OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

Statewide Advisory for Eating Fish from California Coastal Locations Without Site-Specific Advice

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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
CCAMP	Central Coast Ambient Monitoring Program
CDFW	California Department of Fish and Wildlife
CFCP	Coastal Fish Contamination Program
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
EMAP	Environmental Monitoring and Assessment Program
FDA	Food and Drug Administration
Hg	mercury
MDL	method detection limit
mm	millimeters
N	sample size
nm	nautical miles
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
SCB	Southern California Bight

Se	Selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TSMP	Toxic Substances Monitoring Program
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. This task 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 in the section on public health advisories.

This report presents guidelines for eating fish from the California coast. The report provides background information and a description of how the guidelines were developed. The resulting advice is summarized in the illustration after the Table of Contents and List of Figures, Tables, and Appendices.

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Women 18 - 45 years and Children 1 - 17 years


Croaker


Low-PCB Surfperch


Queenfish


Very Low-PCB Surfperch


Topsmelt

2 total servings a week


Small Flatfish


California Corbina


Barred Sand Bass


Cabezon


Lingcod


Kelp Bass


Medium-Mercury Rockfish


High-Mercury Rockfish


Sharks

6 total servings a week OR **1 total serving a week**

Do not eat

Women 46 years and older and Men 18 years and older


Croaker


Queenfish


Medium-Mercury Rockfish

4 total servings a week


Small Flatfish


Very Low-PCB Surfperch


Topsmelt


Low-PCB Surfperch


Cabezon


Barred Sand Bass


Kelp Bass


Lingcod


California Corbina


High-Mercury Rockfish


Sharks

6 total servings a week OR **2 total servings a week** OR **1 total serving a week**

Croaker species include: White and Yellowfin
Small Flatfish species include: Diamond Turbot, Longfin Sanddab, Speckled Sanddab, Spotted Turbot

Medium-Mercury Rockfish species include: Black, Blue, Brown, Kelp, Olive, Rosethorn, and Vermillion
High-Mercury Rockfish species include: Black and Yellow, China, Copper and Gopher

Very Low-PCB Surfperch species include: Barred, Black, Pile, Rainbow, Spotfin, and White
Low-PCB Surfperch species include: Shiner, Silver, and Walleye

What is a serving?

For Adults **For Children**

A serving is about the size and thickness of your hand for fish fillets. Give children smaller servings.

Why eat fish?

Eating fish is good for your health. Fish have omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

What is the concern?

Some fish have high levels of mercury and PCBs. Mercury can harm the brain, especially in unborn babies and children. PCBs can cause cancer.

Do not combine advice. If you eat 2 servings of fish from the "2 total servings per week group", do not eat any other fish that week from any source (caught or store bought).

