OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Protocol for Fish Sampling and Analysis to Support the Development of Fish Advisories in California

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
BOG	Bioaccumulation Oversight Group (now called the 'Safe to Eat Workgroup')
CalEPA	California Environmental Protection Agency
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
COC	chain of custody
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
EFSA	European Food Safety Authority
FL	fork length
GPS	Global Positioning System
ID	identification
MeHg	methylmercury
mm	millimeter
MPSL	Marine Pollution Studies Laboratory
OEHHA	Office of Environmental Health Hazard Assessment
OSPR	Office of Spill Prevention and Response
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PE	petroleum ether
ppb	parts per billion
SOP(s)	standard operating procedure(s)
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
US EPA	United States Environmental Protection Agency

PREFACE

The Office of Environmental Health Hazard Assessment (OEHHA), a department in the California Environmental Protection Agency, is responsible for evaluating potential public health risks from chemical contamination of sport fish.[1] This includes issuing fish consumption advisories, when appropriate, for the State of California. OEHHA's authorities to conduct these activities are based on mandates in the:

- California Health and Safety Code
  - Section 59009, to protect public health
  - Section 59011, to advise local health authorities
- California Water Code
  - Section 13177.5, to issue health advisories

The health advisories are published in the California Department of Fish and Wildlife Sport Fishing Regulations booklet in the section on public health advisories.

This document is an update to the 2005 guidance for a fish sampling and analysis plan to support the development of fish consumption advisories. This document can be used by agencies or other entities who wish to conduct fish sampling that is suitable for OEHHA to develop fish consumption advisories.

[1] Sport fish includes all fish and shellfish caught from California waters for non-commercial purposes (e.g., recreational, tribal/cultural, and subsistence practices).

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INTRODUCTION

The Office of Environmental Health Hazard Assessment (OEHHA), a department within the California Environmental Protection Agency (CalEPA), is responsible for issuing fish[2] consumption advisories for fish caught and consumed by recreational, subsistence, and tribal fishermen[3] and their families.[4] Fish consumption advisories are guidelines that recommend how often you can safely eat fish caught from California water bodies. Fish contaminant monitoring for persistent chemicals, particularly polychlorinated biphenyls (PCBs) and mercury, has been conducted in California for many years and, as a result, OEHHA has been able to develop site-specific advisories for more than 130 water bodies. Additionally, statewide advisories have been developed for coastal areas, anadromous species, and lakes and reservoirs without site-specific advice. While fish consumption advisories historically have emphasized high-contaminant fish, providing consumption advice for low-contaminant fish that can be eaten in quantities likely to provide health benefits is also a priority.

The United States Environmental Protection Agency (US EPA) published a series of four guidance documents to assist states with the development of fish consumption advisories. The first document, *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis (Third Ed.)* (US EPA, 2000) provides advice on how to develop a fish contaminant monitoring program. In 2005, OEHHA published a California-specific sampling and analysis protocol based on that document. Since that time, the Surface Water Ambient Monitoring Program[5] (SWAMP) of the State Water Resources Control Board (SWRCB) has published sampling and analysis plans for several fish contaminant monitoring projects, which are designed, in part, to collect data that can be used in the development of fish consumption advisories. The purpose of this document is to provide updated general sampling recommendations that are specific to fish advisories, particularly for local agencies or organizations that do not have established sampling programs, while referring to other more detailed guidance documents, as appropriate. Users of this document should also refer to the latest SWAMP sampling and analysis plans, as applicable.

Future sampling should be focused on increasing the number of water bodies with site-specific advisories and the number of fish and shellfish species that can be included in new and updated advisories. Consultation with OEHHA is recommended for agencies and organizations that plan to conduct fish sampling and analysis for the purpose of fish

[2] The general term “fish” refers to any finfish, shellfish, or other aquatic invertebrate species.
[3] The term “fishermen” is considered gender neutral.
[4] Information regarding OEHHA’s fish advisory program can be found online at: https://oehha.ca.gov/fish/advisories
[5] Information about the Surface Water Ambient Monitoring Program can be found online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/

consumption advisory development to ensure that collected samples will be suitable to meet those goals. This document addresses the following topics:

- Target water bodies
- Target species
- Target analytes
- Sample collection
- Sample handling and documentation
- Sample preparation
- Chemical analyses
- Data submission

This document does not include information on sampling and analysis for generally non-persistent contaminants like cyanotoxins or marine biotoxins, or for oil spill response.

TARGET WATER BODIES

Water bodies (sites) are selected for sampling depending on the goals of the sampling program or organization. It is desirable that data be collected so that OEHHA can provide site-specific advice for as many species at as many water bodies as possible. Site selection may be prioritized by considering the following factors:

- Accessibility and popularity for fishing, including tribal or subsistence fishing
- Proximity to known pollution sources
- Water bodies listed as impaired by an Advisory Tissue Level (ATL) chemical for beneficial uses related to fish consumption under the Clean Water Act
- Water bodies in areas with high CalEnviroScreen scores[6]
- Water bodies where high contaminant levels have been found in fish with limited prior sampling
- Water bodies expected to be low in contaminants to provide options for safer fish consumption

OEHHA conducts an annual review of fish contaminant data that have been uploaded to the California Environmental Data Exchange Network (CEDEN) to determine water bodies that have sufficient data to develop or update an advisory. Accordingly, OEHHA can assist agencies or organizations to identify and prioritize target water bodies based on previous sampling results.

[6] CalEnviroScreen is a mapping tool that identifies communities with a higher pollution burden and is available online at: https://oehha.ca.gov/calenviroscreen/about-calenviroscreen.

TARGET SPECIES

Species are targeted for sampling based on the following factors:

- Recreational, subsistence, or tribal importance
- Higher contaminant species
- Lower contaminant species

Fish species legally[7] caught and consumed for recreational, subsistence, and tribal purposes should be prioritized for sampling. Fishing information can be obtained from water body managers, the California Department of Fish and Wildlife (CDFW), local fishermen, sport fishing organizations, and creel surveys. The CDFW Fishing Guide website (https://apps.wildlife.ca.gov/fishing/) is another resource to locate potential species. To identify tribally-important species, appropriate representatives from tribes that may consume fish from the water bodies of interest should be contacted prior to sampling. The California Environmental Protection Agency's (CalEPA) Tribal Consultation Protocol[8] provides a starting point for identifying tribes on a county level (see "Appendix B - List of California Native American Tribes by County"). As recommended in the protocol, the Native American Heritage Commission should be contacted for the most updated list. OEHHA may also assist with contacting tribal representatives.

