OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Statewide Health Advisory and Guidelines for Eating Fish that Migrate

American Shad, Chinook (King) Salmon, Steelhead Trout, Striped Bass, and White Sturgeon in California Rivers, Estuaries, and Coastal Waters

November 2022

Fish, Ecotoxicology, and Water Section
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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
BPTCP	Bay Protection and Toxic Cleanup Program
CALFED	California Bay-Delta Program
CDFW	California Department of Fish and Wildlife, formerly California Department of Fish and Game (CDFG)
CFCP	Coastal Fish Contamination Program
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
EPA	eicosapentaenoic acid
FDA	United States Food and Drug Administration
FMP	Fish Mercury Program
Hg	mercury
MDL	method detection limit
MeHg	methylmercury
MLML	Moss Landing Marine Laboratories
mm	millimeters
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
RMP	Regional Monitoring Program
RWB	Regional Water Quality Control Board
Se	selenium
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SFEI	San Francisco Estuary Institute
SRWP	Sacramento River Watershed Program

SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TSMP	Toxic Substances Monitoring Program
UCD	University of California, Davis
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
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's (CDFW) Inland and Ocean Sport Fishing Regulations in their respective sections on public health advisories.[2]

This report presents guidelines for eating American Shad, Chinook (King) Salmon, Steelhead Trout, Striped Bass, and White Sturgeon that migrate between California rivers, estuaries, and coastal waters. The report provides background information and a technical description of how the guidelines were developed. The resulting advice is summarized in the illustrations after the Table of Contents and the List of Figures and Tables.

[1] Sport fish includes all fish and shellfish caught from California waters for non-commercial purposes (e.g., recreational, tribal/cultural, and subsistence practices).
[2] CDFW's Inland and Ocean Sport Fishing Regulations can be found online at: https://wildlife.ca.gov/Fishing/Inland and https://wildlife.ca.gov/Fishing/Ocean, respectively.

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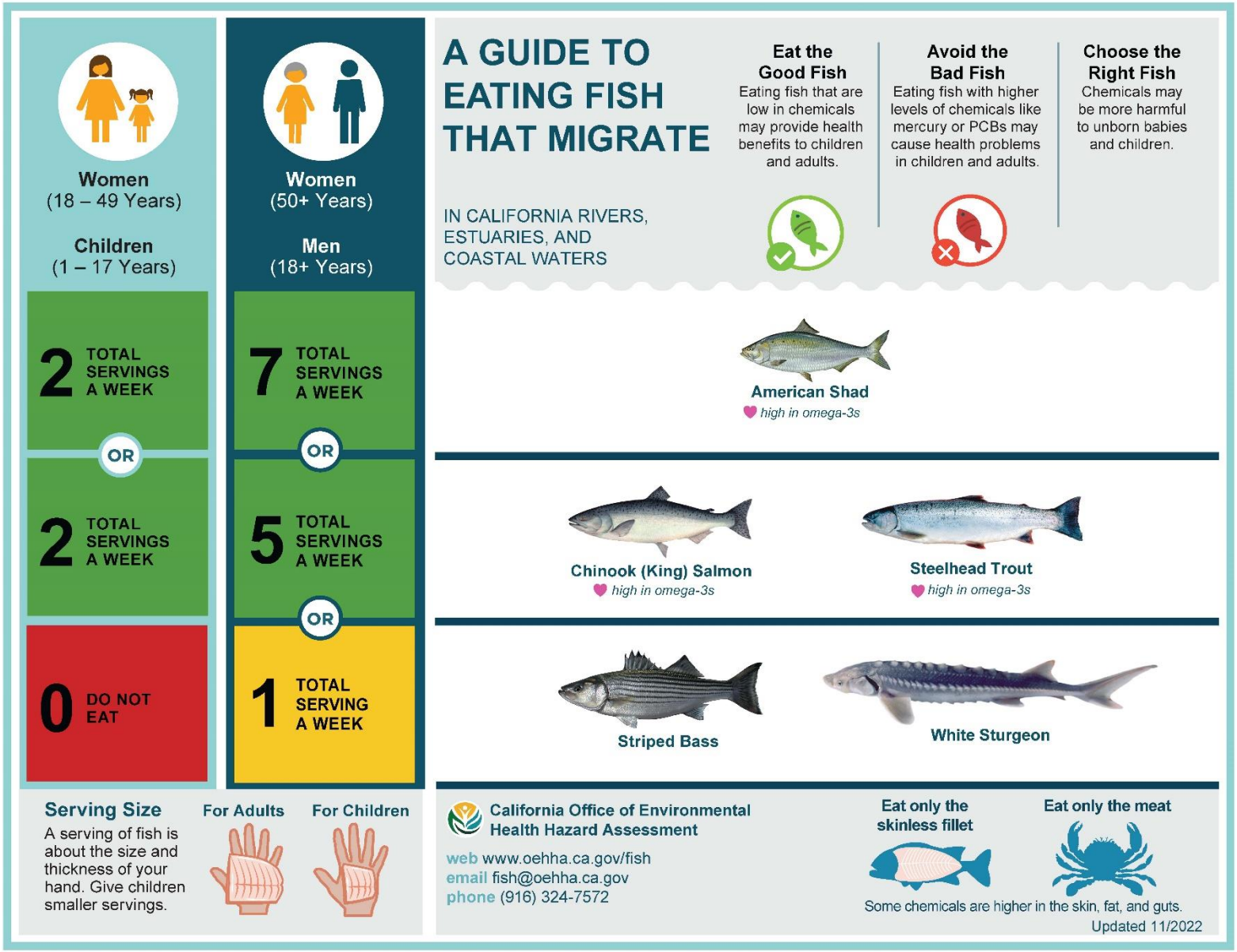
A GUIDE TO EATING FISH THAT MIGRATE
IN CALIFORNIA RIVERS, ESTUARIES, AND COASTAL WATERS
Eat the Good Fish
Eating fish that are low in chemicals may provide health benefits to children and adults.
Avoid the Bad Fish
Eating fish with higher levels of chemicals like mercury or PCBs may cause health problems in children and adults.
Choose the Right Fish
Chemicals may be more harmful to unborn babies and children.
Women (18 – 49 Years)
Children (1 – 17 Years)
Women (50+ Years)
Men (18+ Years)
2 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
0 DO NOT EAT
7 TOTAL SERVINGS A WEEK
OR
5 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
American Shad
high in omega-3s
Chinook (King) Salmon
high in omega-3s
Steelhead Trout
high in omega-3s
Striped Bass
White Sturgeon
Serving Size
A serving of fish is about the size and thickness of your hand. Give children smaller servings.
For Adults
For Children
California Office of Environmental Health Hazard Assessment
web www.oehha.ca.gov/fish
email fish@oehha.ca.gov
phone (916) 324-7572
Eat only the skinless fillet
Eat only the meat
Some chemicals are higher in the skin, fat, and guts.
Updated 11/2022

SUMMARY

This report updates and supersedes the Office of Environmental Health Hazard Assessment's (OEHHA) 2012 advisory for consumption of American Shad, Chinook (King) Salmon,[3] Steelhead Trout,[4] Striped Bass, and White Sturgeon that migrate between and are caught from California rivers, estuaries, and coastal waters. It provides advice for safe consumption of five species when found in waters with access to the ocean; advice does not apply to these species caught in lakes or reservoirs. Separate advice is provided for the sensitive population (women 18 – 49 years and children 1 – 17 years) and the general population (women 50 years and older and men 18 years and older).

To develop this statewide advisory, OEHHA compared contaminant levels in fish caught from more than 90 sampling locations to levels that are considered safe for human consumption. However, only mercury and PCB levels were sufficient to impact advice. OEHHA's consumption guidelines balance the risks and benefits of fish consumption, as low-contaminant fish are part of a healthy, well-balanced diet. Fish are a good source of protein and vitamins, and are a primary dietary source of heart-healthy omega-3 fatty acids.

OEHHA recommends the number of servings of each covered species that may be eaten safely. A serving is about the size and thickness of your hand for fish fillets. Children should be given smaller servings. For small fish species, several individual fish may make up a serving. The advice is as follows:

Women 18 – 49 years and children 1 – 17 years

- **Should not eat:** Striped Bass or White Sturgeon.
- **May eat:**
  - Two servings per week of American Shad, Chinook (King) Salmon, or Steelhead Trout.

Women 50 years and older and men 18 years and older

- **May eat:**
  - One serving per week of Striped Bass or White Sturgeon, or
  - Five servings per week of Chinook (King) Salmon or Steelhead Trout, or
  - Seven servings per week of American Shad.