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INTRODUCTION

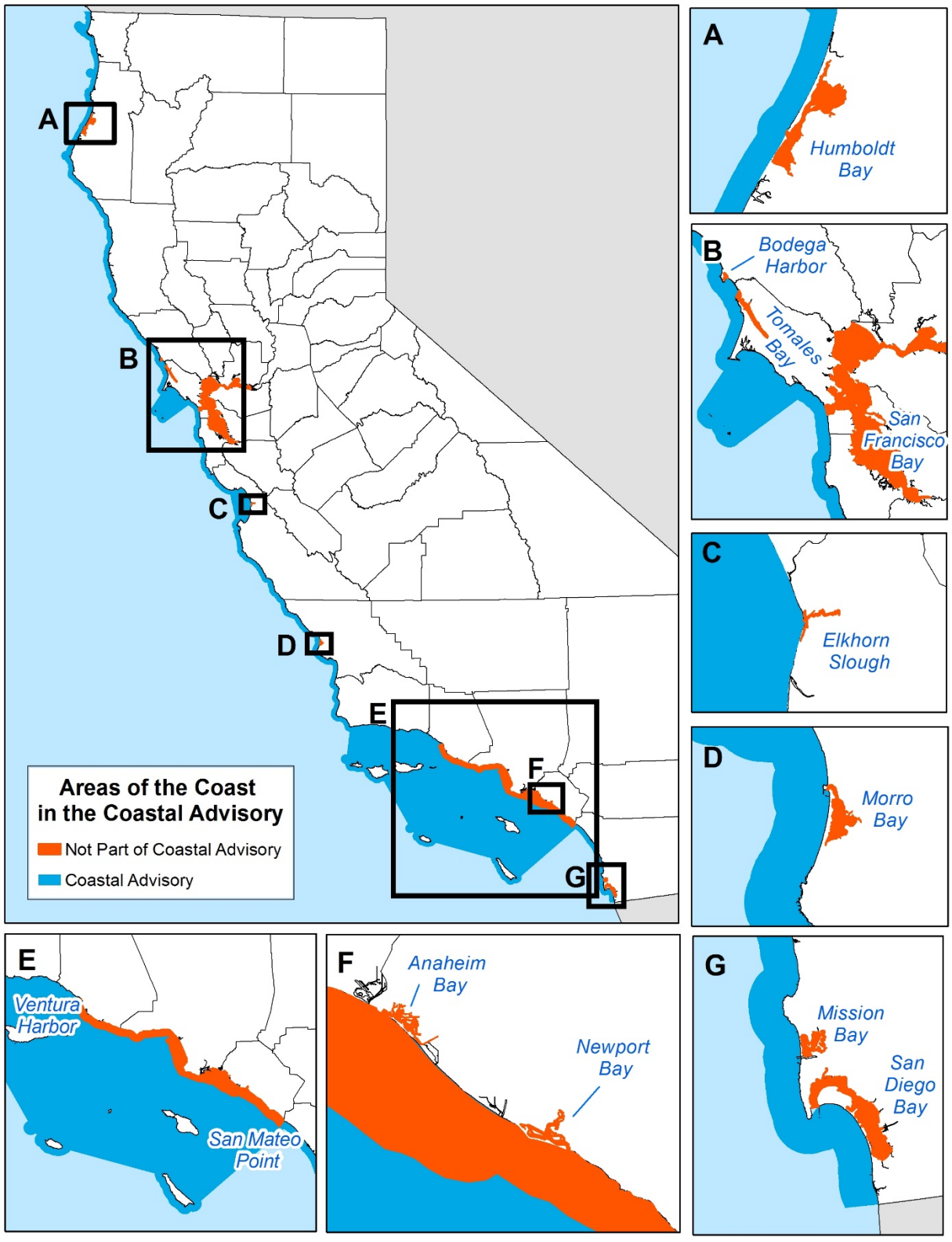
The California coast spans a wide array of marine habitats and a large diversity of fisheries. These habitats range from virtually pristine coastline to those adjacent to heavily developed urban areas. The Office of Environmental Health Hazard Assessment (OEHHA) has previously issued advisories for coastal areas with known environmental contamination (i.e., areas near the Palos Verdes Shelf in southern California), the stretch of coastline from Ventura Harbor to San Mateo Point in Orange County, and for several bays near large urban populations (i.e., Mission and San Diego Bays, and San Francisco Bay). However, there are several hundred miles of coastline and coastal state waters for which fish consumption advisories have not yet been issued. Thus, OEHHA developed a fish consumption advisory for the California coast, excluding enclosed bays and areas with existing advisories.

LOCATION

This technical report presents guidelines for eating fish caught from coastal waters of California, excluding enclosed bays (for which advisories may be developed in the future) and areas with existing advisories. The excluded areas are as follows: Humboldt Bay, Bodega Harbor, Tomales Bay, San Francisco Bay, Elkhorn Slough, Morro Bay, coastal areas from Ventura Harbor to San Mateo Point[1], Anaheim Bay, Newport Bay, Mission Bay, and San Diego Bay. Coastal state waters are defined as extending three nautical miles (nm) from the mean low tide line and three nm beyond the outermost islands (e.g., the Channel or Farallon islands), including all waters between those islands and the coast, from the Oregon/California border to the United States/Mexico border. Coastal areas of California included and excluded from the California Coastal Advisory are shown in Figure 1.

[1] This segment is covered by three separate advisories (Ventura Harbor to Santa Monica Pier, Santa Monica Beach south of Santa Monica Pier to Seal Beach Pier, and South of Seal Beach Pier to San Mateo Point) at www.oehha.ca.gov/fish/advisories.

FIGURE 1. MAP OF THE CALIFORNIA COASTLINE



Approach Used

OEHHA used the results from six monitoring studies described in this report to develop the California Coastal Advisory. OEHHA uses the following general process in developing consumption advice for sport fish:

1) Evaluation of all fish contaminant data available from a water body 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 an appropriate measure of central tendency (often a weighted arithmetic mean[2]) and other descriptive statistics of the contaminant data, as appropriate, for a chemical of potential concern for the selected fish species.
4) Comparison of the calculated chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of potential concern.
5) Development of fish consumption advice based on a thorough review of the data and best professional judgment relating to benefits and risks of consuming a particular fish species.

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 considered the health benefits associated with including fish in the diet (OEHHA, 2008 and 2011). The ATLs should not be interpreted as static "bright lines," but one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of benefits and risks of consuming sport fish.

[2]Means are an arithmetic average of individual values and/or a weighted average of composites. 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, combined.

CHEMICALS OF POTENTIAL CONCERN

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

Mercury is a natural element found in some rock and soil. Human activities, such as burning coal and the 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 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.

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

Selenium is a naturally occurring metalloid and an essential nutrient for many important biological processes, including thyroid regulation and vitamin C metabolism. Selenium toxicity can include symptoms ranging from hair loss and gastrointestinal distress to dizziness and tremors.

Chlordanes, 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 water bodies in California. At a high enough exposure level, these chemicals may cause cancer or other adverse effects.

Polybrominated diphenyl ethers (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.

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” and “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)” (OEHHA, 2008 and 2011).