OEHHA considers both the risks and benefits of fish consumption when developing advice. Thus, targeting lower contaminant species is also a priority, particularly those that contain high levels of omega-3 fatty acids (eicosapentaenoic acid plus docosahexaenoic acid levels ≥ 0.5 grams/100 grams tissue), such as Rainbow Trout. These species can provide a healthier alternative for fish consumers.

OEHHA can assist agencies or organizations to identify and prioritize target species based on previous sampling results. OEHHA encourages collection of as many species as possible from a water body and will include all species that are collected in sufficient numbers and appropriate sizes in its site-specific advisories. Appendix I lists anadromous, freshwater, and marine species that are typically collected by monitoring programs in California. This list provides information regarding suggested analytes and legal/edible sizes for each species (see discussion in the "Sample Collection" section).

FINFISH

Finfish are collected and analyzed by various monitoring programs in far greater numbers than are shellfish or other aquatic invertebrates. Thus, most fish

[7] CDFWs fishing regulations for legal seasons, size limits, and catch methods is available online at: https://wildlife.ca.gov/Regulations.
[8] CalEPA's Tribal Consultation Protocol is available online at: https://calepa.ca.gov/wp-content/uploads/sites/6/2020/03/CalEPA-Tribal-Consult-Protocol_200220_Final_a.pdf.

advisories in California have been issued for marine, freshwater, or anadromous finfish. Predatory and bottom-feeding fish are recommended as target species due to their propensity to accumulate contaminants via the food web and the benthic and epibenthic environments, respectively (US EPA, 2000). In California, longer-lived predatory species such as shark, black bass, Striped Bass, Sacramento Pikeminnow, and White Sturgeon tend to accumulate high concentrations of mercury. They may also accumulate organic contaminants, such as PCBs, in environments where these chemicals are found. Bottom-feeding fish, such as catfish, carp, and goldfish, are known to take up organic contaminants but can also accumulate high mercury levels as they age. Large Channel Catfish collected from Lake Natoma[9], for example, had sufficiently high mercury levels to result in "do not eat" advice for both population groups[10] (OEHHA, 2021).

Based on analysis of statewide data, typically lower contaminant fish that should be analyzed include Rainbow Trout, small (16 inches or less) Brown Trout, bullhead species, and small sunfish species in freshwaters; small flatfish and surfperch species in marine environments; and Steelhead Trout, American Shad, and Chinook Salmon in anadromous waters. Note that review of California data shows that Chinook Salmon contain, on average, about four times more mercury when found in a lake or reservoir compared to anadromous waters, even though they are approximately half the length. Thus, Chinook Salmon should be collected and analyzed when they are found in landlocked water bodies so that appropriate advice for this species can be provided. OEHHA does not recommend targeting (especially recently) stocked fish because their contaminant levels are expected to be considerably lower than resident fish and may not best represent contaminant levels for a species in a water body.

OEHHA evaluates several freshwater species as two distinct species groups: black bass species (Largemouth, Redeye, Smallmouth, or Spotted) and sunfish species (Bluegill, Green Sunfish, Pumpkinseed, or Redear Sunfish). Any combination of fish within these species groups can be used to meet the minimum sample size requirement for the group (e.g., usually nine for lakes and reservoirs). There are similar groupings of rockfish and surfperch species for marine waters (OEHHA, 2016). OEHHA may combine other related species (e.g., Brown and Black Bullhead, White and Channel Catfish, Black and White Crappie, or Goldfish and Carp), if data indicate that it is appropriate for a water body.

[9] https://oehha.ca.gov/fish/advisories/lake-natoma

[10] Population groups are defined in fish advisories as the sensitive population (women 18 to 49 years and children 1 to 17 years), and the general population (women 50 years and older, and men 18 years and older).

SHELLFISH

Shellfish, such as shrimp, clams, crab, crayfish, mussels, oysters, and lobsters, tend to be lower in mercury than many finfish species and, thus, they are recommended by the US Food and Drug Administration as a lower mercury seafood option.[11] When shellfish are harvested and consumed from a water body, mercury analysis should be conducted in these species. At water bodies where PCBs, PBDEs, legacy pesticides, or selenium may be contaminants of concern, particularly in enclosed bays with current or historical industrial activities, analyzing these additional contaminants should also be considered. As shellfish species are known to accumulate cadmium, OEHHA also recommends that cadmium analysis be conducted for shellfish species. These data could be incorporated into advisories if OEHHA develops an ATL for cadmium in the future (see description in the following paragraph). OEHHA encourages the collection of more shellfish in monitoring programs, including invertebrate species such as Sea Cucumber and Sea Urchin.

TARGET ANALYTES

OEHHA develops ATLs for chemicals considered to be of potential concern for people who eat fish because of their toxicity and ability to accumulate in fish tissue. ATLs are chemical levels in fish tissue that are considered acceptable, based on chemical toxicity, for a range of consumption rates. Development of the ATLs also includes consideration of health benefits associated with including fish in the diet (OEHHA, 2008).

To date, OEHHA has developed ATLs for chlordanes, dichlorodiphenyltrichloroethane and its metabolites (DDTs), dieldrin, mercury, polybrominated diphenyl ethers (PBDEs), PCBs, selenium, and toxaphene (OEHHA, 2008, 2011) (Table 1). Detailed discussion of the toxicity of these chemicals is presented in the respective ATL documents. If OEHHA determines other chemicals to be of potential concern, additional ATLs may be developed. Analytical methods used must be sufficiently sensitive to support evaluation at ATL concentrations.

[11] https://www.fda.gov/food/consumers/advice-about-eating-fish

TABLE 1. ADVISORY TISSUE LEVELS FOR SELECTED ANALYTES

Contaminant	Consumption Frequency Categories (8-ounce servings/week)[1] and ATLs (in ppb)							
	7	6	5	4	3	2	1	0
Chlordanes	≤80	>80–90	>90–110	>110–140	>140–190	>190–280	>280–560	>560
DDTs	≤220	>220–260	>260–310	>310–390	>390–520	>520–1,000	>1,000–2,100	>2,100
Dieldrin	≤7	>7–8	>8–9	>9–11	>11–15	>15–23	>23–46	>46
Methylmercury (Women 18–49 and children 1–17)	≤31	>31–36	>36–44	>44–55	>55–70	>70–150	>150–440	>440
Methylmercury (Women ≥50 and men ≥18)	≤94	>94–109	>109–130	>130–160	>160–220	>220–440	>440–1,310	>1,310
PBDEs	≤45	>45–52	>52–63	>63–78	>78–100	>100–210	>210–630	>630
PCBs	≤9	>9–10	>10–13	>13–16	>16–21	>21–42	>42–120	>120
Selenium	≤1000	>1,000–1,200	>1,200–1,400	>1,400–1,800	>1,800–2,500	>2,500–4,900	>4,900–15,000	>15,000
Toxaphene	≤87	>87–100	>100–120	>120–150	>150–200	>200–300	>300–610	>610

[1] Serving sizes (prior to cooking, wet weight) are based on an average 160-pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts. ATL concentrations are in wet weight.

