommended the Program and partners consider assessing the safety of consuming non-animal species as they relate to tribal consumption and cultural purposes. For example, some individuals regularly consume kelp, seaweed, and cattail roots. It would be helpful if there was more guidance on the safety of consuming these types of species, especially in the context of algal toxin exposure.

Some recommendations that have been mentioned in other sections of this document but warrant highlighting again here include:

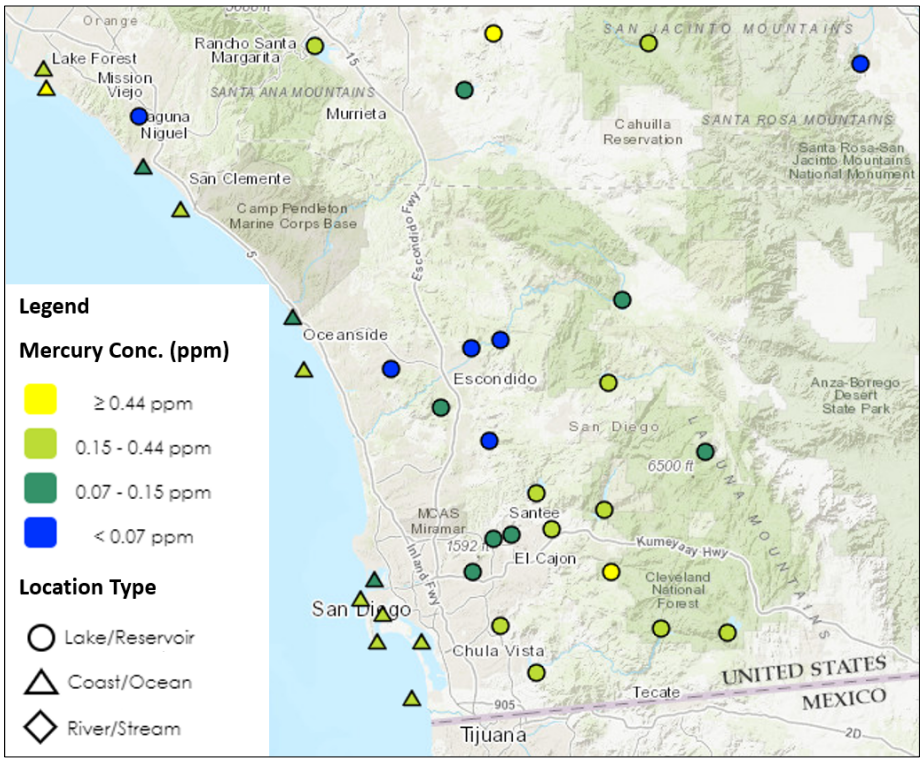
- The Committee recommended the Program work with OEHHA to determine the extent to which consumption advisories can be adapted or developed to include advisories for those who consume fish and shellfish at a rate and manner consistent with subsistence and sustenance by traditionally underrepresented communities, as well as Tribal traditions, culture, and subsistence (i.e., a rate that can be much greater than four servings per week for some communities). See the San Diego Realignment Species and Tissue Types Section for more details.
- The Committee recommended that the SWAMP Bioaccumulation Monitoring Program work with the SWAMP Freshwater and Estuarine Harmful Algal Bloom (FHAB) Program and OEHHA partners involved with FHAB response, monitoring, and research to determine the extent to which the SWAMP Bioaccumulation and FHAB Programs can partner to monitor, understand, and address FHABs as they relate to consumption of fish and shellfish in 2022 and into the future. See Appendix 7 for more details.

The logistics of addressing or implementing these recommendations will require multiple discussions, and long-term partnership and coordination between SWAMP teams as well as Tribal and agency partners (e.g. OEHHA, CDPH, CDFW).

Appendix

Appendix 1: San Diego Region highest average mercury concentrations, 2007 – 2017

Mercury results for the species with the highest average concentration are indicated by color, location types are indicated by shape. Screenshot from the [Safe to Eat Portal](#).