[3] The names Chinook (King) Salmon and Chinook Salmon are used interchangeably.
[4] Steelhead are defined as "any Rainbow Trout greater than 16 inches in length found in anadromous waters" (CDFW, 2022). Steelhead, Rainbow Trout, and Steelhead Rainbow Trout greater than 16 inches are grouped under "Steelhead Trout" for the purposes of this advisory.

INTRODUCTION

This report presents statewide advice for eating anadromous[5] species recreationally caught in waters with access to the ocean (hereafter referred to as anadromous waters),[6] also known as fish that migrate. Sufficient mercury and PCB data were available on a statewide basis to issue advice for five anadromous or migrating species: American Shad, Chinook Salmon, Steelhead Trout, Striped Bass, and White Sturgeon. Anadromous fish are those that live, or spend time, in the ocean but swim up rivers to spawn in freshwater. Due to this pattern of movement, these species can be caught from many different locations including the Pacific Ocean off the California coast, San Francisco Bay, Sacramento-San Joaquin Delta, and rivers that flow into the greater San Francisco Bay region: American, Cosumnes, Feather, Mokelumne, Sacramento, and San Joaquin. These species are also found in streams, creeks, or tributaries to major rivers and in ocean-side lagoons, such as the Klamath, Mad, and Russian rivers. The statewide health advisory and eating guidelines described in this report do not apply to these five species when caught from lakes and reservoirs.

The Office of Environmental Health Hazard Assessment (OEHHA) released its first statewide advisory for fish that migrate in 2012. Since the 2012 advisory, significant sampling has been conducted through regional and statewide efforts, including in anadromous waters. OEHHA updated the statewide advisory for fish that migrate because additional fish contaminant data became available and the metric[7] upon which consumption advice is based was revised. OEHHA used all available and suitable data from anadromous waters throughout the state to update the consumption advice for species included in the 2012 advisory, with the exception of samples collected from the Port of Stockton[8] where a site-specific advisory recommending no consumption is in effect.

This report updates and supersedes the 2012 “Health Advisory and Safe Eating Guidelines for American Shad, Chinook (King) Salmon, Steelhead Trout, Striped Bass, and White Sturgeon Caught in California Rivers, Estuaries, and Coastal Waters” (i.e., the statewide advisory for fish that migrate), and provides consumption advice based on levels of mercury and/or PCBs. These contaminants are the risk drivers (the contaminant(s) that result(s) in the most restrictive consumption advice) for these species in California anadromous waters. Other contaminants were evaluated for this advisory but, similar to many site-specific advisories for California rivers, estuaries, and coastal waters, did not impact advice.

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[5] Species that migrate from marine/coastal waters to inland freshwater areas (e.g., rivers and estuaries) to spawn. Information online at: https://www.fisheries.noaa.gov/node/8071.
[6] “Inland waters that are accessible to fish migrating from the ocean” (CDFW, 2022).
[7] OEHHA selected the 90th percentile of the contaminant concentrations as the preferred metric for developing advice.
[8] Port of Stockton Advisory online at: https://oehha.ca.gov/advisories/port-stockton.

SPECIES DISTRIBUTION

The following sections provide information on the locations where each species can be found in anadromous waters. The descriptions were based on Moyle (2002) unless otherwise indicated.

American Shad

American Shad (*Alosa sapidissima*)[9] is a large-sized member of the herring family native to the Atlantic coast. A large number of fry were planted in the Sacramento River between 1871 and 1881, and they became abundant. The species spawns in major rivers, including the Sacramento River, and rivers as far north as British Columbia. In the Sacramento River, they reach up to Red Bluff and into tributaries including the American, Feather, and Yuba rivers. Smaller runs also exist in the Mokelumne, Cosumnes, Stanislaus, Klamath, Russian, Eel, and Old Rivers, and in the northern Sacramento-San Joaquin Delta. American Shad caught from lakes or reservoirs (e.g., San Luis Reservoir) are not included in this advisory.

Salmonids: Chinook (King) Salmon and Steelhead Trout

Members of the salmonid family adapt well to diverse and changing environments as long as the water is cool and well oxygenated. Like other anadromous species, they use freshwater habitats for spawning and the ocean for feeding. Salmonids have the ability to evolve relatively quickly into genetically distinct local forms, races, and spawning runs (for example, spring or winter runs). Most salmonids in California, however, are in danger of extinction[10] (Moyle, 2002).

The California Department of Fish and Wildlife (CDFW) operates hatchery programs to rear salmon and trout, including Steelhead Trout, to restore and preserve fish in inland water bodies and anadromous waters. The fish raised in hatcheries are sometimes planted in reservoirs resulting in landlocked populations. Salmon collected from inland reservoirs have typically accumulated higher levels of mercury or other chemicals (OEHHA, unpublished data). This advisory applies to ocean or river-run Chinook (King) Salmon and Steelhead Trout. Chinook Salmon and Steelhead Trout can be caught from numerous rivers and streams in California.

[9] American Shad information online at: https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=491.
[10] Information online at: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/california-coastal-chinook-salmon and https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109405&inline.

Chinook (King) Salmon

Chinook (King) Salmon (*Oncorhynchus tshawytscha*)[11] are widely distributed in the pelagic (offshore) North Pacific Ocean and can be found south of Monterey Bay. Spawning runs occur or occurred in larger coastal streams north of San Francisco Bay to the Oregon border, including all major streams draining the Sierra Nevada except as limited by dams. Moyle (2002) describes two basic types of life-history strategies, both of which occur in California. In stream-type Chinook Salmon, adults run upstream before reaching full maturity, in spring or summer, and juveniles remain in freshwater for an extended period, usually more than one year. In ocean-type Chinook Salmon, adults spawn soon after entering freshwater, in summer and fall, and juveniles spend a shorter time in freshwater, between 3 and 12 months. There are many variations on the timing and duration of spawning runs, by location and over time.

Steelhead Trout

Steelhead Trout (*Oncorhynchus mykiss*)[12] are the anadromous form of native coastal Rainbow Trout on the west coast, ranging from Baja to Alaska. CDFW defines Steelhead Trout as any Rainbow Trout over 16 inches in total length found in anadromous waters (CDFW, 2022). The diversity of forms of trout combined with widespread planting of hatchery-raised trout with mixed origins and hybridization, has contributed to confusion in identification and naming of "species" and local forms. Moyle (2002) names several types of Steelhead Trout, by location, as follows: Klamath Mountains Province, Northern California, Central Valley, Central Coast, South/Central Coast, and Southern Steelhead. Although Moyle (2002) indicated that each form also has a nonmigratory population, the advisory described in this report does not apply to nonmigratory (landlocked) Steelhead. For this advisory, OEHHA included data labeled as Rainbow, Steelhead, or Steelhead Rainbow Trout (*Oncorhynchus mykiss gairdneri*), provided the samples were over 16 inches and from anadromous waters.

Striped Bass

Striped Bass (*Morone saxatilis*)[13] were first introduced to California in 1879; they were planted in the San Francisco Estuary and subsequently proliferated. The species is native to streams and bays of the Atlantic coast and is tolerant of a wide range of salinity. The main breeding population remains in the San Francisco Estuary. They are abundant in the ocean and estuaries when water temperatures are warmer due to El

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[11] Chinook (King) Salmon information online at: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=920.
[12] Steelhead Trout information online at: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=910.
[13] Striped Bass information online at: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=787.

Niño, and they reach upstream as far as barrier dams on the Sacramento, American, and Yuba rivers. Although some Striped Bass have survived plantings in reservoirs, the species thrives by using large cool-water pools for spawning and large water bodies, such as San Francisco Bay or the ocean, to feed on small fishes. Striped Bass in California spend much of their lives in San Francisco and San Pablo bays. Striped Bass caught from lakes or reservoirs are not included in this advisory.