OEHHA evaluates all chemicals measured in edible fish tissue for which ATLs have been developed. The chemical that results in the most restrictive advice for a species at a water body is referred to as the chemical "risk driver." More than one risk driver may be responsible for the advice provided at a water body, depending on the species or fish-consuming population group. Risk drivers for OEHHA fish consumption advisories at the time of publication of this report are presented in Table 2. Mercury is the risk driver for one or more species for either population group in the vast majority of advisories (97%), followed by PCBs (40%) and, in a few cases, selenium, PBDEs, or some legacy pesticides (organochlorine pesticides that are no longer used but remain in the environment).

For the sensitive population (women 18–49 years and children 1–17 years), the combined effects of mercury, PCBs, and/or DDTs may also be a risk driver, even if the

concentrations of the individual chemicals are relatively low. For this reason, it is important to analyze PCBs and other secondary contaminants when indicated.

TABLE 2. CURRENT CHEMICAL RISK DRIVERS FOR OEHHA FISH CONSUMPTION ADVISORIES

Chemical Risk Driver	Percent of Advisories[1]
Mercury	97
PCBs	40
Selenium	8
DDTs	4
Dieldrin	2
PBDEs	1

[1]Based on 137 advisories as of July 2022.

MERCURY

As noted above, mercury is the contaminant that results in the highest number of fish consumption advisories in California. Mercury is a risk driver for at least one species in almost all advisories, including marine, estuarine, and freshwater environments. As such, mercury should be analyzed in all fish and shellfish sampled. Although the toxicity value (i.e., "reference dose") developed for mercury-related toxicity associated with fish consumption is based on the more toxic form, methylmercury (MeHg) (US EPA, 2001) and not total mercury, measuring total mercury in tissues is considerably less expensive than methylmercury analysis. The total mercury to methylmercury ratio in fish tissue varies, based on factors such as species and location (Bloom, 1992; Lasorsa and Allen-Gil, 1995). Other forms of mercury that may be found in fish or shellfish also have adverse effects and these forms can be accounted for with different methods used to calculate exposure and risk (EFSA, 2012). However, US EPA recommends analyzing total mercury as a health protective measure in fish monitoring programs, with the assumption that all mercury in fish tissue is in the form of methylmercury (US EPA, 2000); OEHHA supports this approach.

POLYCHLORINATED BIPHENYLS (PCBS)

PCBs are the second most likely contaminant to impact fish consumption advice in California. PCBs are more commonly found near urban areas but may be sporadically elevated in other water bodies as a result of leaks or spills. PCB analysis is very expensive, however, and analysis is not justified for all species at all locations. Because PCBs often accumulate in sediments and because of their feeding habits, catfish and Common Carp are the freshwater species most likely to have been analyzed for PCBs and the most likely to have PCB concentrations that impact advice in existing California advisories. Nonetheless, numerous other freshwater species such as black bass, goldfish, Kokanee, Sacramento Pikeminnow, Sacramento Sucker, and sunfish have had PCB concentrations that impact advice in one or more advisories. For freshwater species, OEHHA recommends that PCBs should be measured in catfish, carp, and/or

other bottom feeding species in all water bodies unless previous sampling has shown that PCBs do not impact advice. Black bass and trout species can serve as alternatives if bottom feeding species are not available.

Historical contaminant data can be found in CEDEN. If possible, aliquots of additional sampled species should be archived until the PCB results for bottom feeder species are available in the event that concentrations are high enough to warrant analyses in other species. When PCBs are detected in bottom feeding species in a water body, OEHHA can provide advice on the likelihood of PCBs impacting advice in other species. For example, if mercury concentrations in a species are near, but do not exceed, the "do not consume" threshold for the sensitive population, even modest PCB concentrations may push the overall consumption recommendation to "do not consume." Thus, when this is the case, it is important to determine PCB concentrations in these species in water bodies where PCBs are found.

In most California coastal environments, excluding bays and estuaries, PCBs have only been a driver for a small number of species (Corbina and certain surfperch species); however, in an area of southern California with known PCB contamination, PCBs drive risk (alone or in combination with mercury) in the majority of marine species tested (OEHHA, 2009). In California bays and estuaries, PCBs drive risk in nearly half of the species tested. For coastal, estuarine, and anadromous waters, it is recommended to consult with OEHHA on the need for PCB analysis.

SELENIUM

Selenium has been analyzed in at least one species in more than half of the water bodies with existing fish consumption advisories. Unlike all other chemicals for which OEHHA has developed ATLs, selenium is an essential nutrient. Fish and shellfish are considered good sources of selenium in the diet. Thus, selenium's presence in fish is expected and generally not of concern. However, there are some areas of California where high levels of selenium associated with agricultural drainage water caused death and deformity in aquatic birds (Ohlendorf et al., 1988) and the potential for excessive selenium exposure in humans (Fan et al., 1988). Fish and wildlife consumption advisories were put in place at that time.

As of the writing of this report, selenium is a risk driver in only eleven site-specific fish consumption advisories. All are located (wholly or partially) in Imperial County, with the exception of Palmdale Lake in Los Angeles County. Typically, selenium is higher and mercury is lower in fish in Imperial County and, for that reason, selenium is more likely to be a risk driver in this area of California than in other parts of the state. Nonetheless, selenium levels in these areas are not especially high – in only one advisory (Ferguson Lake[12]) is the selenium-based advice more restrictive than two meals per week.