Appendix 2: San Diego River maximum observed tissue concentrations, 2013 – 2015

Maximum observed tissue concentration results from targeted sampling along the San Diego River from 2013-2015. Concentrations from skin-of fillets. Concentration units: µg/g ww = microgram/gram wet weight; ng/g ww = nanogram/gram wet weight. ND = No Data

Fish Species	Mercury (ug/g ww)	Total PCBs (ng/g ww)	Chlordanes (ng/g ww)	Diazinon (ng/g ww)	DDTs (ng/g ww)	Selenium (ug/g ww)
Brown Bullhead	0.045	3.7	0.653	ND	1.06	0.52
Bluegill	0.017	1	0.967	ND	0.902	1.52
Black Crappie	0.025	0.462	ND	ND	ND	0.62
Largemouth Bass	0.107	0.586	0.546	ND	1.1	0.96

Appendix 3: Target species, size ranges, and processing instructions – lakes/reservoirs

Target species, size ranges, and processing instructions for lake and reservoir sample locations. Species that have been identified as a priority by the San Diego Realignment Advisory Committee have been underlined. I - process as individuals. C - process as composites. 1 = first choice for PCBs and selenium or algal toxins. 2 = second choice for PCBs and selenium or algal toxins. Target sizes will be adjusted as necessary based on location-specific size limits to maintain a focus on legal sized fish.

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 1) Predators			
Black bass (largemouth, smallmouth, spotted)	I	2	2X(200-249), 2X(250-304), 7X(305-407), 3X(407-500)
Striped bass	I	2	2X(250-349), 2X(350-456), 7X(457-599), 3X(>600)
Group 2) Bottom feeders			
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)

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 3) Sunfish, tilapia, and others			
Bluegill	C	Selenium Only	5X(127-170)
Redear sunfish	C	Selenium Only	5X(165-220)
Black crappie	C	Selenium Only	5X(187-250)
Tilapia	C	Selenium Only	5X(235-314)
Green sunfish	C	Selenium Only	5X(119-159)

Appendix 4: Target species, size ranges, and processing instructions – coastal locations

Target species, size ranges, and processing instructions for coastal sample locations. Species that have been identified as a priority by the San Diego Realignment Advisory Committee have been underlined. I - process as individuals. C - process as composites. Target sizes will be adjusted as necessary based on location-specific size limits to maintain a focus on legal-sized fish.

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 1) Primary Target Species			
Kelp Bass	I, C	C	I: 3X(156-255), 3X(256-355), 5X(>356) C: >356
Barred Sand Bass	I, C	C	I: 3X(156-255), 3X(256-355), 5X(>356) C: >356
Spotted Sand Bass	I, C	C	I: 3X(156-255), 3X(256-355), 5X(>356) C: >356
Shiner Surfperch	C	C	20X(> 100)
Gopher Rockfish	I	C	3X(141-191), 3X(191-241), 5X(> 241)
Lingcod	I	C	3X(359-458), 3X(459-558), 5X(> 559)
White Croaker	C	C	5X(> 189)
Chub Mackerel	C	C	5X(> 260)
Jacksmelt	C	C	5X(> 227)

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 2) Secondary Target Species			
Scorpionfish	C	C	5X(> 254)
Blue Rockfish	C	C	5X(> 251)
Brown Rockfish	I	C	3X(159-209), 2X(209-259), 5X(> 259)
Copper Rockfish	C	C	5X(> 352)
Vermillion Rockfish	C	C	5X(> 355)
Spotfin Croaker	C	C	5X(> 189)
Yellowfin Croaker	C	C	5X(> 230)
Barred Surfperch	C	C	5X(> 160)
Walleye Surfperch	C	C	5X(> 150)
White Surfperch	C	C	5X(> 173)
Topsmelt	C	C	5X(> 150)
Leopard Shark	I	C	3X(914-1074), 4X(1074-1234), 3X(> 1234)
Spiny Dogfish	C	C	3X(> 867)

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Brown Smoothound	C	C	3X(> 610)
Gray Smoothound	C	C	3X(> 580)
California Halibut	C	C	3X(> 574)
Halfmoon/Opaleye	C	C	5X(> 200)
Kelp Greenling	C	C	5X(> 305)
California Sheephead	C	C	5X(> 305)
Group 3) Shellfish[1]			
California Mussel	C	C	10X(> 50)
Pacific Oyster	C	C	10X(> 50)
California Spiny Lobster	I	C	5X(> 82.55 carapace length)

1) Not all shellfish species will be collected in all coastal survey locations due to logistics, availability, or budget constraints. If a subset must be collected for any of these reasons, California Mussel and California Spiny Lobster will be prioritized for coastal locations and Pacific Oyster and California Spiny Lobster will be prioritized for coastal embayments.