White Sturgeon

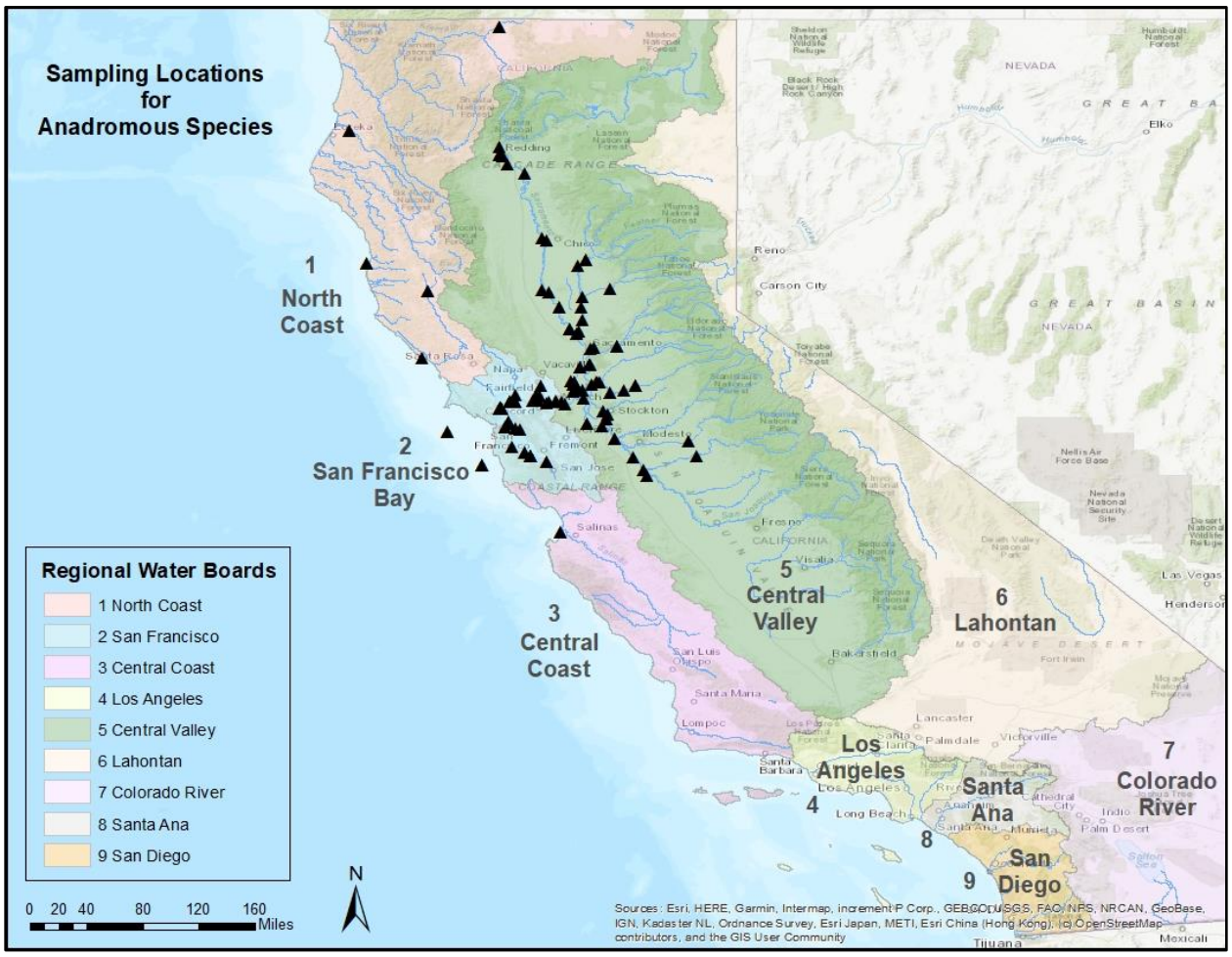
White Sturgeon (*Acipenser transmontanus*)[14] can be found from Ensenada, Mexico to the Gulf of Alaska; however, spawning occurs only in rivers from the Sacramento-San Joaquin and northward. Currently, self-reproducing populations exist mainly in the Sacramento River and, to the north, in the Columbia and Fraser rivers. The San Francisco Estuary population spawns mainly in the Sacramento or Feather rivers, or in the San Joaquin River when water flow and quality are adequate. Following construction of dams, some White Sturgeon have become landlocked, as in Shasta Reservoir. The species is also cultivated and is sometimes planted in other reservoirs. This advisory applies only to White Sturgeon free to swim between marine and fresh waters.

Sampling Locations Contributing Mercury and/or PCB Data to the Statewide Advisory Dataset

Figure 1 shows California locations where fish were collected and evaluated for mercury and/or PCBs and met OEHHA's data quality criteria for inclusion in the statewide dataset. Also shown are the State Water Resources Control Board's (SWRCB) nine Regional Water Quality Control Boards (Regional Water Boards, or RWBs). Data from more than 90 sampling locations were used to evaluate fish mercury and/or PCB levels. Maps of sampling locations for mercury and PCB analyses by species can be found in Appendix I.

[14] White Sturgeon information online at: https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=300.

FIGURE 1. MAP OF SAMPLING LOCATIONS IN CALIFORNIA RIVERS, ESTUARIES, AND COASTAL WATERS CONTRIBUTING MERCURY AND/OR PCB DATA TO THE STATEWIDE ADVISORY DATASET



APPROACH USED

OEHHA used the results from ten monitoring studies described in this report to develop the statewide advisory for fish that migrate. OEHHA used the following process in developing consumption advice for fish included in this advisory:

1) Evaluation of all fish contaminant data available from anadromous waters and selection of appropriate data that meet data quality criteria and sampling plan guidelines.
2) Determination of fish species for which adequate data are available to issue fish consumption advice.

3) Calculation of the species mean[15] and 90th percentile value of the samples[16,17] for each species, as well as other descriptive statistics of the contaminant data, as appropriate, for a chemical of potential concern for the selected fish species.
4) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of potential concern.
5) Development of final advice based on a thorough review of the data and best professional judgment relating to the benefits and risks of consuming a particular fish species.

As was the case for the 2012 statewide advisory, OEHHA calculated the mean (average) concentrations for each contaminant in each species from all sampling locations combined. Mean concentrations were calculated as the weighted average of all samples. The 90th percentile of the contaminant concentrations was then calculated for each individual species and selected as the preferred metric to update the statewide advisory. This is a more health protective approach than using the mean contaminant concentration of a species for all the sampled locations and is consistent with the approach used for the statewide advisories for rivers and for lakes and reservoirs.

The ATLs (discussed further in a subsequent section of this report) 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 included consideration of health benefits associated with including fish in the diet (OEHHA, 2008). The ATLs should not be interpreted as static "bright lines," but as one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of the benefits and risks of consuming sport fish.

CHEMICALS OF POTENTIAL CONCERN

Certain chemicals are of potential concern for people who eat fish because of their toxicity and their ability to accumulate in fish tissue. The majority of fish consumption advisories in California are issued because of mercury (Hg), followed by polychlorinated biphenyls (PCBs) and, in a few cases, selenium (Se), polybrominated diphenyl ethers (PBDEs), or some legacy pesticides (pesticides that are no longer used but remain in the environment).

Mercury is an element found in some rock and soil. Human activities, such as burning coal and the historical use of mercury to mine gold, also add mercury to the environment. If mercury enters waterways, it can be converted to a more toxic form

[15] Means are an arithmetic average of individual values and/or composites weighted by number of fish. A weighted average of composites is calculated by multiplying the chemical concentration in each composite by the number of fish in that composite for each species. Products are then summed and divided by the total number of fish in all composites for that species.
[16] "Sample" includes both individual and composite samples.
[17] The 90th percentile represents an upper bound value of the chemical concentrations from sampled locations for a fish species.

known as methylmercury – which can pass into and build up in fish. High levels of methylmercury can harm the brain, especially in fetuses and children, whose brains are still developing.

PCBs are industrial chemicals previously used in electrical transformers, plastics, and lubricating oils, and were often used as flame retardants or electrical insulators. Their use was banned in the 1970s, but they can accumulate in fish because they do not break down easily and they persist in the environment. Depending on the exposure level, PCBs may cause cancer or other health effects, including neurotoxicity, in humans.

Selenium is an element and at low doses is an essential nutrient for many important human health processes, including thyroid regulation and vitamin C metabolism. Higher doses cause selenium toxicity, which can include symptoms ranging from hair loss and gastrointestinal distress to dizziness and tremors.

PBDEs are a class of flame retardants historically used in a variety of consumer products, including furniture, textiles, automotive parts, and electronics. The use of PBDEs in new products was largely phased out by 2013 but, due to their wide usage and persistence in the environment, they are still being detected in fish tissues. PBDEs may affect hormone levels or learning and behavior in children.

Chlordanes, dichlorodiphenyltrichloroethane (DDT), dieldrin, and toxaphene are pesticides that were banned from use in 1973 (DDT), the late 1980s (chlordanes and dieldrin) and 1990 (toxaphene), but are still found in some fish in certain California water bodies. Depending on the exposure level, these chemicals may cause cancer or adverse effects on the nervous system.

Detailed discussion of the toxicity of these chemicals and references are presented in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene" (OEHHA, 2008) and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)" (OEHHA, 2011).

As noted above, only mercury and PCB data were used in the development of this advisory. This advice was based on mercury and PCB analyses of over 615 and 245 fish, respectively. American Shad was the only species for which PCBs were not analyzed. Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study. Additionally, some studies do not analyze these chemicals and instead focus only on mercury. All fish species collected and used in this statewide advisory development were analyzed for mercury and selenium. Some fish were also analyzed for PCBs, PBDEs, and legacy pesticides as indicated in Table 1.