[12] https://oehha.ca.gov/advisories/ferguson-lake

In recent years, there has also been considerable scientific interest in the potential role of selenium in the mitigation of mercury toxicity, which has been proposed to occur through a variety of mechanisms (Burger and Gochfeld, 2013; Cusack et al., 2017; Ganther et al., 1972; Kuras et al., 2018; Ralston, 2008; Spiller, 2018). It has been suggested that a selenium to mercury molar ratio greater than one in fish may provide protection against mercury toxicity in fish consumers (Ralston et al., 2016, 2019). Selenium to mercury ratios have been calculated for a variety of freshwater and marine fish species in a variety of locations (Burger and Gochfeld, 2013; Cusack et al., 2017; Kehrig et al., 2013; Ulusoy et al., 2019). At the present time, however, there is an inadequate understanding of the potential interaction between selenium and mercury to incorporate selenium to mercury ratios into fish consumption guidance (Burger and Gochfeld, 2013; Cusack et al., 2017; Gerson et al., 2020). Selenium analysis of sportfish has been included as part of a long-term bioaccumulation monitoring plan for California lakes and reservoirs in the event that the information proves useful in the future (Davis et al., 2022).

PBDEs and Pesticides

PBDEs have been analyzed in at least one species in about 30 percent of the California water bodies with existing advisories, including more than half of the counties in various regions of the state. In recent years, the production and use of these compounds has been phased out in the United States (US EPA, 2017) and PBDE levels in fish have generally declined since that time (Gandhi et al., 2017; Sutton et al, 2014; Zhou et al., 2019). To date, PBDEs have only impacted advice for one species in one fish advisory (Sacramento Sucker in the Sacramento River), based on data that were collected more than 10 years ago. California statewide monitoring programs no longer routinely analyze PBDEs in fish unless they are specifically requested. Based on previous sampling results and declining levels, OEHHA does not recommend PBDE analysis in fish species collected for the purpose of advisory development.

Organochlorine legacy pesticides (chlordanes, DDTs, dieldrin, and/or toxaphene) have been analyzed in at least one species in about 75 percent of the California water bodies with existing advisories. DDTs and dieldrin are the only pesticides that are currently found at levels that impact fish consumption advice and only in a small number of water bodies. This is consistent with national trends for decreasing organochlorine pesticide concentrations in fish tissue (Connor et al., 2007; Davis et al., 2007; Mahmood et al., 2013; West et al., 2017; Zhou et al., 2018). California statewide monitoring programs no longer routinely analyze organochlorine pesticides in fish unless they are specifically requested. OEHHA recommends screening an indicator fish species (e.g., catfish and Common Carp) for organochlorine pesticides in previously untested water bodies, particularly if there has been historical organochlorine production use, or documented contamination in the watershed. If a legacy organochlorine pesticide is a risk driver in an existing advisory for that water body, analysis of the chemical(s) should continue in subsequent sampling efforts.

SAMPLE COLLECTION

SAMPLING TIMING

To the extent possible, sampling should take place during the time of year when fishing or harvesting pressure is the greatest for the targeted species (US EPA, 2000). If organics will be analyzed and legal fishing and harvesting is allowed, August to October is the best sampling time because the lipid content of fish (and, thus, concentration of organics) tends to be highest during this period (US EPA, 2000). Samples should only be collected during periods that are legal for recreational fishing or harvesting of each target species at a water body in order to best represent human exposure to fish contaminants (US EPA, 2000).

SAMPLING LOCATIONS

The number of sampling locations needed will depend on the type and size (area or length) of the water body. Table 3 shows the minimum number of sampling locations recommended for advisory development, based on water body type and size. However, if a localized source of contamination is known for a water body, targeted sampling in that location can provide the most health protective advice. The recommended minimum number of sampling locations for lakes and reservoirs ranges from one (for water bodies less than 500 hectares[13]), to a range of two to four (for water bodies greater than 5000 hectares) (Davis et al., 2019, Appendix II). The number of sampling sites for rivers and creeks should be based on river characteristics, such as width, depth, flow, species presence, passage restrictions (e.g., above and below dams), and accessibility. OEHHA recommends at least one sampling location for each species per 25-mile segment. For bays and estuaries, the number of sampling locations is size-dependent and, for the open coast, OEHHA recommends sampling from three or more CDFW commercial fishing blocks,[14] depending on the range of the species.

OEHHA recommends consulting with Regional Water Board staff, CDFW wildlife officers, and local water body managers to determine sampling location criteria, such as described in Davis (2019):

- Areas of fishing activity
- Known areas of contamination or bioaccumulation potential (e.g., near areas of mining discharge)

[13] One hectare equals 2.47 acres.

[14] CDFW commercial fishing blocks ("blocks" in this report) are approximately 10 x 10 nautical-mile areas, denoted by specific 3-digit numbers, that commercial fishermen or captains of Commercial Fishing Passenger Vessels (CPFV) use to report the location of their catch. Maps of the commercial fishing blocks are available under "California Fisheries Charts".

TABLE 3. RECOMMENDED MINIMUM NUMBER OF SAMPLING LOCATIONS AND INDIVIDUALS PER SPECIES PER WATER BODY

Water Body Type	Water Body Size (Hectare)	Recommended Minimum Number of Sampling Locations	Recommended Minimum Number of Individuals per Species per Water Body
Lake/Reservoir[1]	<500	1	9
	500 – 1000	2	10
	1000 – 5000	2 – 4	10 – 20
	>5000	2 – 4	10 – 20
Rivers/Creeks	n/a	1 per 25-mile segment	3 – 9 per 25-mile segment
Estuaries/Enclosed bays	n/a	Size dependent	Size dependent
Open coast	n/a	3 blocks	10 per block

[1] Davis et al., 2019.
n/a – not applicable.

SAMPLE SIZE

OEHHA has general requirements for the number of fish to be collected for a predefined area (i.e., sample size or "n") to support the development of fish consumption advisories, which are based on recommendations by Bonnema (2017) and US EPA (2000). The minimum recommended number of individuals per species for each water body type is listed in Table 3. To develop an advisory for small- to moderate-sized enclosed water bodies (i.e., lakes or reservoirs), OEHHA generally requires at least nine individuals per species and at least three species. When the number of sampling locations is two or greater, the recommended minimum number of individuals per species per sampling location decreases from nine individuals to five per site (with a minimum of at least 10 individuals per water body). Additional sampling locations increase confidence in mean tissue contaminant levels. For relatively short rivers and creeks (25 to 50 miles), a minimum of nine individuals per species is recommended. As river length increases, the number of individuals per segment can be reduced. Exceptions for the number of species required are made for water bodies with lower species diversity (e.g., high elevation lakes, rivers, and creeks that may contain only trout). Exceptions for the number of individuals per species may be made if it results in more health protective advice than would otherwise be given (e.g., providing advice based on PCBs, rather than mercury, even though a composite of fewer than 9 fish were analyzed for PCBs). For longer rivers and larger lakes and bays, additional samples are recommended. In such circumstances, it is important to collect samples from multiple areas within a lake or bay or from multiple segments ("reaches") of a river. For the development of statewide or regional advice for coastal marine species, OEHHA requires at least 10 individuals from each of at least three locations (comprising three separate commercial fishing blocks). Relatively small species, including some shellfish, may require a larger number of

individuals in order to obtain adequate tissue for analysis (see the “Sample Preparation” section below).