Appendix 5: Target species, size ranges, and processing instructions – rivers/streams

Target species, size ranges, and processing instructions for river and stream sample locations. Species that have been identified as a priority by the San Diego Realignment Advisory Committee have been underlined. 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. 1 = first choice for PCBs and selenium or algal toxins. 2 = second choice for PCBs and selenium or algal toxins. Target sizes will be adjusted as necessary based on location-specific size limits to maintain a focus on legal sized fish.

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 1) Predators			
Black bass (largemouth, smallmouth, spotted)	I*	2	2X(200-249), 2X(250-304), 7X(305-407), 3X(>407)
Striped bass	I*	2	2X(250-349), 2X(350-449), 7X(450-599), 3X(>600)
Group 2) Bottom feeders			
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)

Fish Species	Process for Mercury	Process for PCBs and Selenium	Number of individuals to be collected (Corresponding size range; mm)
Group 3) Shellfish[1]			
Crayfish	I	C	5X(adults)

1) Crayfish may not be collected in all survey locations due to logistics, availability, or budget constraints.

Appendix 6: Target species, size ranges, and processing instructions – by each location

Lake and Reservoir Locations

Chollas Lake

Water body type: lake and reservoir

Location (lat, lon): 32.736940, -117.063567

Size Category: Small (one sampling location)

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 3 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeders: (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Sunfish, tilapia, and others: Mercury, Selenium
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A sample size of 9 for each species is sufficient for this water body.

Cuyamaca Reservoir

Water body type: lake and reservoir

Location (lat, lon): 32.9886, -116.582 (907CUYRES)

Size Category: Small (one sampling location)

Past Program Sampling: 2016; contaminant concentrations were low

Sampling Priority: High priority for 2022; In Panel 5 of long-term bass lake monitoring plan; will sample in 2022 instead of 2023

Target species and analyses (see Appendix 3 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Sunfish, tilapia, and others: Mercury, Selenium
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Coastal Locations – High Priority for 2022

Dana Point Harbor and Jetty

Water body type: coastal

Location (lat, lon): 33.4583, -117.697 (90110DANA)

Past Program Sampling: SWAMP/BIGHT 2009, 2018

- Samples collected in 2018 were from within the Harbor and Jetty
- Species sampled at this location previously include: white croaker and shiner surfperch (Primary Target Species, 2009); barred sand bass, chub mackerel, white croaker, shiner surfperch, and spotted sand bass (Primary Target Species, 2018); and opaleye, spotfin croaker, topsmelt, and white surfperch (Secondary Target Species).

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (oyster and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data; recommend PCBs be analyzed in all samples collected from this location. Current data gaps include:

- California Corbina: Collect a minimum of 7 fish for Mercury; run PCBs
- Cortez Bonefish: Collect a minimum of 5 fish for Mercury; run PCBs
- Pacific Mackerel (PCBs only): Collect a minimum of 5 fish for PCBs

Imperial Beach Pier

Water body type: coastal

Location (lat, lon): 32.579564, -117.137282

Past Program Sampling: None; Sampling in existing coastal zone (Tijuana to North Island [91001TJNI]) is very nearby offshore

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs, OC Pesticides, PBDEs
- Group 2) Secondary Target Species: Same analyses as Primary
- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, PCBs, OC Pesticides, PBDEs, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location is covered by OEHHA's Statewide Advisory for Eating Fish from California Coastal Locations without Site-Specific Advice, so any data collected will be evaluated for use in a potential future update.

Mission Bay Jetties

Water body type: coastal

Location (lat, lon): 32.758897, -117.255620

Past Program Sampling: None; Sampling in existing coastal zone (Point Loma to La Jolla [90605PLLJ]) is very nearby offshore

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs, OC Pesticides, PBDEs
- Group 2) Secondary Target Species: Same analyses as Primary
- Group 3) Shellfish (mussel or oyster, lobster): Methylmercury, Selenium, PCBs, OC Pesticides, PBDEs, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Oceanside Harbor

Water body type: coastal

Location (lat, lon): 33.209, -117.401 (90208OCNH)

Past Program Sampling: SWAMP/BIGHT 2009, 2018

- Species sampled at this location previously include: white croaker, barred sand bass, and spotted sand bass (Primary Target Species), and white surfperch, spotfin croaker, yellowfin croaker, queenfish (Secondary Target Species).