DATA SOURCES

The guidelines for eating fish that migrate between rivers, estuaries, and coastal waters are based on the chemicals detected in the fish collected for the 10 monitoring studies described below. These studies met OEHHA's data quality criteria, including adequate documentation of sample collection, fish preparation methods (e.g., skinning or filleting), chemical analyses, quality assurance, and sufficiently low detection limits. "Sample," as used in this report, refers to an individual fish or a composite of multiple fish for which contaminant data were reported. "Sampling" or "sampled" refers to the act of collecting fish for chemical analysis. The studies or entities contributing data to this advisory are described below.

Bay Protection and Toxic Cleanup Program (BPTCP), Regional Monitoring Program

The BPTCP funded a pilot study in 1994 to identify chemicals, fish species, and geographical regions of concern in San Francisco Bay (SFBRWQCB, 1995). This study was managed by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) and conducted by CDFW. Sites were sampled throughout the Bay to characterize the extent and severity of contamination. Striped Bass and White Sturgeon were collected in 1994 and analyzed for mercury and selenium.

CALFED Bay-Delta Program (CALFED)

The CALFED Bay-Delta Program was a state and federal interagency group, established in 1994, to develop strategies and provide funding for projects that improve water quality, increase water supply, and support ecosystem restoration and levee improvement in the San Francisco Bay-Delta (CALFED, 2005; Davis et al., 2004). This program was composed of more than 20 state and federal agencies including the California Environmental Protection Agency, CDFW (then known as the California Department of Fish and Game), US Environmental Protection Agency (US EPA), and the US Fish and Wildlife Service. CALFED funded the Surface Water Ambient Monitoring Program (SWAMP) sampling efforts for historical bioaccumulation studies in fish. Striped Bass were collected from 1999 – 2000 and analyzed for mercury.

Coastal Fish Contamination Program (CFCP)

The CFCP (1998 – 2003) was a statewide monitoring program managed by the SWRCB to assess human health risks from eating sport fish and shellfish caught from nearshore (marine and estuarine) waters in California (Gassel et al., 2005). Sampling was conducted along various portions of the coast over a five-year period. CDFW, in cooperation with the SWRCB and the RWBs, collected Chinook Salmon and Striped Bass from 2000 – 2003, as part of the program. Fish samples were analyzed for mercury, PCBs, selenium, and legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene).

FISH MERCURY PROJECT (FMP)

The FMP was a three-year (2005 to 2007) sampling program funded by the CALFED. Monitoring of sport fish from Central Valley water bodies was planned and conducted by CDFW, OEHHA, the California Department of Public Health, the University of California, Davis (UCD), and the San Francisco Estuary Institute. Fish were collected from popular fishing locations in the Central Valley Regional Water Quality Control Board jurisdiction to help characterize the spatial and temporal mercury trends in fishery resources (SFEI, 2009). American Shad, Chinook Salmon, Steelhead Trout, Striped Bass, and White Sturgeon were collected and analyzed for total mercury. Striped Bass were also analyzed for PCBs and legacy pesticides (chlordanes, DDTs, and dieldrin).

REGIONAL MONITORING PROGRAM (RMP)

Established in 1993, the RMP is a partnership between regulatory agencies and the regulated community in the San Francisco Bay Area. Program activities, including sport fish monitoring, are planned and overseen by committees comprising waste dischargers, industry representatives, regulators, scientists, and community advocates. One of the objectives of the RMP is to produce the information needed for updating fish consumption advisories. Chinook Salmon, Striped Bass, and White Sturgeon were collected from San Francisco Bay from 1997 – 2015 and analyzed for mercury, PBDEs, and PCBs. Striped Bass and White Sturgeon were also analyzed for selenium and legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene).

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP operated from 1976 to 2003 as a state water quality monitoring program managed by the SWRCB (SWRCB, 2007 and 2013b). Its objective was to provide statewide information on the occurrence of toxic substances by monitoring water bodies with known or suspected water quality impairment. CDFW collected American Shad, Chinook Salmon, Rainbow Trout, and Striped Bass from 1985 – 2003, as part of the program. Fish samples were analyzed for mercury and selenium.

SACRAMENTO RIVER WATERSHED PROGRAM (SRWP)

The SRWP[18] was founded in 1996 and certified as a California not-for-profit corporation in 2002. Its mission is to sustain, restore, and enhance current and potential resources in the Sacramento River watershed including the Sacramento, San Joaquin, Feather, and American rivers. The SRWP operates through collaborative partnerships and conducts coordinated research and monitoring activities to assess water quality and other indicators of watershed health. The SRWP collected Chinook Salmon, Rainbow Trout, and Striped Bass (mercury only) from 1999 – 2005 and analyzed samples for

[18] Information about the SRWP online at: www.sacriver.org and https://sacriver.org/our-work/sacramento-river-watershed-data-program/.

mercury (except Chinook Salmon), PBDEs (Chinook Salmon only), PCBs, and legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene).

CONTAMINANTS IN FISH FROM CALIFORNIA RIVERS AND STREAMS, 2011 – 2012 (SWAMP)

From 2011 – 2012, the program performed a statewide survey of rivers and streams to evaluate contaminants in commonly consumed sport fish and to gain information about contamination in the greater aquatic food web (SWRCB, 2013a). Chinook Salmon, Steelhead Trout, and Striped Bass were collected and analyzed for mercury and selenium. Chinook Salmon and Steelhead Rainbow Trout were also analyzed for PCBs and legacy pesticides (chlordanes, DDTs, and dieldrin).

CONTAMINANTS IN FISH FROM THE CALIFORNIA COAST, 2018 – ONGOING (SWAMP)

In 2018, the program performed a statewide survey of California coastal waters to evaluate contaminants in commonly consumed sport fish and to gain information about contamination in the greater aquatic food web as part of an ongoing monitoring program.[19] The survey collected Chinook Salmon and analyzed samples for mercury, PCBs, and selenium.

UNIVERSITY OF CALIFORNIA, DAVIS (UCD)

UCD, in collaboration with SWAMP, conducted survey-level studies to assess methylmercury levels in fish in northwestern Sierra Nevada rivers impacted by historical gold mining practices (Slotton et al., 1995). The study provided information about the relationships between trophic feeding level, ecological feeding niches, and relative mercury concentrations. Rainbow Trout were collected in 1993 and analyzed for mercury.

FISH SAMPLES INCLUDED IN THE STATEWIDE DATASET

The fish sampling data used in this advisory were retrieved from the California Environmental Data Exchange Network (CEDEN),[20] the state's repository for environmental data. Samples were excluded when the fish were not legal size to take or did not meet OEHHA's criteria for minimum "edible" size, based on species size at maturity and professional judgment (as described in OEHHA, 2022). CDFW permits legal take of White Sturgeon with fork lengths[21] of 40 – 60 cm (CDFW, 2022). For White Sturgeon samples where total length data were reported, OEHHA converted values to fork lengths based on the conversion factor cited in Brennan (1988) to insure that all samples used to develop advice were of legal size. A summary of all fish species evaluated for this advisory is shown in Table 1, including the name of the

[19] Information about the Bioaccumulation Monitoring Program online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/bioaccumulation_monitoring.html.
[20] Online at: http://ceden.waterboards.ca.gov/AdvancedQueryTool.
[21] Fork length is measured from the tip of the snout with closed mouth to the center of the fork in the tail.

species, number of samples collected, total number of fish, project name, year sampled, and contaminants analyzed.

For the initial 2012 statewide advisory and this 2022 update, OEHHA included all available data for fish caught from anadromous waters not impounded by dams, with the exception of the Port of Stockton, that were from samples of appropriate length and met OEHHA data quality criteria (see *Data Sources*). For each anadromous species, sampling locations were representative of biogeographic jurisdictions of two or more Regional Water Boards. These criteria were met for five anadromous species (American Shad, Chinook (King) Salmon, Steelhead, Striped Bass, and White Sturgeon).