Fish and Shellfish Size

CDFW has stipulated legal size limits for certain species, which may differ among water bodies (e.g., black bass). The current California freshwater or saltwater sport fishing regulations should be checked when developing a sampling plan to determine which species and sizes are legal to catch at that water body. For species that do not have legal size limits, OEHHA has determined minimum “edible” sizes (the typical size at maturity). Legal or “edible” size limits are shown in Appendix I for anadromous, freshwater, and marine species. Fish length should be recorded in total length, except when legal size is determined in fork length (FL) (e.g., White Sturgeon). Shellfish should be measured as described in the CDFW fishing regulations. Rays should be measured as disc width (wing tip to wing tip).

In most instances, OEHHA does not include in their assessments samples that are below these minimum sizes, including composites that contain one or more individuals that are below the minimum length. Mercury is well known to increase in fish as they grow (Davis et al., 2008; Gewurtz et al., 2011; Sackett et al., 2013). The relationship between length and PCB concentration is not as well established, but does hold for some species (Gewurtz et al., 2011). The use of undersized fish in the development of fish consumption advisories would likely underestimate the mercury or PCB exposure for the typical fish consumer. OEHHA recommends targeting larger fish of a species from a water body in order to provide appropriate health protective advice.

Field Collection Procedures

Target species may be collected by a variety of methods, depending on species and habitat, including electrofishing, seines, trawls, hook and line, nets, grabs, traps, scoops, scrapers, and rakes (US EPA, 2000). Collection of samples that are free from field-related contamination requires extensive planning and preparation. Common sources of field contamination include sampling gear, boat or tool grease, engine exhaust, dust, and ice used for cooling (US EPA, 2000). Polypropylene and polyethylene surfaces may contaminate samples to be analyzed for organics and should be avoided (BOG, 2020). Samples should be handled with disposable nitrile gloves that are changed between samples. OEHHA refers the reader to more detailed guidance on field collection procedures, such as the Marine Pollution Science Laboratory (MPSL)[15] Standard Operating Procedures (SOPs) (BOG, 2020, Appendix III) and Bonnema (2017).

[15] The Marine Pollution Studies Laboratory (MPSL) is associated with San Jose State University (SJSU) and Moss Landing Marine Laboratory (MLML).

SAMPLE HANDLING AND DOCUMENTATION

Sample handling and documentation will depend, in part, on the goals of the sampling program. Various state and regional monitoring programs may be required to follow specific protocols and SOPs, such as MPSL-102a (included in Davis et al., 2019, Appendix 3 and BOG, 2020). The following discussion includes selected information from MPSL-102a, and OEHHA and OSPR (2020), but focuses on the minimum needs of data collected for the purpose of developing fish advisories.

General Field Processing Methods

Once samples have been collected, they should be identified by a qualified expert and measured in the field, recording weight and total length[16] in a manner that prevents contamination (BOG, 2020; Davis et al., 2019). If total length is recorded in the field, each fish must be uniquely identified (e.g., Floy Tags or individually-labeled bags) so that the sample can be matched with chemistry results. All individual samples from each collection site should be packaged as described in Table 4. The sealed plastic bags, with sample labels and chain-of-custody forms as described below, should be transported to the laboratory on ice or dry ice in an ice chest.

Large finfish may be partially processed in the field to conserve shipping and storage space (MPSL-102a). If ancillary data, such as sex, are to be collected, it should be done when the fish is initially dissected in the field. (Note, exposed tissue must not be used in the analytical sample.)

[16] MPSL protocols also request fork length measurements.

TABLE 4. SAMPLE PACKAGING METHODS BY ORGANISM TYPE[1]

Organism	Trace Metals[2]	Synthetic Organics[3]
Bivalves	Double bag in plastic zipper-closure bags	Wrap in PE[4]-cleaned aluminum foil (dull side to the sample) and then double bag in plastic zipper-closure bags
Crustaceans	Double bag in plastic zipper-closure bags	Double bag in plastic zipper-closure bags
Finfish	Wrap whole or proportioned, if necessary, in aluminum foil (dull side to the sample) and then double bag in plastic zipper-closure bags	Wrap in PE[4] cleaned aluminum foil (dull side to the sample) and then double bag in plastic zipper-closure bags

[1] Excerpted from BOG, 2020, Appendix IIIB; MPSL-102a.
[2] Includes mercury and selenium.
[3] Includes chlordanes, DDTs, dieldrin, PBDEs, and PCBs.
[4] Petroleum ether.

PHOTO DOCUMENTATION

Photo documentation is helpful if questions later arise relating to sample identification. OEHHA recommends that photographs be taken at each collection site. These could include a photograph of the Global Positioning System (GPS) unit showing the site latitude and longitude, upcoast or upstream, downcoast or downstream, seaward and landward, and/or right bank and left bank of the sampling site, or using cardinal directions, as appropriate. If species identification is in question, a photograph should be taken of the sample on foil next to a scale for size reference.

SAMPLE LABELING

The sample identification (ID), site name, date and time of collection, sampler, and latitude and longitude (in decimal degrees) of the sampling location should be written in indelible ink on an adhesive label and placed on the inner sealed plastic bag (OEHHA and OSPR, 2020).

As an example, samples may be identified using the following convention:

Sampling Location # (Station Code) - Date (MMDDYY) - Sample Type (two or three letters) - Sample # (two numbers); e.g., CB020S-042922-SSP-01

FIELD DOCUMENTATION

Field activities should be documented on a field data sheet. Information listed on the form should include station name and code, sampling location, date, team members,

arrival and departure time, collection time, camera/GPS make and model, geodetic datum (e.g., WGS84), latitude/longitude (in decimal degrees), water depth, color, and clarity, distance from bank, collection method, sampling site details, types and numbers of samples, a list of photographs, and other observations, as appropriate. An example of a field data sheet is found in Appendix II (Bonnema, 2017, Appendix 5). See another example in OEHHA and OSPR (2020).