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium
- Group 3) Shellfish (oyster and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data. Current data gaps include:

- California Corbina: Collect a minimum of 8 fish for Mercury; run PCBs
- Queenfish: Collect a minimum of 5 fish for Mercury
- Spotfin Croaker: Collect a minimum of 1 fish for Mercury
- White Croaker: Collect a minimum of 5 fish for Mercury

- Surfperch Species: Collect a minimum of 3 fish for Mercury; run PCBs
- Yellowfin Croaker: Collect a minimum of 6 fish for Mercury; run PCBs
- Other species not listed above: Collect a minimum of 9 fish for Mercury; run PCBs

Oceanside Pier

Water body type: coastal

Location (lat, lon): 33.193133, -117.386341

Past Program Sampling: None

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium
- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

San Diego Bay

Water body type: coastal

Location (lat, lon): North (32.7123, -117.222, 91203SDNB), South (32.6679, -117.144, 91202SDSB), other various shoreline sites

Past Program Sampling: R9 Lobster 2015, SWAMP/BIGHT 2009, 2018, R9 Oysters 2018/19

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)

- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (oyster and lobster): Mercury, Selenium, PCBs, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data. Current data gaps include:

- Halibut: Collect a minimum of 5 fish for Mercury; run PCBs
- Lobster (of legal size): Collect a minimum of 5 lobsters for Mercury; run Selenium and PCBs
- Other species not in advisory (e.g. sea basses, other croakers, Shortfin Corvina, Bonito, Bat Ray): Collect a minimum of 9 fish for Mercury; run PCBs

Coastal Locations – Other

Agua Hedionda Effluent Jetties

Water body type: coastal

Location (lat, lon): 33.138073, -117.340210

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Agua Hedionda Lagoon

Water body type: coastal (saltwater)

Location (lat, lon): 33.144327, -117.340997

Past Program Sampling: None, Regulatory Sampling for Commercial Shellfish Operation

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (mussel or oyster, lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data. Current data gaps include:

- Diamond Turbot: Collect a minimum of 5 fish for Mercury; run PCBs
- Other species (not Diamond Turbot or surfperch): Collect a minimum of 9 fish for Mercury; run PCBs

Batiquitos Lagoon/Jetties

Water body type: coastal (saltwater)

Location (lat, lon): 33.087255, -117.312904

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (mussel or oyster, lobster): Methylmercury, Selenium, Algal Toxins

- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Ocean Beach Pier

Water body type: coastal (saltwater)

Location (lat, lon): 32.748156, -117.255435

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Pacific Beach Pier

Water body type: coastal (saltwater)

Location (lat, lon): 32.795916, -117.258417

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs

- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

San Clemente Pier

Water body type: coastal (saltwater)

Location (lat, lon): 33.419103, -117.621072

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)
- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (mussel and lobster): Methylmercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: None.

Tijuana River Mouth

Water body type: coastal (saltwater)

Location (lat, lon): 32.567000, -117.133016; mouth of the Tijuana River north of the Tijuana River State Marine Conservation Area

Past Program Sampling: SWAMP/BIGHT 2018

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 4 for full list of species and analyses):

- Group 1) Primary Target Species: Mercury, Selenium, PCBs (if secondary target species is not available)

- Group 2) Secondary Target Species: Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, Algal Toxins
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location (river) has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A sample size of 9 for each species is sufficient for this water body.

River and Stream Locations – High Priority for 2022

San Diego River (Lower)

Water body type: river and stream

Location (lat, lon): Various from 32.761289, -117.203745 (downstream) to 32.884282, -116.814821 (upstream)

Past Program Sampling: R9 Sampling 2014 - Mission Trails to Santee

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data. A minimum of two sites (9 individuals from each site for n=18 total) at least 25 miles apart be sampled for this location, as practicable. Current data gaps include:

- Crappie Species: Collect a minimum of 17 fish for Mercury
- Bullhead Species: Collect a minimum of 13 fish for Mercury
- Common Carp: Collect a minimum of 4 fish for Mercury
- Black Bass Species: Collect a minimum of 14 fish for Mercury

Sweetwater River (Lower and Middle)

Water body type: river and stream

Location (lat, lon):

- Lower (32.657307, -117.079772) to Sweetwater Reservoir
- Middle: Sweetwater Reservoir to (32.741968, -116.927951)
- Note: golf courses above upper middle waypoint have intermittent flow and tribal land is above golf courses.