TABLE 1. FISH SAMPLES EVALUATED FOR THE STATEWIDE ADVISORY FOR FISH THAT MIGRATE

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c]
American Shad	*Alosa sapidissima*	1	5	FMP	2006	Hg
		50	50	TSMP[a]	2003	Hg, Se
Chinook (King) Salmon	*Oncorhynchus tshawytscha*	7	28	CFCP	2000, 2002, 2003	Hg, Se
		6	26	CFCP	2000, 2002, 2003	PCBs
		4	17	CFCP	2000, 2002, 2003	Chlordanes, DDTs, Dieldrin, Toxaphene
		34	34	FMP	2005-2006	Hg
		5	15	RMP	2003, 2006	Hg, PCBs
		3	9	RMP	2006	PBDEs
		3	15	SRWP[a]	2005	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs, Toxaphene

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c]
		2	10	SWAMP	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		1	5	SWAMP	2018	Hg, PCBs, Se
		1	3	TSMP[a]	2002	Hg, Se
Rainbow Trout	*Oncorhynchus mykiss*	2	2	FMP	2005, 2007	Hg
		1	4	SRWP[a]	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Toxaphene
		5	29	TSMP[a]	1985, 1987, 1999, 2002	Hg
		3	17	TSMP[a]	1987, 1999, 2002	Se
		3	3	UCD	1993	Hg
Steelhead (Rainbow) Trout	*Oncorhynchus mykiss gairdneri*	27	27	FMP	2005, 2006	Hg
		3	15	SWAMP	2011-2012	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Striped Bass	*Morone saxatilis*	5	15	BPTCP[b]	1994	Hg, Se
		30	30	CALFED[b]	1999-2000	Hg
		1	3	CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		3	9	CFCP	2003	PCBs
		114	114	FMP	2005-2007	Hg

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c]
		17	17	FMP	2006-2007	Chlordanes, DDTs, Dieldrin, PCBs
		120	139	RMP	1997, 2000, 2003, 2006, 2009, 2014, 2015	Hg
		21	62	RMP	2000, 2003, 2009	Chlordanes, DDTs
		19	56	RMP	2000, 2003, 2009	Dieldrin
		22	65	RMP	2000, 2003, 2009, 2015	PBDEs
		27	80	RMP	2000, 2003, 2009, 2014, 2015	PCBs
		15	44	RMP	2000, 2003	Toxaphene
		11	33	RMP	2009, 2014	Se
		6	6	SRWP[a]	1999, 2000, 2002	Hg
		14	14	SWAMP	2011	Hg
		1	5	SWAMP	2011	Se
		1	6	TSMP[a]	1997	Se
		3	8	TSMP[a]	1988, 1997	Hg

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c]
White Sturgeon	*Acipenser transmontanus*	1	3	BPTCP[b]	1994	Hg, Se
		8	8	FMP	2006, 2007	Hg
		78	78	RMP	1997, 2000, 2003, 2006, 2009, 2014	Se
		29	50	RMP	1997, 2000, 2003, 2006, 2014	Hg
		15	40	RMP	2000, 2003, 2006, 2009	Chlordanes, DDTs, Dieldrin, PBDEs
		19	52	RMP	2000, 2003, 2006, 2009, 2014	PCBs
		8	19	RMP	2000, 2003	Toxaphene

Samples were analyzed as skinless fillets, with the following exceptions:
[a]Study report did not specify whether skin was removed from fillets prior to tissue analysis.
[b]Samples were analyzed as skin-on fillets.
[c]Data for organic chemicals (chlordanes, DDTs, dieldrin, PBDES, PCBs, or toxaphene) generated prior to 1998 were excluded from the analysis because data that are more recent are considered more reliable due to improved analytical methods and are likely to be more representative of fish caught today.

CHEMICAL CONCENTRATIONS

Most fish samples were prepared as skinless fillets; however, the BPTCP study analyzed samples with skin on, and the TSMP study did not report the fillet preparation method. Samples from these studies were included because the mercury concentrations were consistent with those reported from other studies on a species-specific basis. Additionally, the amount of mercury data available from non-TSMP studies is insufficient to provide statewide advice for American Shad. For this advisory, OEHHA used the 90th percentile of the chemical concentrations (in wet weight) for each fish species to estimate human exposure.

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, toxaphene, PBDEs (7 congeners), and PCBs (54 – 55 congeners).[22] Among the chemicals analyzed in fish tissue samples for the statewide dataset, only mercury and PCB levels were sufficiently high to impact consumption advice.

MERCURY

Most samples were analyzed for total mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA) at the CDFW Moss Landing Marine Laboratories (MLML). Some studies used other laboratories for analyses. The DMA method utilizes thermal decomposition and atomic absorption. OEHHA assumed all mercury detected was methylmercury, which is the most common form found in fish and is also the more toxic form (Bloom, 1992). Some samples were analyzed for mercury using cold vapor atomic fluorescence spectrometry or a flow injection mercury system. A small number of samples were analyzed for methylmercury rather than total mercury. The method detection limits (MDLs)[23] and reporting limits (RLs)[24] for total mercury were reported between 3 – 12 and 9 – 36 parts per billion (ppb), respectively, depending on the study. Although mercury was detected at commonly found concentrations in the TSMP study, the MDL and RL for mercury were not reported. Table 2 shows the number of samples, total number of fish, the mean and range of total length, the mean and range of mercury concentrations, and the 90th percentile of mercury concentrations in each species.

PCBS, PBDES, AND PESTICIDES

Pesticides, PBDEs, and PCBs in either individual fish or composite samples were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, PCBs, and PBDEs, each of the concentrations presented was the

[22] Congeners are related compounds with similar chemical forms. Of the 209 possible PBDE and PCB congeners, 6–7 and 48–54 are generally analyzed, respectively.
[23] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[24] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

sum of the detected parent compound, congeners, or metabolites, where applicable. Because the MDLs or RLs were relatively low (≤ 5 ppb), individual congeners or metabolites with concentrations reported as non-detects were assumed to be zero. This is a standard method of handling non-detect values for PCBs and other chemicals with multiple congeners or metabolites in a given sample when detection levels are adequate (US EPA, 2000a). Table 3 shows the number of samples, total number of fish, the mean and range of total length, the mean and range of PCB concentrations, and the 90th percentile of PCB concentrations in each species.

SELENIUM

The CDFW MLML and partnering laboratories analyzed fish tissue for selenium as individual and/or composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS). The ICP-MS method uses desolvation, atomization, and ionization with ion separation based on a mass-to-charge ratio to detect the total selenium concentration in a sample. The MDLs and the RLs for total selenium were reported at 17 – 230 and 17 - 700 ppb, respectively, depending on the study.

Concentrations of chlordanes, dieldrin, DDTs, PBDEs, and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008 and 2011). Selenium values for White Sturgeon were greater than corresponding ATL threshold values for daily consumption (i.e., > 1,000 ppb) but did not impact advice. With the exception of assessing for multiple chemical exposures, these chemicals were therefore not considered further for developing consumption advice and are not shown in this report.

TABLE 2. MERCURY CONCENTRATIONS IN FISH THAT MIGRATE BETWEEN CALIFORNIA RIVERS, ESTUARIES, AND COASTAL WATERS

Species	Number of Samples[a]	Total Number of Fish	Mean[b] Total Length (mm)	Range of Total Lengths[c] (mm)	Mercury Concentrations (ppb)		
					Mean[b]	90th Percentile[d]	Range[c]
American Shad	51	55	427	286 – 571	61	86	29 – 337
Chinook Salmon	50	95	794	510 – 1200	66	118	16 – 150
Steelhead Trout	41	80	532	410 – 930	62	120	0 – 165
Rainbow Trout	11	38	429	410 – 501	37	120	0 – 130
Steelhead	30	42	624	420 – 930	85	115	38 – 165
Striped Bass	293	329	596	457 – 1149	442	711	132 – 3500
White Sturgeon (all locations)	38	61	1359	1150 – 1727	345	510	149 – 914
White Sturgeon in South SF Bay[e]	16	27	1392	1170 – 1727	474	700	243 – 914
White Sturgeon Outside South SF Bay	22	34	1333	1150 – 1603	242	297	149 – 436

[a]Samples were prepared as skinless fillets, except as noted in the footnotes to Table 1.
[b]Means are an arithmetic average of individual values and/or a weighted average of composites.
[c]Range of individuals and/or range of the composites.
[d]The 90th percentile of the sample concentrations.
[e]South San Francisco Bay defined by CDFW as bay waters south of Interstate-80.