Chain-of-Custody

A chain-of-custody (COC) form must be completed to document sample handling and proper sample monitoring (e.g., samples were consistently monitored or stored in a safe and locked location (Bonnema, 2017)). The form should include the station code and name, the sample identification number, the sample date and time, field preparation and preservation, requested analysis, the names and signatures of staff relinquishing and receiving the samples, and the date and time the samples are relinquished.

Shipping

Samples packed according to Table 4 should be chilled to ≤6°C within 24 hours of collection. Shipping or delivery should be coordinated with the receiving laboratory to ensure samples arrive at or below 6°C, and ideally frozen. Typically, frozen samples are shipped on wet ice in a cooler but may also be shipped on dry ice in a cooler (BOG, 2020). The original COC form(s) must accompany the samples. Examples of a COC form can be found in Bonnema (2017, Appendix 5) and OEHHA and OSPR (2020).

Sample Storage

Samples should be chilled to less than 6°C within 24 hours and maintained until delivery to the laboratory. Upon arrival at the designated laboratory, the samples should be frozen at ≤-20°C for storage. Holding times are one year for all analytes. Once tissues for organic analyses (pesticides and PCBs) are thawed, the sample hold time is 14 days for extraction and 40 days from extraction to analysis (Bonnema, 2017).[17]

SAMPLE PREPARATION

MPSL has established protocols for the dissection and preparation of fish and bivalve shellfish samples (Bonnema, 2017, including appendices). The reader is encouraged to check with MPSL for updated methods prior to initiating a sampling and analysis plan. If other laboratories are used, then sample preparation protocols should be consistent with those of MPSL.

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[17] Current SWAMP measurement quality objectives are available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.html

All finfish should be prepared for analysis as skin-off fillets composed solely of muscle tissue (with the exception noted below). The soft tissues (viscera and meat) of bivalves should be analyzed, while only the body and leg or tail meat of crustaceans should be analyzed. The skin, fat, and viscera of fish are known to contain higher levels of organic contaminants, such as PCBs, than the meat (Hora, 1981; OEHHA, 2009; Voiland et al., 1991; Zabik, 1995). Similarly, the viscera of crustaceans contains higher levels of the biotoxin domoic acid than does meat (Schultz et al., 2013). Thus, OEHHA advises all consumers to remove the skin, viscera, and fat before cooking fish and to eat only the meat of crustaceans. Following this advice allows for consumption of the greatest quantity of fish, thereby increasing the benefits of fish consumption while minimizing the risks. Small species (e.g., sardines) that have no established minimum legal or edible size, and may be eaten whole, can be prepared as whole bodies, or gutted with the head and tail removed.

The amount of tissue required for analysis depends on the chemicals evaluated and are established by individual analytical laboratories.

INDIVIDUAL VERSUS COMPOSITE ANALYSIS

Chemical analysis of individuals is preferable to analyzing composites of multiple fish in order to provide an understanding of the range of fish contaminant levels among individuals in a species and allow for the possibility of providing size-based consumption advice. However, resource limitations may prevent this for most contaminants except mercury, which is less expensive to analyze. OEHHA has provided size-driven advice based on mercury for Bat Ray, Brown Trout, Rainbow Trout, and Sacramento Pikeminnow in some water bodies. OEHHA has also used the maximum mercury concentration in a species to support a recommendation for more restrictive consumption advice for that species than the arithmetic mean would indicate. This is particularly the case when the highest concentration considerably exceeds the ATL concentration for no consumption for one or both population groups. The maximum concentrations are not available when samples are analyzed as composites.

Composite samples are prepared from equal amounts of fillet tissue from the individual fish (all of the same species). Composites are generally formed from five individuals, although for small species it may be necessary to use more individuals in order to obtain enough tissue for some chemical analyses. Muscle tissue samples from individuals or composites are homogenized prior to all chemical analyses. Preparation of composite samples is described in Bonnema (2017, Appendix II) and US EPA (2000). Individuals of each species are composited for each site with a single sample ID number.

When making composites of multiple individual fish for analysis, US EPA recommends that the smallest fish in a composite be “no less than 75 percent of the total length (size) of the largest individual” (US EPA, 2000). Having each

composite made of similar sized individuals is most useful for comparing data over a large geographic area, such as when developing a statewide advisory (US EPA, 2000). OEHHA understands that fish contaminant data are collected for multiple uses and adhering to this composite size restriction may be important for some programs. However, in doing so, the number of individuals available to composite may be less than nine and the largest (and usually most contaminated) individuals sometimes has been excluded, particularly if resources only allow for the analysis of one composite per species. When analyzing composites of multiple individual fish is necessary, OEHHA recommends using all legal/edible sized individuals of a species or, at least, the nine largest individuals to make each composite. Fewer individuals can be used if more than one composite will be analyzed for a species, as long as minimum sample sizes are met. The number of individual fish per composite should be recorded. Results from composites containing one or more undersized individuals will not be used in the development of fish advisories, unless it results in more restrictive advice than otherwise would be given.

CHEMICAL ANALYSIS

MPSL has established protocols for the chemical analysis of fish and bivalve shellfish samples, including appropriate quality control measures (Bonnema, 2017, including appendices). The reader is encouraged to check with MPSL for updated methods prior to initiating a sampling and analysis plan. Samples should be processed, analyzed, and stored by a certified and approved laboratory. If other laboratories are used, then analytical methods should be consistent with those of MPSL.

Analytical methods should be technically sound, have acceptably low method detection and quantitation limits (e.g., at least five-fold below the ATL concentration for 7 meals per week), have adequate accuracy and precision, and be cost-efficient (US EPA, 2000). Table 5 shows analytical method references for total mercury, selenium, chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane), DDTs (*o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDT, *p,p'*-DDT), dieldrin, and PCBs used for fish and shellfish chemical analysis by the SWAMP's Safe to Eat Workgroup, formerly known as the Bioaccumulation Oversight Group (BOG). Of the 209 possible PCB congeners,[18] 54–55 are generally reported. It is recommended that agencies or organizations planning to collect fish for analysis consult with OEHHA or MPSL on the suitability of methods not listed in Table 5 (see BOG, 2020 and SWAMP, 2021, for additional details). Percent moisture of the fillet should also be measured to ensure the sample integrity. Chemical concentration data should be reported in wet weight.