Past Program Sampling: None

Sampling Priority: High priority for 2022

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A minimum of two sites (9 individuals from each site for n=18 total) at least 25 miles apart be sampled for this location, as practicable.

River and Stream Locations – Other

Otay River

Water body type: river and stream

Location (lat, lon): 32.590464, -117.090145 to 32.593540, -116.957808. Mostly a series of ponds that connect during high flows. Might be best to sample ponds near the downstream end for mass loading purposes.

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has some existing useful data. Current data gaps include:

- Bullhead Species: Collect a minimum of 8 fish for Mercury; run PCBs
- Sunfish Species: Collect a minimum of 2 fish for Mercury
- Black Bass Species: Collect a minimum of 1 fish for Mercury

Pine Valley Creek

Water body type: river and stream

Location (lat, lon): From I-8 Freeway Overpass (32.823560, -116.559994) to 32.837797, -116.540491; Pine Valley Creek is mostly intermittent except for one perennial stretch with stickleback.

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators:
    - Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
    - Trout: Mercury, Selenium, PCBs (if bass or a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs

- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A sample size of 9 for each species is sufficient for this water body.

CDFW Notes: Rainbow trout and unarmored three spine stickleback are the current species that have been documented at this location. This area has been severely harmed by drought conditions; therefore, the rainbow trout population is extremely small and should not be put under additional stress from sampling. Additionally, since the unarmored three spine stickleback are listed as endangered, CDFW will not sign off on any sampling or take of this species.

San Luis Rey River

Water body type: river and stream

Location (lat, lon): Lower: I-5 Freeway (33.206847, -117.384474) to I-15 Freeway (33.324559, -117.157816). River upstream is largely intermittent and on private/tribal lands. Lower section is a mix of intermittent and perennial with ponds.

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A minimum of two sites (9 individuals from each site for n=18 total) at least 25 miles apart be sampled for this location, as practicable.

San Mateo Creek

Water body type: river and stream

Location (lat, lon): 33.472927, -117.468180 to 33.556242, -117.398349. Intermittent with permanent pools. Upstream is intermittent while downstream is a federal military base. Note endangered southern California steelhead may be present.

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)
- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A sample size of 9 for each species is sufficient for this water body.

Trabuco Creek

Water body type: river and stream

Location (lat, lon): From (33.490609, -117.665990) to (33.659314, -117.586564). Intermittent and perennial sections of stream. Upstream portion is within the USFS and has stocked rainbow trout. Note the endangered southern California steelhead may be present in the lower sampling reach.

Past Program Sampling: None

Sampling Priority: Would like to be sampled but can be skipped if limited by budget or logistics

Target species and analyses (see Appendix 5 for full list of species and analyses):

- Group 1) Predators: Black Bass or other predators: Mercury, Selenium, PCBs (if a bottom feeder is not available)

- Group 2) Bottom feeder (catfish, carp, bullhead, sucker): Mercury, Selenium, PCBs
- Group 3) Shellfish (Crayfish): Mercury, Selenium, PCBs
- FHAB) Collect water samples for surveillance in combination with existing monitoring (see Appendix 7, Phase 1 for more details)

OEHHA Notes & Requests: Sample location has little to no existing useful data; recommend sampling at least 3 commonly consumed species. A sample size of 9 for each species is sufficient for this water body.

Appendix 7: Algal Toxin Context and Recommendations

Background

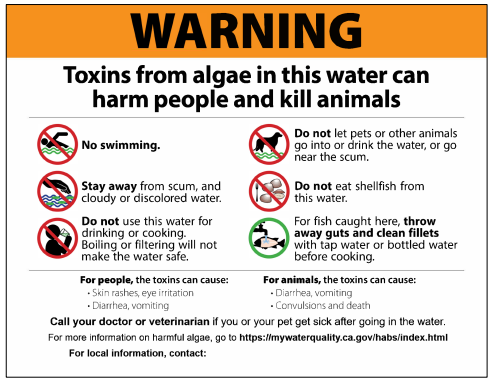
While the San Diego Regional Water Boards has conducted sampling in response to harmful algal blooms (HABs) in the region, the Bioaccumulation Monitoring Program has never attempted to collect water or tissue samples for analysis of algal toxins. Discussions with the San Diego Realignment Advisory Committee have made it very clear that HABs are of concern to the communities they represent, and Committee members recommended the Program consider conducting such analyses in 2022 and into the future.