TABLE 3. PCB CONCENTRATIONS IN FISH THAT MIGRATE BETWEEN CALIFORNIA RIVERS, ESTUARIES, AND COASTAL WATERS

Species	Number of Samples[a]	Total Number of Fish	Mean[b] Total Length (mm)	Range of Total Lengths[c] (mm)	PCB Concentrations (ppb)		
					Mean[b]	90th Percentile[d]	Range[c]
Chinook Salmon	17	71	788	510 – 1200	8	11	1 – 22
Steelhead Trout	4	19	597	422 – 779	5	9	1 – 11
Rainbow Trout	1	4	422	n/a	11	n/a	n/a
Steelhead	3	15	644	485 – 779	3	4	1 – 5
Striped Bass	47	106	567	460 – 820	36	76	2 – 156
White Sturgeon (all locations)	19	52	1357	1155 – 1727	70	148	5 – 383
White Sturgeon in South SF Bay[e]	10	29	1395	1170 – 1727	104	343	13 – 383
White Sturgeon Outside South SF Bay	9	23	1308	1155 – 1560	28	55	5 – 57

[a]Samples were prepared as skinless fillets, except as noted in the footnotes to Table 1.
[b]Means are an arithmetic average of individual values and/or a weighted average of composites.
[c]Range of individuals and/or range of the composites.
[d]The 90th percentile of the sample concentrations.
[e]South San Francisco Bay defined by CDFW as bay waters south of Interstate-80.
n/a = not applicable due to a single sample

DEVELOPMENT OF GUIDELINES

The OEHHA fish advisory process considers the health benefits of fish consumption as well as the risk from exposure to the chemical contaminants found in fish. Benefits are included in the advisory process because there is considerable evidence and scientific consensus that fish should be part of a healthy well-balanced diet. Fish contain many nutrients that are important for general health and, in particular, help promote optimal growth and development of babies and young children, and may reduce the incidence of heart disease in adults (FDA/US EPA, 2017; American Heart Association, 2016; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish are a significant source of the beneficial omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) (USDA/USDHHS, 2020; Weaver et al., 2008).

The US Department of Agriculture (USDA) recommends "including at least 8 ounces of cooked seafood[25] per week. Young children need less, depending on their age and calorie needs."[26] According to the 2020–2025 Dietary Guidelines (USDA/USDHHS, 2020), "women who are pregnant or lactating should consume at least 8 and up to 12 ounces of a variety of seafood per week from choices that are lower in methylmercury." Additionally, "based on FDA and EPA's advice, depending on body weight, some women should choose seafood lowest in methylmercury or eat less seafood than the amounts in the Healthy U.S.-Style Dietary Pattern" (USDA/USDHHS, 2020). For more detailed information, see USDA/USDHHS (2020) and other USDA MyPlate.gov materials. The particular fish that people eat is an important factor in determining the net beneficial effects of fish consumption. For example, studies have shown that children of mothers who ate low-mercury fish during pregnancy scored better on cognitive tests compared to children of mothers who did not eat fish or ate high-mercury fish (Oken et al., 2005 and 2008). Accordingly, because of the high mercury content of certain fish species, the US Food and Drug Administration (FDA) and the US EPA recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children avoid consuming shark, Swordfish, tilefish (Gulf of Mexico), Bigeye Tuna, marlin, Orange Roughy, and King Mackerel (FDA/US EPA, 2017).

To address the potential health concerns associated with exposure to contaminants in sport fish, OEHHA has established ATLs for chemicals that are known to accumulate in the edible tissues of fish. ATLs consider both the toxicity of the chemical and potential benefits of eating fish. OEHHA uses the ATLs to determine the maximum number of servings per week that consumers can eat safely, for each species and from each location, to limit their exposure to these contaminants. Consumers can use OEHHA's guidance when choosing which fish and how much to eat as part of an overall healthy diet.

There are two sets of ATLs for methylmercury in fish because of the age-related toxicity of this chemical (OEHHA, 2008). The fetus and children are more sensitive to the toxic effects of methylmercury. Thus, the ATLs for the sensitive population, including women who might become pregnant (typically 18 to 49 years of age) and children 1–17 years of age, are lower than those for women 50 years and older and men 18 years and older. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLs, are provided in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene" (OEHHA, 2008) and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California

[25] Seafood as used here refers to fish and shellfish from freshwater and marine environments.
[26] Online at: https://www.myplate.gov/.

Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)" (OEHHA, 2011). A list of the ATLs used in this report is presented in the Appendix II.

With the exception of PCBs in White Sturgeon (see following discussion), OEHHA compared the 90th percentile of the mercury and PCB concentrations detected in the fillet for each fish species in this advisory to the corresponding ATLs to establish the maximum number of servings per week that could be consumed (see Appendix II). For fish fillets, a serving size is considered to be 8 ounces, prior to cooking, or about the size and thickness of a hand. Children should be given smaller servings. For smaller fish species, several individual fish may be required to yield a serving.

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of servings per week. Because some chemicals, such as mercury and PCBs, are known to have similar adverse effects, additivity of toxicity is assumed in such cases and may be assessed using multiple chemical exposure methodology (US EPA, 1989 and 2000b). If two or more chemicals with similar adverse effects are present in fish tissue, multiple chemical exposure methodology involving hazard index calculations is employed. This may result in advising the sensitive population to consume fewer servings per week than would be the case for the presence of either chemical alone, in a similar concentration. The potential effect of multiple chemical exposures (mercury and PCBs) was assessed in Chinook Salmon and Steelhead Trout, and was not found to impact advice. Advice for these species, as well as American Shad, was based solely on mercury concentrations for the sensitive population.

OEHHA recommends that individuals strive to meet the US Dietary Guidelines' seafood consumption recommendations,[27] while also adhering to federal and OEHHA recommendations to limit the consumption of fish with higher contaminant levels. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish species. People should eat no more than the recommended number of servings for each fish species or species group. When noted, OEHHA's consumption advice for a particular fish species can be extended to other closely related fish species[28] known to accumulate similar levels of contaminants.

Consumption advice should not be combined. That is, if a person chooses to eat a serving of fish from the "one-serving-a-week'' category, then they should not eat any other fish from any source (including commercial) until the next week. If a person chooses to eat a serving of fish from the "two-servings-per-week" category, they can combine fish species from that category, or eat one serving of fish from that category and one from a category that recommends more than two servings per week (if available), for a total of two servings in that week. Then they should not eat any other fish from any source (including commercial) until the following week.

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[27] Online at: https://www.dietaryguidelines.gov/.
[28] Fish species within the same genus are most closely related, and family is the next level of relationship.

CONSUMPTION ADVICE FOR FISH THAT MIGRATE IN STATEWIDE RIVERS, ESTUARIES, AND COASTAL WATERS

The following advice is based on mercury and/or PCB concentrations and applies to these species when caught from all anadromous rivers, estuaries, and coastal waters. The advice covers both the sensitive population and the general population. The sensitive population is defined as women 18 to 49 years and children 1 to 17 years, and the general population is defined as women 50 years and older and men 18 years and older. Mercury and PCB concentrations are reported below, however, it should be noted that PCB data for American Shad were not available. PCB concentrations were high enough to impact advice (or match advice based on mercury levels) for Chinook Salmon, Striped Bass, and White Sturgeon.

American Shad

The 90th percentile value of sample mercury concentrations in American Shad was 86 ppb. Based on the concentration of mercury, OEHHA recommends a maximum of two servings per week for the sensitive population and a maximum of seven servings a week for the general population. PCBs were not analyzed in this species.

Chinook (King) Salmon

The 90th percentile values of sample mercury and PCB concentrations in Chinook (King) Salmon were 118 and 11 ppb, respectively. OEHHA recommends a maximum of two servings per week for the sensitive population based on the concentration of mercury, and a maximum of five servings a week for the general population based on mercury or PCBs.

Steelhead Trout (Rainbow Trout, Steelhead)

The 90th percentile values of sample mercury and PCB concentrations in Steelhead Trout were 120 and 9 ppb, respectively. Mercury and PCB 90th percentile concentrations were as follows, Rainbow Trout (Hg: 120 ppb, PCB: n/a[29] ppb) and Steelhead (Hg: 115, PCB: 4 ppb). Based on the concentration of mercury in these species, OEHHA recommends a maximum of two servings a week for the sensitive population, and a maximum of five servings a week for the general population. PCBs did not impact advice.

Striped Bass

The 90th percentile values of sample mercury and PCB concentrations in Striped Bass were 711 and 76 ppb, respectively. OEHHA recommends no consumption for the

[29] The 90th percentile could not be calculated based on a single sample of 11 ppb.

sensitive population based on the concentration of mercury, and a maximum of one serving a week for the general population based on mercury or PCBs.

WHITE STURGEON

The 90th percentile values of statewide mercury and PCB concentrations in White Sturgeon were 510 and 148 ppb, respectively, which would result in advice for no consumption of this species for the sensitive (based on mercury or PCBs) and the general population groups (based on PCBs). Using the following rationale, OEHHA opted to develop consumption advice for this species using the 90th percentile for mercury concentration (510 ppb) in the statewide dataset and the mean PCB concentration (104 ppb) for samples collected from the South San Francisco Bay, the area with the highest known PCB levels in White Sturgeon in California.