Fish used for the California Coastal Advisory were analyzed for one or more of the following contaminants: mercury (as a measure of methylmercury), PCBs, PBDEs, selenium, and legacy pesticides (chlordanes, dieldrin, DDTs (DDT and its metabolites),

and toxaphene). Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study.

DATA SOURCES

The guidelines for eating fish from the California coast are based on the chemicals detected in the fish collected in the six monitoring studies described below. These studies met OEHHA's data quality criteria, including adequate documentation of sample collection, fish preparation method (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 composite of multiple fish for which contaminant data were reported, or the act of collecting fish or shellfish for chemical analysis ("sampling" or "sampled").

Central Coast Ambient Monitoring Program (CCAMP)

This monitoring program is a regional-scale water quality monitoring and assessment program administered by the Central Coast Regional Water Quality Control Board (CCRWQCB). CCAMP is funded by the Surface Water Ambient Monitoring Program (SWAMP) and the Bay Foundation of Morro Bay. CCAMP follows SWAMP protocols for data quality and management (CCRWQCB, 2016).

Coastal Fish Contamination Program (CFCP)

The Coastal Fish Contamination Program was a statewide monitoring program of chemical contamination in sport fish and shellfish in nearshore (marine and estuarine) waters in California (Gassel et al., 2005). The CFCP was designed to provide data for assessing human health risks from sport fish consumption. The program began as a result of legislation (Assembly Bill 2872) passed in 2000 and continued for five years until it was halted due to budget constraints.

Environmental Monitoring and Assessment Program (EMAP)

The US Environmental Protection Agency (US EPA) previously sponsored the EMAP to develop tools to monitor and assess the ongoing status of national ecological resources. The EMAP Western Pilot Study was launched to generate data for state and regional assessments of waters in the western United States. Coastal watersheds in Northern and Southern California were two areas of special focus for this program. EMAP collected field data from 1990 to 2006 (US EPA, 2006).

Surface Water Ambient Monitoring Program (SWAMP) Coastal Fish Contamination Survey

SWAMP is a California state program that monitors water quality in state surface waters. The Coastal study was a two-year survey of contaminants in California coastal

fish, conducted in 2009-2010 (SWRCB, 2012). The sampling design was modeled after the approach described in "Health Advisory and Safe Eating Guidelines for Fish from Coastal Areas of Southern California: Ventura Harbor to San Mateo Point" (OEHHA, 2009). The coast was divided into 68 spatial units termed "zones." Zones focused on nearshore areas in waters from 60-200 m in depth. Sampling efforts from the SWAMP program were leveraged with other sampling programs (the Southern California Bight (SCB) RMP and the San Francisco Bay RMP), to maximize the amount of species and samples collected. The Los Angeles Regional Water Quality Control Board (LARWQCB) provided additional funds to sample the SCB.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP (1976-2003) was a state water quality monitoring program managed by the State Water Resources Control Board (SWRCB, 2013). 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 staff collected a variety of fish samples from coastal waters.

REGIONAL MONITORING PROGRAM (RMP)

The Bay Protection and Toxic Cleanup Program (BPTCP) funded a pilot study in 1994 to identify chemicals, fish species, and geographical regions of concern in San Francisco Bay. This study was managed by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) and conducted by the California Department of Fish and Wildlife (CDFW). Sites were sampled throughout the Bay to characterize the extent and severity of contamination. Samples from this pilot program are listed as "RMP (BPTCP)".

Following the original BPTCP pilot study, monitoring of chemicals in fish in San Francisco Bay continued every three years under the purview of the 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 comprised of waste dischargers, industry representatives, regulators, scientists, and community advocates. One of the objectives for the RMP fish contamination monitoring is to produce the information needed for updating fish consumption advisories. RMP monitoring data for shark in San Francisco Bay was used in the development of the advice for shark consumption (see discussion below).

FISH SAMPLED FROM THE CALIFORNIA COAST

The data set used in this advisory ("coastal data set") was derived from the six monitoring studies listed above; they were retrieved from the California Environmental

Data Exchange Network (CEDEN[3]). Fish sampling data were excluded from the data set when they did not meet either CDFW's legal size requirements or OEHHA's criteria for minimum "edible" size based on species size at maturity and professional judgment (OEHHA, 2005). Fish sampling data from areas with existing advice were also excluded (see discussion below in the section "Consumption Advice for Fish from the California Coast").

In most cases, a species was only retained in the data set if there were mercury data for at least 30 individual fish taken from a total of at least three sites. Mercury is considered the "risk driver" (chemical resulting in the most restrictive consumption advice) for a majority of species in California and thus, monitoring programs often focus on analyzing for mercury. By using this criterion, we maximized the number of species in the advisory.

When reasonable, we combined related species into one of six "fish groups:" croakers, rockfishes, sea basses, sharks, small flatfishes, and surfperches. In some cases, this approach increased sample size sufficiently to develop advice for species that otherwise would not have met the sample size criteria. Another advantage of combining related species into a fish group is to simplify risk communication. For a species to be included in a fish group, a minimum of nine fish (either as individual or composite samples), collected from at least one site, was required.