[18]Congeners are related compounds with similar chemical forms.

TABLE 5. RECOMMENDED ANALYTICAL METHODS AND REPORTING LIMITS

Analytes	Method	Reporting Limit
Mercury, Total	EPA 7473	0.030 µg/g wet weight
Organochlorine Pesticides (chlordanes, DDTs, dieldrin)	EPA 1699	0.2–0.4 ng/g wet weight
PBDEs	EPA 1614A	2 – 5 ng/g wet weight
PCBs	EPA 1688A	3.0–6.2 pg/g wet weight per congener
Selenium	EPA 3052M EPA 200.8M	0.70 µg/g wet weight

DATA SUBMISSION

OEHHA requires specific sample information (Table 6) for the corresponding results to be used for the development of fish consumption advisories. OEHHA recommends that fish tissue data be submitted to CEDEN; this allows the data to be accessed by State agency staff and the public[19]. Specific reporting requirements for submission of tissue data are published by CEDEN and updated periodically.

Table 6 shows the minimum sample information data necessary for OEHHA to develop a fish consumption advisory.

[19] https://ceden.waterboards.ca.gov/AdvancedQueryTool

TABLE 6. MINIMUM DATA NECESSARY FOR FISH CONSUMPTION ADVISORY DEVELOPMENT

OEHHA Requirements
Composite Sample ID
Composite Sample Date
Composite Common Name
Composite Scientific Name
Composite Project Name
Composite Latitude
Composite Longitude
Composite Station Name
Number of Fish per Composite
Composite Tissue Name (e.g., fillet)
Composite Tissue Prep (e.g., skin off)
Analytical Method
Analyte (including moisture and lipid)
Unit (e.g., ng/g wet weight; %)
Result (in wet weight)
Method Detection Limit
Reporting Limit
Total Length, Minimum (millimeter, mm)
Total Length, Maximum (mm)
Total Length, Average (mm)

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APPENDIX I. Suggested analytes and legal/edible size limits for fish species typically caught in California.

Habitat	Species	Suggested Analytes	Size limit (mm)[1]	Basis for Size Limit[2]
Anadromous[3]	American Shad	Mercury	275	Edible
	Chinook Salmon	Mercury	Refer to CDFW regulations	Legal
	Steelhead Trout	Mercury	406	Legal
	Striped Bass	Mercury, PCBs	457	Legal
	White Sturgeon	Mercury	1016–1524[4]	Legal
Freshwater	American Shad	Mercury	275	Edible
	Black Bass species (Largemouth, Redeye, Smallmouth, Spotted)	Mercury	305	Legal
	Brown Trout	Mercury	200	Edible
	Bullhead species (Black, Brown)	Mercury, PCBs	Black – 170, Brown – 200	Edible
	Catfish species (Channel, White)	Mercury, PCBs	200	Edible
	Chinook Salmon	Mercury	200 (landlocked)	Edible
	Common Carp	Mercury, PCBs	200	Edible
	Crappie species (Black, White)	Mercury	150	Edible
	Golden Shiner	Mercury	No minimum	Edible
	Goldfish	Mercury, PCBs	200	Edible
	Hitch	Mercury	150	Edible
	Inland Silverside	Mercury	No minimum	Edible

Habitat	Species	Suggested Analytes	Size limit (mm)[1]	Basis for Size Limit[2]
Freshwater	Kokanee	Mercury, PCBs	200	Edible
	Rainbow Trout (including Eagle Lake and Lahontan Cutthroat)	Mercury	200	Edible
	Sacramento Pikeminnow	Mercury	250	Edible
	Sacramento Sucker	Mercury	200	Edible
	Striped Bass	Mercury, PCBs	457	Legal
	Sunfish species (Bluegill, Green Sunfish, Pumpkinseed, Redear Sunfish)	Mercury	100	Edible
	Threadfin Shad	Mercury	No minimum	Edible
	Tui Chub	Mercury	No minimum	Edible
	Tule Perch	Mercury	No minimum	Edible
	White Sturgeon	Mercury	1016-1524[3]	Legal
Marine	Littleneck Clams, Chiones, Northern Quahog, Cockles	Mercury	38	Legal
	Mussels	Mercury	50	Edible
	Pismo Clams	Mercury	127: North of Monterey and San Luis Obispo (SLO) County Line 114: South of Monterey and SLO County Line	Legal

Habitat	Species	Suggested Analytes	Size limit (mm)[1]	Basis for Size Limit[2]
Marine	California Spiny Lobster	Mercury	83	Legal
	Dungeness Crabs	Mercury	146	Legal
	Rock Crab species (Brown, Red, Yellow)	Mercury	102	Legal
	Barred Sand Bass	Mercury, PCBs	356	Legal
	Barred Surfperch	Mercury, PCBs	160	Edible
	Black Perch	Mercury, PCBs	150	Edible
	Black Rockfish	Mercury	355	Edible
	Black and Yellow Rockfish	Mercury	200	Edible
	Blue Rockfish	Mercury	200	Edible
	Brown Rockfish	Mercury	250	Edible
	Brown Smoothhound Shark	Mercury, PCBs	610	Edible
	Cabezon	Mercury	381	Legal
	California Corbina	Mercury, PCBs	250	Edible
	California Halibut	Mercury, PCBs	559	Legal
	China Rockfish	Mercury	260	Edible
	Chinook Salmon	Mercury	Refer to CDFW regulations	Legal
	Chilipepper Rockfish	Mercury	230	Edible
	Copper Rockfish	Mercury	320	Edible
	Diamond Turbot	Mercury, PCBs	165	Edible

Habitat	Species	Suggested Analytes	Size limit (mm)[1]	Basis for Size Limit[2]
Marine	Gray Smoothhound Shark	Mercury, PCBs	580	Edible
	Gopher Rockfish	Mercury	135	Edible
	Kelp Bass	Mercury	356	Legal
	Kelp Rockfish	Mercury	180	Edible
	Leopard Shark	Mercury, PCBs	914	Edible
	Lingcod	Mercury	559	Legal
	Longfin Sanddab	Mercury, PCBs	150	Edible
	Olive Rockfish	Mercury	320	Edible
	Pacific (Chub) Mackerel	Mercury	260	Edible
	Pacific Bonito	Mercury	610[3]	Legal
	Pacific Herring	Mercury	170	Edible
	Pile Perch	Mercury, PCBs	180	Edible
	Queenfish	Mercury, PCBs	125	Edible
	Rainbow Surfperch	Mercury, PCBs	125	Edible
	Rosethorn Rockfish	Mercury	230	Edible
	Shiner Perch	Mercury, PCBs	100	Edible
	Silver Surfperch	Mercury, PCBs	125	Edible
	Speckled Sanddab	Mercury, PCBs	70	Edible
	Spotfin Surfperch	Mercury, PCBs	100	Edible