Nearly all White Sturgeon samples (98%) were collected from Region 2 (San Francisco Bay Regional Water Control Board), as shown in Appendix I. White Sturgeon samples analyzed for mercury were collected from a variety of locations throughout the region. However, about half of all White Sturgeon PCB samples (10 of 19 samples comprising 29 of 52 total fish) were collected from a relatively small area in the South San Francisco Bay (see map in Appendix I). White Sturgeon PCB levels in this area were highly variable, ranging from 13 to 383 ppb, and included the only three samples that exceeded the do not consume threshold for PCBs. For the statewide dataset, the 90th percentile for PCBs in White Sturgeon was heavily influenced by two very high South San Francisco Bay composite samples. Even so, if a site-specific advisory[30] were developed for the South San Francisco Bay, OEHHA would advise no consumption for the sensitive population, based on the mean mercury concentration (474 ppb), and one serving a week for the general population, based on either the mean mercury or PCB concentration (104 ppb). Thus, OEHHA determined that it would be inappropriate to develop statewide advice for no consumption of White Sturgeon based on the 90th percentile value for PCBs when site-specific advice based on the mean PCB concentration for the area with the highest PCB levels reported in this species would recommend a maximum of one serving a week for the general population.

OEHHA therefore recommends no consumption of White Sturgeon for the sensitive population based on mercury, and a maximum of one serving a week for the general population based on mercury or PCBs.

[30] Advice based on the mean mercury (474 ppb) and PCB (104 ppb) concentrations in White Sturgeon caught from the South San Francisco Bay would result in no consumption for the sensitive population based on mercury, and a maximum of one serving a week for the general population based on mercury or PCBs.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish that migrate in rivers, estuaries, and coastal waters are shown in Table 4.

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH THAT MIGRATE IN STATEWIDE RIVERS, ESTUARIES, AND COASTAL WATERS

Fish Species	Women 18–49 years and Children 1–17 years	Women 50 years and older and Men 18 years and older
American Shad	2	7
Chinook (King) Salmon	2	5
Steelhead Trout	2	5
Striped Bass	0	1
White Sturgeon	0	1

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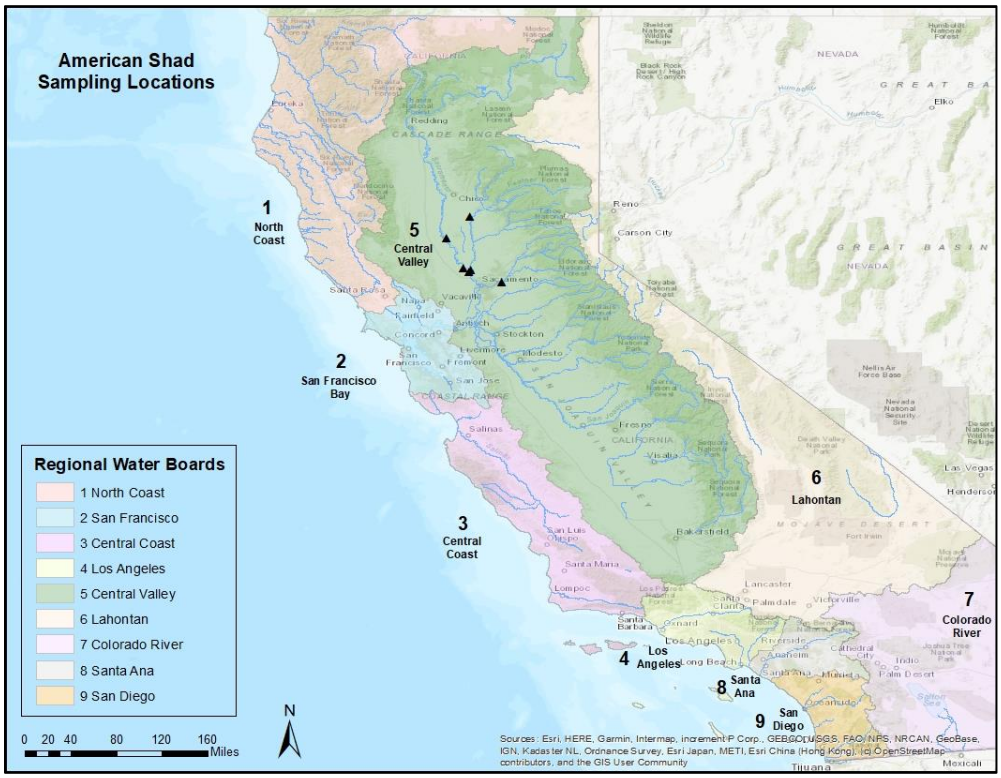
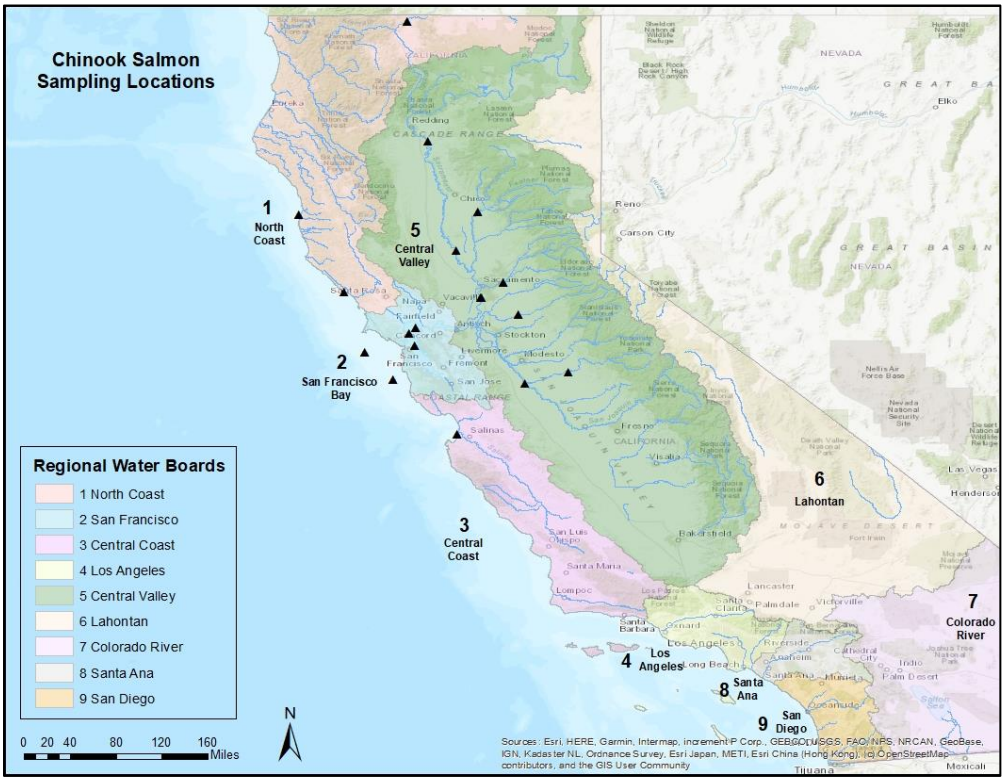
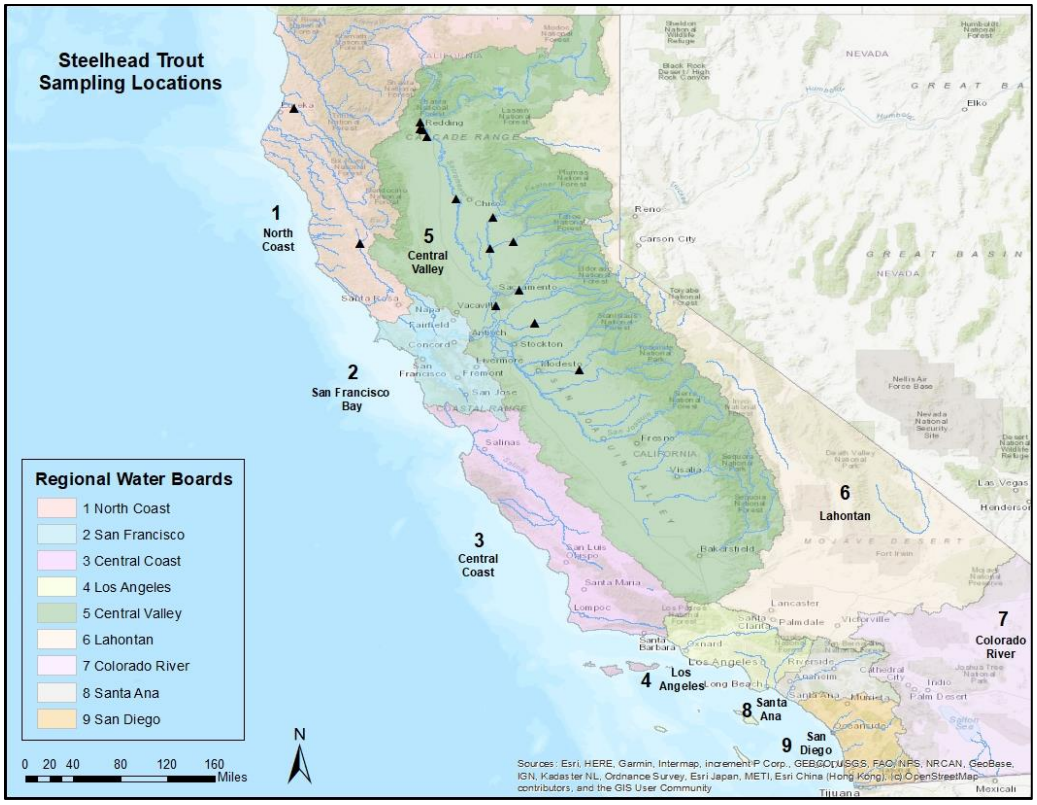
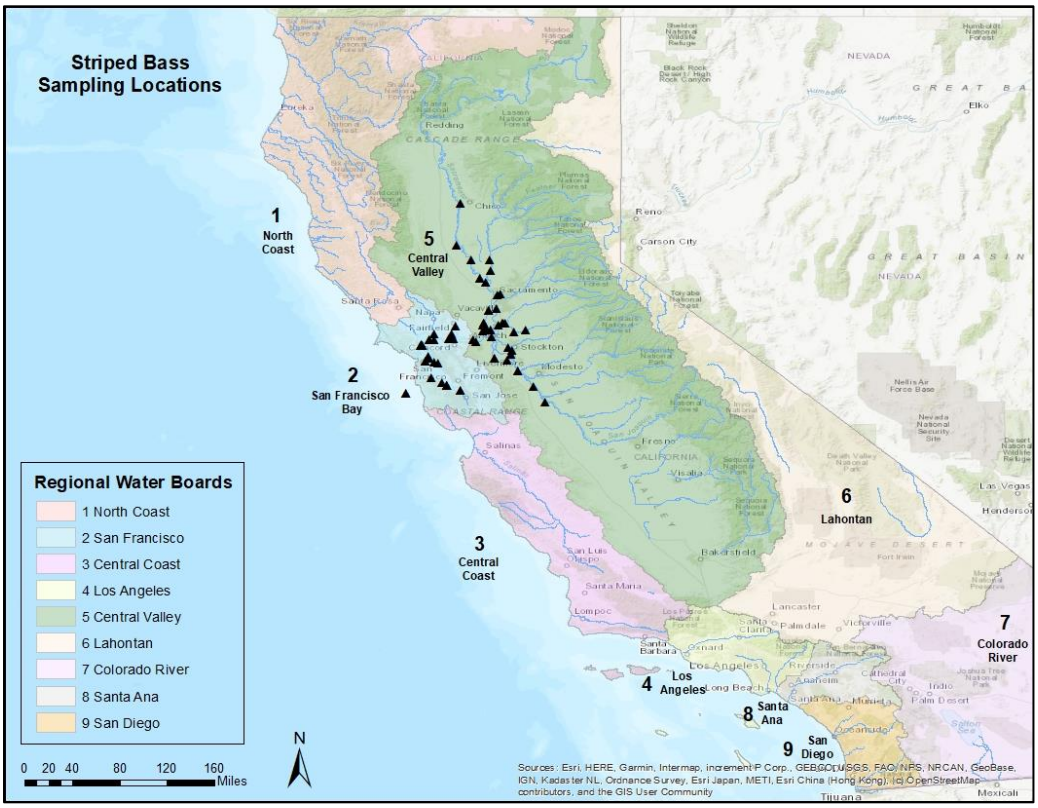
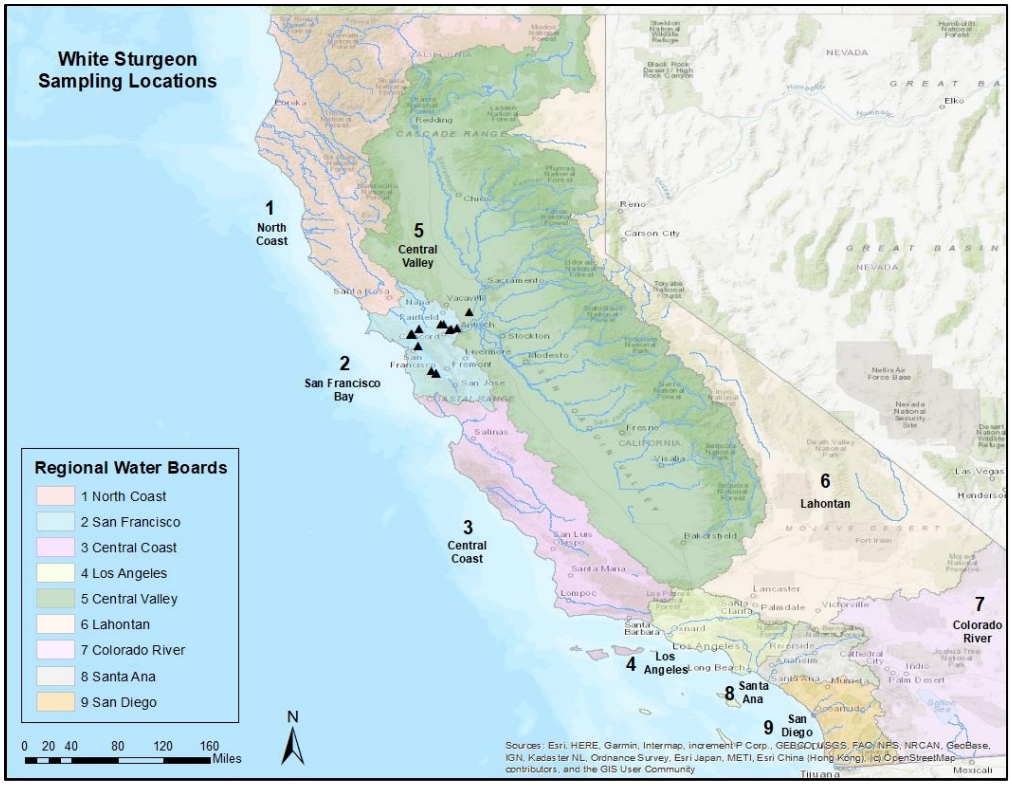
APPENDIX I. SAMPLING LOCATIONS FOR MERCURY AND PCB ANALYSES BY SPECIES