Once fish groups were identified, individual species in a fish group were rank-ordered, based on the concentration of a particular contaminant. In most cases, contaminant concentrations were comparable among species within a group, i.e., consumption advice for an individual species was generally the same or close to that for the group as a whole. In these circumstances, a single advisory was developed for the whole group. However, for two fish groups, Rockfish and Surfperch, contaminant concentrations were notably different (i.e., sufficient to change consumption advice) among species within a group. Rockfish and Surfperch species were found to fall largely into two consumption frequencies, based on mercury and PCB concentrations, respectively. For this reason, the rockfish group was split into medium- and high-mercury groups and the surfperch group was split into very low- and low-PCB groups (see discussion below in the section "Consumption Advice for Fish from the California Coast").

Following the exclusion and grouping processes described, the data set was comprised of 33 species and 2,481 fish. Shark were not included in this data set, but were evaluated separately as described below. There were not sufficient data to evaluate other species that may be found in these water bodies.

Using the original exclusion criteria (not using fish sampling data from enclosed bays and areas with existing advisories), there were insufficient numbers of shark sampling

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[3] http://ceden.waterboards.ca.gov/AdvancedQueryTool

data to provide advice for shark species. However, shark are known to frequently have high levels of mercury. The US Food and Drug Administration (FDA) and US EPA issued a joint consumer advisory on methylmercury in fish recommending, in part, that women who may become pregnant, pregnant women, nursing mothers, and young children do not consume shark (FDA/US EPA, 2004; 2014). OEHHA determined it was important to include shark in the California Coastal Advisory. In order to increase the amount of sampling data for these species, sampling data from enclosed bays and areas with existing advisories (excluding Ventura Harbor to San Mateo Point, see discussion below) were included in this report. By including data for related species with similar contaminant levels from the additional sites, and using the sample size criteria for an individual species or a fish group, there were sufficient data to provide advice for three shark species. The resulting data set was comprised of a total of 301 sharks caught from 32 sites.

A summary of all fish species included in the advisory is shown in Tables 1 (finfish) and 2 (shark), including the name of the species, project name, years sampled, and contaminants analyzed. Maps of sampling sites for various fish species and fish groups included in the advisory are shown in Figures 2-9.