Habitat	Species	Suggested Analytes	Size limit (mm)[1]	Basis for Size Limit[2]
Marine	Spotted Turbot	Mercury, PCBs	150	Edible
	Striped Bass	Mercury, PCBs	457 (North of Point Conception)	Legal
	Topsmelt	Mercury, PCBs	150	Edible
	Vermillion Rockfish	Mercury	355	Edible
	Walleye Surfperch	Mercury, PCBs	115	Edible
	White Croaker	Mercury, PCBs	150	Edible
	White Surfperch	Mercury, PCBs	125	Edible
	Widow Rockfish	Mercury	360	Edible
	Yellowtail Croaker	Mercury, PCBs	230	Edible

[1] Size limits are measured as: greatest shell diameter for mollusks, carapace length for crustaceans, and total length for finfish unless indicated otherwise.
[2] Legal size limits based on CDFW Fishing Regulations as of time of publication. Regulations may change annually, please check CDFW for current size limits. When legal minimum and/or maximum sizes are not available, OEHHA develops minimum “edible” size based on professional judgment and species size at maturity.
[3] Some species in the “Anadromous” category are listed in the “Freshwater” and “Marine” categories to reflect where they may be caught.
[4] Size is measured in fork length.

APPENDIX II. Field Data Sheet Example (from MLML)

SWAMP Tissue Sampling – Field Data Sheet Example 2021				Dbase entry (initial/date)			Pg of Pgs
StationCode:	**StationName:**			**Purpose: Habitat, Tissue,** WaterChem			**Agency** **MPSL**
Location #___ of ___	**Date** (mm/dd/yyyy): / /			**FailureCode**: Dry, Non-sampleable, Equipment Failure, No Access, Other			
Sampling Crew:	ArrivalTime:	**Beaufort Scale** (see attachment):		**Wind Direction** (from):	N W E S		**PictureCode** (RB & LB assigned when facing downstream; RENAME to StationCode_yyyy_mm_dd_uniquecode):
	DepartureTime:						
DominantSubstrate: Concrete,Cobble,Gravel,Sand,Mud,Other_____,unk		**WaterColor**: Colorless, Green, Yellow, Brown					1: (RB / LB / BB / US / DS / ##)
OtherPresence: Vascular,Nonvascular,OilySheen,Foam,Trash,Other____		**WaterClarity**: Clear, Cloudy (>4" vis), Murky (<4" vis)					
Comments:				Water Temperature < 70 deg F: Y N			2: (RB / LB / BB / US / DS / ##)
				Conductivity <400 us/cm: Y N			
				Visibility > 3': Y N			3: (RB / LB / BB / US / DS / ##)
				Volts not to exceed 600V or 60Hz, No AC			

Tissue Collection

CollectionDevice: , EPA raft_____ , Backpack Model _____, Other_____

GPSModel: Map64st, Legend, Vista, CellPhone, Other___ **Datum**: **NAD83** WGS84

Location			**Distance from Bank (m):**			Accuracy (ft)	Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, gill net, seine, hook & line, yoyo's, trap		Start Time	Coord. 1					
SAMPLE LOCATION:	Location____Shock/Net/Hook____		Net#	Coord. 2					
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert, Dam		End Time	Coord. 3					
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4					
Location			**Distance from Bank (m):**				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, gill net, seine, hook & line, yoyo's, trap		Start Time	Coord. 1					
SAMPLE LOCATION:	Location____Shock/Net/Hook____		Net#	Coord. 2					
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert, Dam		End Time	Coord. 3					
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4					
Location			**Distance from Bank (m):**				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, gill net, seine, hook & line, yoyo's, trap		Start Time	Coord. 1					
SAMPLE LOCATION:	Location____Shock/Net/Hook____		Net#	Coord. 2					
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert, Dam		End Time	Coord. 3					
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4					

Comments:	**LMB(14)** **200-249 (2)** **250-304 (2)** **305-407 (7)** **>407 (3)**	**PREY FISH SPP**	**PREY FISH SPP**	**PREY FISH SPP**	**OTHER SPP Seen**

SWAMP Tissue Sampling – Field Data Sheet Example 2021 | Pg: of Pgs

StationCode: | **StationName:** | **Date** (mm/dd/yyyy): / /

Location #	Organism ID	Tag #	Species Name/Code	TL (mm)	FL (mm)	StdL (mm)	Weight (g)	Count	Count Est.	Sex	Anomaly	Condition
										M F U L		
										M F U L		
										M F U L		
										M F U L		
										M F U L		
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										M F U L		

Location #: Match fish with Location # from Tissue Collection sheet | **Organism ID:** Combine SpeciesCode and fish # (e.g., fish 1 of bag WHC01 is WHC01-01) to be unique | **Tag #**: Use if applicable

Species Code: Largemouth Bass (**LMB**), Smallmouth Bass (**SMB**), Spotted Bass **(SPB)**,Sacramento Pike Minnow **(SPM)**, Rainbow Trout **(RBT),** Brown Trout **(BNT),** Brook Trout **(BRT)**, White Catfish **(WHC),** Carp **(CAR)**, Channel Catfish **(CHC)**, Brown Bullhead **(BRB)**, Sacramento Sucker **(SAS)**, Redear (**RES)**, Black Crappie (**BCR**), Bluegill (**BGL**), Tilapia **(TIL)**, Green Sunfish **(GRS),** Kokanee **(KOK)**, Threadfin Shad **(TFS)**, Mississippi Silverside **(MSS),** Flathead Catfish **(FHC),** Pumpkinseed **(PKS),** Steelhead **(STH),**

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR) | **Count Est**: If appropriate, add < or > if count is estimated

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (P), Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination | **Sex**:unk(**U**),taken at Lab(**L**) | **BodyLocation**: Branchial Chamber(BRC), Buccal Cavity(BC), Eyes(E), Musculoskeleton(M), Skin/Fins(SF)

Comments: Mark fish requiring further ID; **SEPARATE FISH BY LOCATION AND INDICATE LOCATION # ON LABEL**