This Appendix was developed in partnership with the Freshwater and Estuarine Harmful Algal Bloom (FHAB) Program and California Office of Environmental Health Hazard Assessment (OEHHA) partners involved with FHAB response, monitoring, and research so that their expertise and experience would inform how the SWAMP Bioaccumulation and FHAB Programs partner to monitor, understand, and address FHABs as they relate to consumption of fish and shellfish in 2022 and into the future.

Algal Toxin Advisories and Monitoring Context

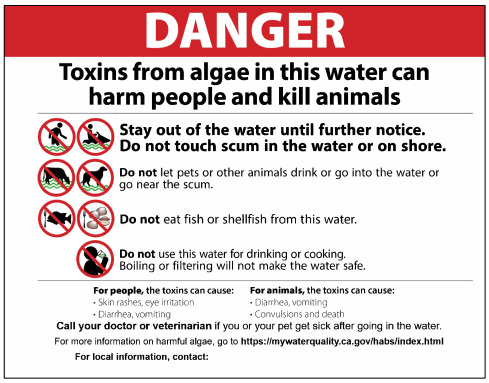
HAB Advisories

The OEHHA fish consumption advisories that the Bioaccumulation Monitoring Program and San Diego Realignment Advisory Committee are most familiar with do not include guidance pertaining to HABs. Research (albeit limited) suggests that fish fillet cyanotoxin concentrations will decrease rapidly by depuration after cyanotoxin concentrations in water decrease or fish are removed from exposure (Dyble et al., 2011; Schmidt et al., 2014). The mismatch between the non-persistent nature of cyanotoxin compounds and the existing timeframes of current OEHHA fish consumption advisory development for persistent chemicals such as mercury and PCBs, make it very difficult for OEHHA to develop "traditional" fish consumption advisories for HABs.



California's harmful algal bloom (HAB) advisories do include guidance for fish and shellfish consumption. Advisory selection criteria are based on water concentration of cyanotoxins and/or visual indicators of

cyanobacteria and according to California's voluntary guidance for Response to HABs in Recreational Inland Waters. When water cyanotoxin concentrations exceed thresholds and trigger a Caution or Warning advisory, the consumption of fish viscera (i.e. internal organs) and shellfish is not recommended. Fish tissue (i.e. fillets) should be cleaned with tap water or bottled water before cooking. When water cyanotoxin concentrations exceed thresholds and trigger a Danger advisory, consumption of fish viscera, fish fillets, and shellfish is not recommended.



HAB Monitoring

Currently, there are no standardized or consistent procedures for collecting and analyzing fish tissues for HABs. This is mainly due to current questions around the overall feasibility of conducting sampling and analysis for such non-persistent compounds, general logistical limitations, and historical SWAMP budget limitations. The enactment of Assembly Bill 834 (AB 834, 2019) formalized the SWAMP FHAB Program and allocated funds to support statewide assessment, monitoring, and research of FHABs, among other objectives.

The 2021 Framework and Strategy for FHAB Monitoring includes recommendations for three special studies (SS16-18) related to analytical methods for tissue analyses, shellfish cyanotoxins, and toxin accumulation/depuration rates. The FHAB Program will fund some components of these special studies, focused on fish tissue collection and lab analytical methods beginning in 2022. In addition to these special studies, the FHAB Program will also be working with partners to develop standardized fish tissue collection and lab analysis procedures in late 2022. The standardized fish tissue collection and lab analysis procedures will be informed with research and expert guidance, and could include combining discrete water samples and/or deployment of Solid Phase Adsorption Toxin Tracking (SPATT) passive sampling devices with collection and analysis of fish and/or shellfish tissue.