FIGURE 2. MAP OF SAMPLING SITES FOR CROAKER SPECIES

FIGURE 3. MAP OF SAMPLING SITES FOR SMALL FLATFISH SPECIES

FIGURE 4. MAP OF SAMPLING SITES FOR MEDIUM-MERCURY ROCKFISH SPECIES

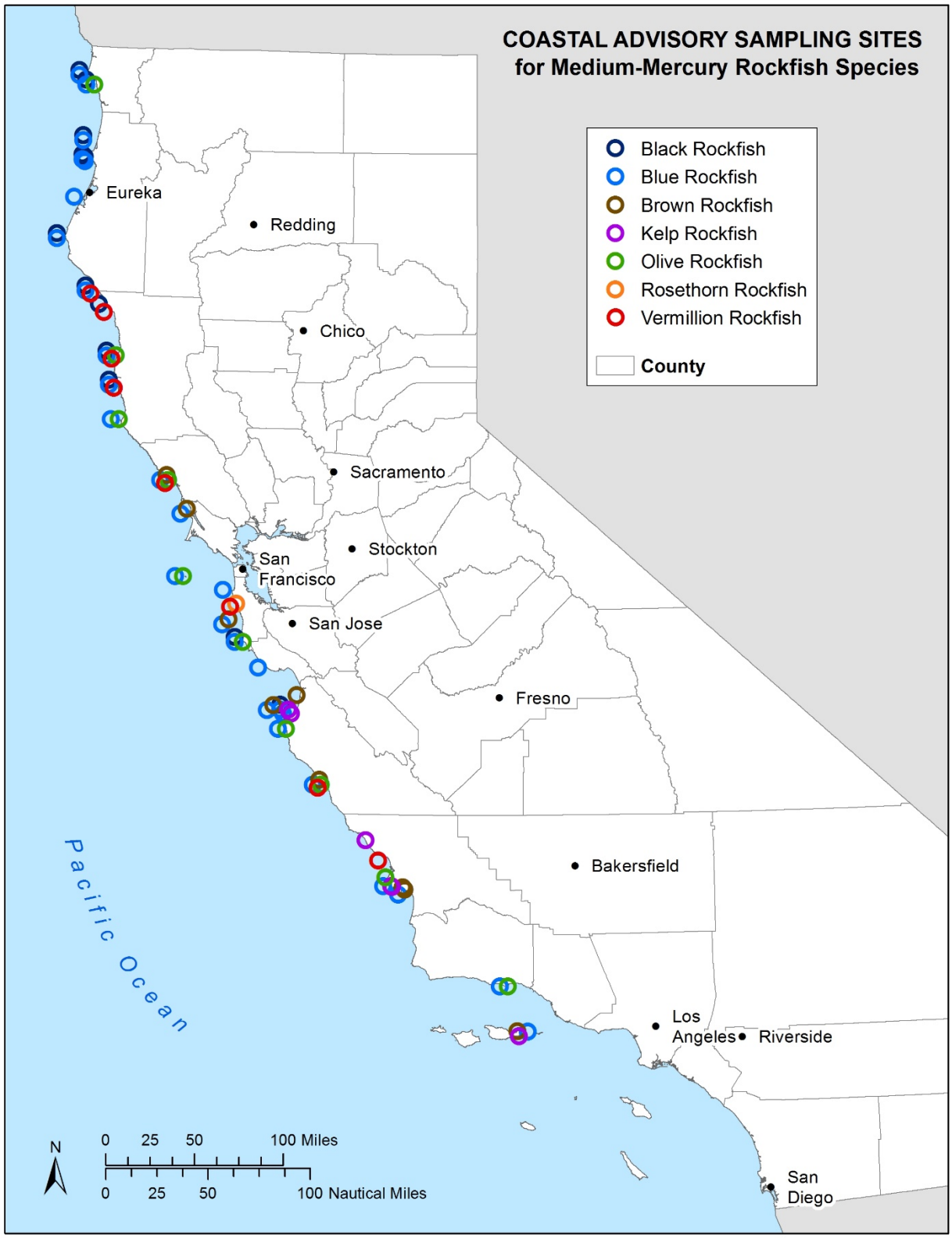

FIGURE 5. MAP OF SAMPLING SITES FOR HIGH-MERCURY ROCKFISH SPECIES

FIGURE 6. MAP OF SAMPLING SITES FOR VERY LOW-PCB SURFPERCH SPECIES

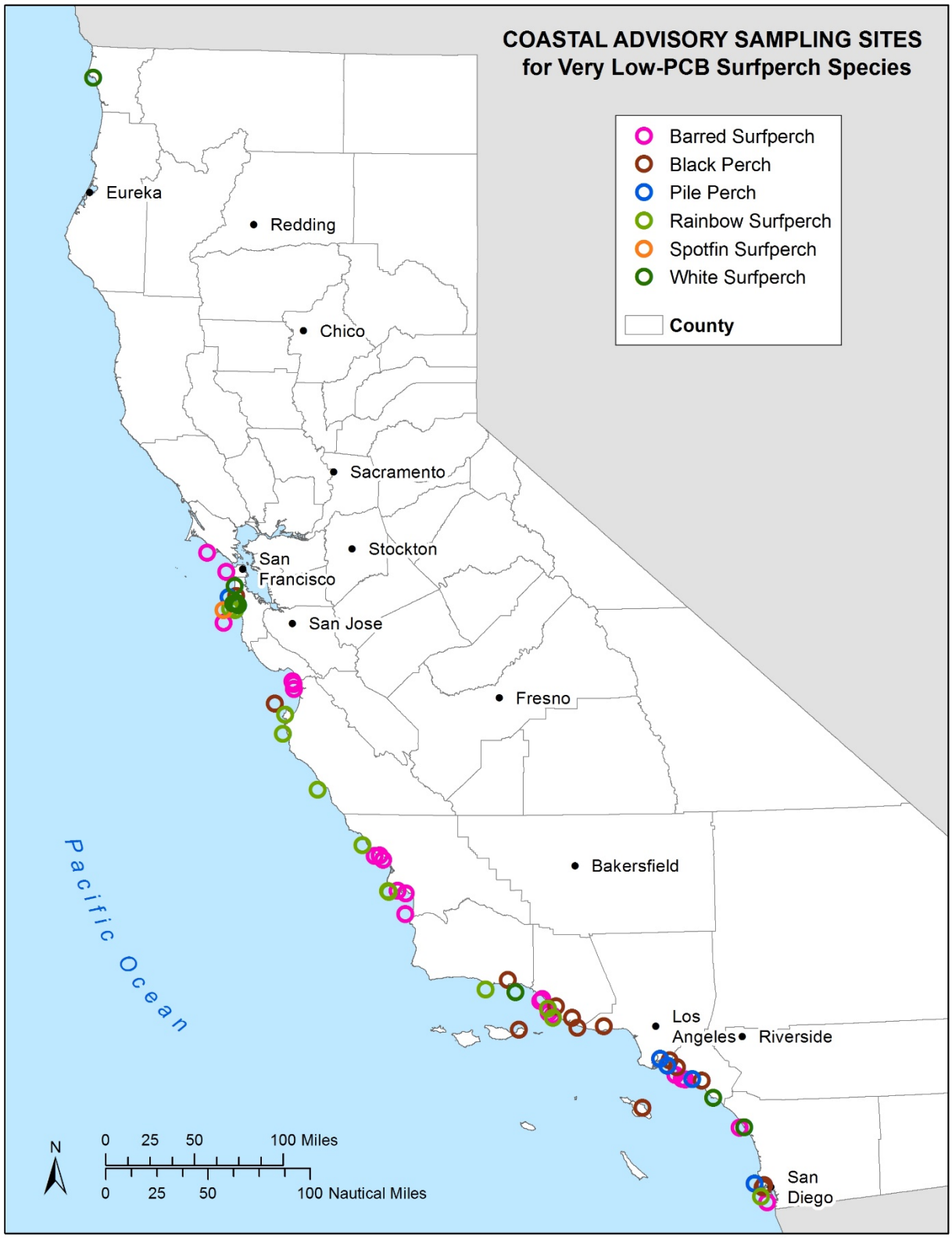

FIGURE 7. MAP OF SAMPLING SITES FOR LOW-PCB SURFPERCH SPECIES

FIGURE 8. MAP OF SAMPLING SITES FOR CABEZON, LINGCOD, SEA BASS SPECIES AND TOPSMELT

FIGURE 9. MAP OF SAMPLING SITES FOR SHARK SPECIES

TABLE 1. FISH SAMPLES EVALUATED FOR THE CALIFORNIA COASTAL ADVISORY

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Barred Sand Bass	*Paralabrax nebulifer*	SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Barred Surfperch	*Amphistichus argenteus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Hg
Black Perch	*Embiotoca jacksoni*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2002	DDTs, Hg, PCBs
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Black Rockfish	*Sebastes melanops*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Hg
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Black and Yellow Rockfish	*Sebastes chrysomelas*	CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Hg, PCBs, Se
Blue Rockfish	*Sebastes mystinus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		TSMP	1989	Hg, Se
		TSMP	1990	Hg, Se
Brown Rockfish	*Sebastes auriculatus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Cabezon	*Scorpaenichthys marmoratus*	SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
California Corbina	*Menticirrhus undulatus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2002	DDTs, Hg, PCBs,
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
China Rockfish	*Sebastes nebulosus*	CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Copper Rockfish	*Sebastes caurinus*	SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Diamond Turbot	*Hypsopsetta guttulata*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Gopher Rockfish	*Sebastes carnatus*	CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Kelp Bass	*Paralabrax clathratus*	SWAMP Coastal Study	2009	Hg, Se
Kelp Rockfish	*Sebastes atrovirens*	CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Hg, PCBs, Se
		TSMP	1988	Hg, Se
		TSMP	1989	Hg, Se
		TSMP	1990	Hg, Se

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Lingcod	*Ophiodon elongatus*	CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Hg
		CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Longfin Sanddab	*Citharichthys xanthostigma*	CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Olive Rockfish	*Sebastes serranoides*	CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Pile Perch	*Rhacochilus vacca*	CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2002	DDTs, Hg, PCBs
Queenfish	*Seriphus politus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Rainbow Surfperch	*Hypsurus caryi*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Rosethorn Rockfish	*Sebastes helvomaculatus*	CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Shiner Perch	*Cymatogaster aggregata*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		TSMP	1993	Hg, Se
Silver Surfperch	*Hyperprosopon ellipticum*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Speckled Sanddab	*Citharichthys stigmaeus*	CCAMP	2004	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		EMAP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Spotfin Surfperch	*Hyperprosopon anale*	CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
Spotted Turbot	*Pleuronichthys ritteri*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Hg, PCBs
Topsmelt	*Atherinops affinis*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se,
		TSMP	1988	Hg, Se
Vermillion Rockfish	*Sebastes miniatus*	CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Walleye Surfperch	*Hyperprosopon argenteum*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
White Croaker	*Genyonemus lineatus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		CFCP	2002	DDTs, Hg, PCBs
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se

Common Name	Scientific Name	Project or Program name	Year Collected	Contaminants Analyzed
White Surfperch	*Phanerodon furcatus*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Yellowfin Croaker	*Umbrina roncador*	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene

Hg = Mercury, Se = Selenium

TABLE 2. SHARK SAMPLES EVALUATED FOR THE CALIFORNIA COASTAL ADVISORY

Common Name	Scientific Name	Project	Year Collected	Contaminants Analyzed
Brown Smoothhound Shark	*Mustelus henlei*	CFCP	1998	Hg
		CFCP	1999	Hg
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		RMP (BPTCP)	1994	Hg, Se
		RMP	2003	Hg, PCBs
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		TSMP	1998	Hg, Se
Gray Smoothhound Shark	*Mustelus californicus*	CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		TSMP	1988	Hg, Se
		TSMP	1989	Hg, Se
		TSMP	1991	Hg, Se
		TSMP	1992	Hg, Se
		TSMP	1993	Hg, Se
		TSMP	1994	Hg, Se
		TSMP	1997	Hg, Se
Leopard shark	*Triakis semifasciata*	CFCP	1999	Hg
		CFCP	2000	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		CFCP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene

Common Name	Scientific Name	Project	Year Collected	Contaminants Analyzed
Leopard shark	*Triakis semifasciata*	CFCP	2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		RMP	1997	Hg
		RMP	2000	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Toxaphene
		RMP	2003	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Toxaphene
		RMP	2009	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se
		SWAMP Coastal Study	2009	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		SWAMP Coastal Study	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se

Hg = Mercury, Se = Selenium

CHEMICAL CONCENTRATIONS

As shown in Tables 1 and 2, samples were analyzed for total mercury, selenium, chlordanes, DDTs, dieldrin, toxaphene, PBDEs, and PCBs (54 congeners[4]). Most samples were prepared as skinless fillets. However, Longfin Sanddab, Speckled Sanddab, surfperch (Black Perch, Rainbow Surfperch, Silver Surfperch, Walleye Surfperch, and White Surfperch), and Topsmelt were prepared as eviscerated whole bodies (with or without head) because of their small size.

Samples were analyzed either individually or as composites. Composites were prepared from equal amounts of tissue from several similarly sized fish of a single species. Following the US EPA guidelines in preparing composite samples, the length of the smallest fish in a composite must be at least 75% of the length of the largest fish in the composite (US EPA, 2000a).

For this advisory, OEHHA used the weighted (by the number of individual fish) arithmetic mean (average) of the chemical concentrations (in wet weight) for each fish species or fish group (croakers, rockfishes, sea basses, small flatfishes, shark, and surfperches) to estimate average human exposure.

[4] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54 are generally reported.

MERCURY

Samples were analyzed for total mercury, either as individual fish or composite samples, using either a direct mercury analyzer (DMA; used in RMP, CFCP, SWAMP, and TSMP) or flow injection mercury system (FIMS; used in CCAMP) at the CDFW Moss Landing Marine Laboratory or the US EPA Region IX laboratory. The method of mercury analysis for the EMAP study was not recorded in CEDEN.

OEHHA assumed all total mercury detected was methylmercury; methylmercury is the most common form found in fish and is also the more toxic form (Bloom, 1992). Table 3 shows the averages and ranges for total length[5] and mercury concentrations in individual fish species and fish groups. The method detection limit (MDL)[6] for total mercury and the reporting limit (RL)[7] for each data source are listed in Appendix 1.

PESTICIDES, PBDES, AND PCBS

Fish were analyzed for legacy pesticides (chlordanes, dieldrin, DDTs, and toxaphene), PBDEs, and PCBs as composite samples. Pesticides, PBDEs, and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For PBDEs, PCBs, chlordanes, and DDTs, each of the concentrations presented is the sum of the detected parent compound, congeners, or metabolites, where applicable. The MDLs or RLs for PCBs are shown in Appendix 1. 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 sufficiently low (US EPA, 2000a). Table 4 shows the averages and ranges for total length and PCB concentrations in individual species and fish groups. Concentrations of chlordanes, dieldrin, DDTs, PBDEs, and toxaphene were not sufficiently high to alter consumption advice and are not shown.

SELENIUM

The CDFW Moss Landing Marine Laboratories analyzed California coastal fish species for selenium, either as individual fish or composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS). Selenium concentrations were not sufficiently high to alter consumption advice and are not shown.

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[5] Total length is the maximum length of the fish, measured from the tip of the closed mouth to the tip of the pinched tail fin.

[6] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.

[7] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

TABLE 3. MERCURY CONCENTRATIONS IN FISH FROM THE CALIFORNIA COAST*

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	Mercury (ppb)	
						Mean	Range
Cabezon	13	13	55	467	380-575	379	188-731
California Corbina	6	8	39	465	330-569	131	69-225
Croaker Group	37	68	393	220	141-365	128	0-297
Queenfish	3	3	19	160	141-193	60	38-70
White Croaker	35	63	364	222	156-309	133	0-297
Yellowfin Croaker	1	2	10	291	232-365	105	73-138
Lingcod	16	17	70	683	551-932	327	165-669
Rockfish Group, High-Hg	31	124	222	301	147-522	447	50-1170
Black and Yellow Rockfish	4	4	19	280	245-320	397	323-462
China Rockfish	5	5	25	328	271-385	544	243-735
Copper Rockfish	6	15	33	421	340-522	692	295-1150
Gopher Rockfish	25	100	145	271	147-371	381	50-1170
Rockfish Group, Medium-Hg	38	324	475	348	215-558	155	16-594
Black Rockfish	12	77	83	415	355-511	200	77-594
Blue Rockfish	27	178	204	305	215-558	94	16-391
Brown Rockfish	9	9	42	319	272-392	206	116-404
Kelp Rockfish	6	9	48	312	269-395	122	53-239
Olive Rockfish	10	42	45	386	320-496	202	64-460
Rosethorn Rockfish	1	1	20	329	298-358	255	n/a