Steelhead Trout
Sampling Locations
Regional Water Boards
1 North Coast
2 San Francisco
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River
8 Santa Ana
9 San Diego
1 North Coast
2 San Francisco Bay
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River
8 Santa Ana
9 San Diego
0 20 40 80 120 160 Miles
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community


Striped Bass
Sampling Locations
Regional Water Boards
1 North Coast
2 San Francisco
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River
8 Santa Ana
9 San Diego
1 North Coast
2 San Francisco Bay
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River
8 Santa Ana
9 San Diego
0 20 40 80 120 160 Miles
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community


White Sturgeon
Sampling Locations
1
North
Coast
2
San Francisco
Bay
3
Central
Coast
4
Los
Angeles
5
Central
Valley
6
Lahontan
7
Colorado
River
8
Santa
Ana
9
San
Diego
Regional Water Boards
1 North Coast
2 San Francisco
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River
8 Santa Ana
9 San Diego
0 20 40 80 120 160
Miles
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community


White Sturgeon
PCB Sampling Locations
Grizzly Bay
San Pablo
Bay
Suisun Bay
South
Bay
North Bay (9 Samples, 23 fish)
South Bay (10 Samples, 29 fish)
San Francisco Bay
0 2.5 5 10 15 20
Miles
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

APPENDIX II. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs; OEHHA, 2008 and 2011) guide the development of advice for people eating sport fish. ATLs are levels of contaminants found in fish that correspond to the maximum numbers of recommended fish servings. OEHHA uses ATLs to provide advice to prevent consumers from being exposed to:

- More than the reference dose[31] on an average daily basis for chemicals not known to cause cancer, such as methylmercury, or
- For cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer risk level is the maximum acceptable risk level recommended by the US EPA (2000b) for fish advisories.

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for one to seven eight-ounce servings per week. The most health-protective ATLs for each chemical, selected from either cancer or non-cancer based risk, are shown in the table below for zero to seven servings per week. When the guidelines for eating fish from a water body are followed, exposure to chemicals in fish from the water body would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

ADVISORY TISSUE LEVELS FOR SELECTED ANALYTES

Contaminant	Consumption Frequency Categories (8-ounce servings/week)[a] 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
MeHg (Women 18–49 and children 1–17)	≤ 31	>31–36	>36–44	>44–55	>55–70	>70–150	>150–440	>440
MeHg (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	≤ 1,000	>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

[a] 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.

[31] The reference dose is an estimate of the maximum daily exposure to a chemical likely to be without significant risk of harmful health effects over a lifetime.