It is important to note that algal toxin concentrations are variable during a single day, at depth, and across a waterbody. Therefore, any future fish consumption advisory from OEHHA would likely be based on the water column toxin concentration and risk based assumptions of the accumulation of toxins in tissue (similar to California's current HAB advisories). Future fish consumption advisories pertaining to HABS would likely not be based on fish tissue data since it may not appropriately estimate the health risk due to variable cyanotoxin production in impacted water bodies. Moreover, the collection of HAB tissue data needed to develop robust advisories is so resource intensive that it can become logistically and budgetarily prohibitive. The current FHAB Program hypothesis is that a combination of water samples and visual indicators collected

following the procedures to assess water recreation risk, will likely be a better determination of tissue health risk than frequent (every 2 - 4 weeks) fish tissue monitoring.

Despite historic and current limitations, OEHHA and the FHAB Program have provided some recommendations for HAB monitoring that should be considered if sampling does occur before standardized fish tissue collection and lab analysis procedures are available (i.e. after 2022):

- A minimum of 2 or more months prior to fish collection - Submit proposed study design to FHAB Program for review
    - To meet OEHHA data needs to evaluate fish consumption advisories for algal toxins, it is critical to submit the proposed study design for cyanotoxins in fish tissues to the FHAB Program for review and feedback as soon as study design discussions begin - the earlier, the better. Effective study designs will need to include the strategic collection of water quality monitoring data preceding fish collection and tissue analysis (see below, timeframes may include 1-4 weeks prior to collection).
    - If cyanotoxins sampling and analysis will be included in the sampling plan, be sure to consider previous studies related to the location and analysis if samples (e.g. coastal confluences and SoCal streams; Fetscher et al, 2015), as well as the HAB Incident Reports Map for historical occurrences of HABs. Note that benthic cyanobacteria can occur in locations with higher flow, lower nutrients, and better water clarity than planktonic cyanobacteria. Coastal confluences may have a greater proportion of dissolved cyanotoxins with cyanobacteria lysing if salinity exceeds thresholds for that taxa.
    - Members of the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network have submitted FHAB fish tissue data to OEHHA without undergoing this review process, with incomplete fish metadata, various analytical methods, and no water quality testing - these data were insufficient to evaluate fish consumption safety.
- 3 - 4 weeks prior to fish collection - Conduct visual monitoring
    - Visual monitoring up to one month before fish collection is ideal to understand the length of a cyanobacteria bloom prior to fish collection. Bloom presence and duration of bloom can be documented by visual monitoring at shorelines on the windward side and opposite side for visual indicators of a cyanobacteria bloom. For more information, see the FHAB standardized procedures.
- 3 weeks - 7 days prior to fish collection - Collect water samples
    - OEHHA recommends monitoring at least two times prior to fish collection to determine potential impacts to fish tissue by documenting algal bloom presence,

duration of bloom, and toxin production. Potential toxin production by the algal community can be determined by (1) microscopy of water samples to determine taxa, or (2) quantitative polymerase chain reaction (qPCR) of toxin genes. Toxin presence in a waterbody can be measured by deployment of a SPATT passive sampling device for up to 14 days.

- SPATT devices are small, light, and need to remain submerged during deployment. SPATT devices are commonly attached to a structure (dock) in the water or submerged and attached to a metal pole (rebar and chain) that is attached to the lake/stream bed. Retrieval of the SPATT device is the least time intensive part of the process and SPATT samples can be stored in a cooler along with water samples and then frozen to extend holding time.
- Analysis of SPATT devices provides data on the relative abundance of dissolved toxins in the system during the deployment, whereas qPCR of toxin genes provides data on the potential toxin production by the community of cyanobacteria near the water surface.
- Conducting water monitoring prior to fish collection will inform which cyanotoxins are present in each system so that the lab analysis of tissues can be done strategically and better inform public health.

- Day of fish collection
  - Retrieve SPATT devices or collect water samples and analyze by microscopy and qPCR of toxin genes.

- Water and Tissue Analysis Considerations
  - The FHAB Program routinely measures four classes of cyanotoxins in water using the enzyme linked immunosorbent assay (ELISA) method to quantify total microcystins, anatoxin-a and homoanatoxin, cylindrospermopsin, and saxitoxins, which costs approximately $500 per sample.
  - In 2018 Flores et al. concluded that the HAB community needs comprehensive and uniform detection methods of analysis of cyanotoxin in fish and shellfish matrices due to differing results for the level of cyanotoxins in fish tissue depending on the type of tissue (fillet, viscera) and lab analysis methods (Flores et al., 2018). The FHAB Program is aware of numerous publications of improved lab analysis methods for certain classes of cyanotoxins in tissues with contrasting quality control results for toxin extraction efficiencies, recoveries of standards, and more quality objectives. However, a robust review of these recent methods to determine the current best practice is not available and the FHAB Program will fund some tasks with partners beginning in 2022 to meet this need.

- A further complication of lab analysis of tissues is the chemistry of cyanotoxins in these complex matrices (i.e. fish and shellfish tissues). While much of the research has been focused on microcystins, cyanotoxins are found in tissues as both free toxin and protein-bound to the tissue. The free toxins are readily analyzed by lab analysis methods; however, the bound toxins are connected by strong covalent bonds that are difficult to break without destroying the toxin prior to analysis. The proportion of bound toxin compared to free toxin is uncertain so lab analysis methods with robust extraction efficiencies are critical to measure the risk to public health - especially since mammals metabolize both free and bound fractions (Cadel-Six et al., 2014; Lepoutre et al., 2020).
- More research is available for microcystin analysis in fish tissue, US EPA has conducted special studies that are yet to be published with favorable quality control results supporting the use of two methods to measure both fractions of toxins.
    - US EPA method 546 by ELISA and the MMPB (3-methoxy-2-methyl-4-phenylbutyric acid) by tandem mass spectrometry (Foss et al., 2015).
    - Note that the following analytical methods still need to undergo research to confirm their efficacy: Anatoxin-a, cylindrospermopsin, Saxitoxin, BMAA (beta-N-methylamino-L-alanine).
    - Tissue preparation for cyanotoxin analysis should separate viscera and fish fillet to enable analysis on each portion individually.

Monitoring and Analysis Recommendations

It is unclear if the current timeline and budget of the Bioaccumulation Monitoring Program will allow for the rapid turn-around between water sampling and FHAB advisory development (on the order of days) and the frequency of water sampling needed to account for rapidly changing FHAB/toxin conditions within each water body (recommend bi-weekly during an active FHAB if possible and no longer than one month after the end of a FHAB).

With these potential logistical and budgetary constraints in mind, the FHAB Program recommends the Bioaccumulation Monitoring Program use a phased approach to integrate FHAB sampling and analysis into their monitoring and analysis work plans:

- PHASE 1: Collect water samples for surveillance in combination with existing monitoring.
    - Collect a minimum of one sample at the shoreline, one sample at open water, and visual observations described on the field data sheet. Samples collected along the shoreline should be opportunistically sampled at beaches where water contact recreation is allowed. If collecting shoreline samples is not feasible, opportunistic samples should be collected at the boat dock. The field data sheet from the FHAB

Program is available for download or fields to collect visible observations of HAB indicators can be integrated into the existing Bioaccumulation Monitoring Program field data sheet. The water samples will be submitted to the FHAB contracted lab for HAB tiered analysis (microscopy, qPCR, cyanotoxins) for baseline data.

- PHASE 2: Deploy a SPATT passive sampling device for up to two weeks (14 days) before fish are collected and retrieved upon regular Bioaccumulation Monitoring Program monitoring.
    - The deployment of SPATT devices can be in collaboration with the Regional Water Boards to assist with deployment and/or retrieval based on sampling schedules. SPATT deployment should align with existing Bioaccumulation Monitoring Program monitoring plans and site selection.

- PHASE 3: Implement the most appropriate lab analysis methods and tissue process procedures for the monitoring questions at hand.
    - As a reminder, the procedures to assess water recreation risk detail how to collect water and SPATT samples and the FHAB Program will be working with partners to develop standardized fish tissue collection and lab analysis procedures in late 2022.

    - The standardized fish tissue collection and lab analysis procedures will be informed with research and expert guidance, and could include combining discrete water samples and/or deployment of SPATT devices with collection and analysis of fish and/or shellfish tissue.

For the 2022 Monitoring and Analysis Workplan for the San Diego Region, the FHAB Program recommends limiting the scope of FHAB sampling to PHASE 1 as described above (i.e. collect water samples for surveillance in combination with existing monitoring.)