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	Mercury (ppb)	
						Mean	Range
Vermillion Rockfish	8	8	33	451	365-551	273	70-392
Sea Bass Group	14	72	75	398	349-590	229	0-662
Barred Sand Bass	8	29	29	394	349-590	268	0-662
Kelp Bass	13	43	46	400	349-512	205	50-559
Shark Group	32	201	301	980	586-1410	868	84-2390
Brown Smoothhound Shark	13	41	73	829	612-1114	877	84-1844
Gray Smoothhound Shark	5	28	66	713	586-924	486	117-1041
Leopard Shark	20	132	162	1095	900-1410	1020	320-2390
Small Flatfish Group	24	35	388	124	79-290	35	0-139
Diamond Turbot	6	7	32	233	194-290	78	43-139
Longfin Sanddab	2	2	10	219	201-241	110	91-130
Speckled Sanddab	14	20	324	103	79-140	27	0-77
Spotted Turbot	4	6	22	220	183-260	43	29-60
Surfperch Group, Low-PCB	20	46	203	145	101-242	60	0-184
Shiner Perch	10	29	124	119	101-150	37	0-108
Silver Surfperch	4	6	32	196	150-235	105	27-179
Walleye Surfperch	9	11	47	174	134-242	90	0-184
Surfperch Group, Very Low-PCB	53	215	523	238	109-372	81	0-343

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	Mercury (ppb)	
						Mean	Range
Barred Surfperch	21	66	154	222	162-363	95	24-302
Black Perch	16	71	151	247	155-316	76	16-222
Pile Perch	5	10	45	309	244-372	94	39-185
Rainbow Surfperch	12	24	66	261	185-342	94	23-343
Spotfin Surfperch	1	1	13	129	109-140	37	n/a
White Surfperch	8	43	94	214	150-286	56	0-135
Topsmelt	4	4	38	258	153-380	90	59-126

*Shaded rows denote species or fish groups for which advice was developed.
**Means are an arithmetic average of individual values and/or a weighted average of composites.
***Range of individuals and/or range of the composites.
n/a not applicable due to a single sample.

TABLE 4. PCB CONCENTRATIONS IN FISH FROM THE CALIFORNIA COAST*

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	PCBs (ppb)	
						Mean	Range
Cabezon	13	13	55	467	380-575	0	n/a
California Corbina	5	7	34	468	330-569	82	18-264
Croaker Group	35	47	285	223	146-309	10	0-62
Queenfish	2	2	9	162	146-174	12	1-21
White Croaker	34	44	271	224	156-309	9	0-45
Yellowfin Croaker	1	1	5	256	232-284	62	n/a

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	PCBs (ppb)	
						Mean	Range
Lingcod	15	15	66	686	551-932	3	0-8
Rockfish Group, High-Hg	30	39	181	300	147-507	0	0-4
Black and Yellow Rockfish	4	4	19	280	245-320	1	0-1
China Rockfish	5	5	25	328	271-385	0	n/a
Copper Rockfish	6	6	28	411	340-507	1	0-2
Gopher Rockfish	24	24	109	269	147-371	0	0-4
Rockfish Group, Medium-Hg	36	62	308	347	215-558	1	0-11
Black Rockfish	9	9	43	400	355-487	1	0-11
Blue Rockfish	26	26	126	311	215-558	0	0-4
Brown Rockfish	9	9	42	319	272-392	1	0-4
Kelp Rockfish	5	5	25	312	269-395	0	0-1
Olive Rockfish	4	4	19	401	342-496	1	0-3
Rosethorn Rockfish	1	1	20	329	298-358	3	n/a
Vermillion Rockfish	8	8	33	451	365-551	1	0-5
Sea Bass Group	1	1	5	380	355-405	33	n/a
Barred Sand Bass	1	1	5	380	355-405	33	n/a

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	PCBs (ppb)	
						Mean	Range
Shark Group	23	43	147	976	612-1360	15	0-136
Brown Smoothhound Shark	8	10	42	854	612-1114	28	1-136
Gray Smoothhound Shark	4	4	16	698	616-784	14	4-41
Leopard Shark	17	29	89	1083	900-1360	9	0-44
Small Flatfish	23	31	370	120	79-290	6	0-62
Diamond Turbot	6	6	27	233	194-290	5	0-13
Longfin Sanddab	2	2	10	219	201-241	5	2-8
Speckled Sanddab	13	19	319	103	79-140	6	0-62
Spotted Turbot	3	4	14	225	183-260	7	1-10
Surfperch Group, Low-PCB	10	14	122	141	101-242	37	7-74
Shiner Perch	5	5	77	117	101-144	43	25-63
Silver Surfperch	2	4	22	188	150-220	29	7-74
Walleye Surfperch	4	5	23	174	134-242	23	9-31
Surfperch Group, Very Low-PCB	40	69	369	242	109-372	12	0-95
Barred Surfperch	9	15	74	227	165-311	10	1-47
Black Perch	15	22	119	251	155-316	17	0-87

Fish Species or Fish Group	Number of Sites	Number of Samples	Total Number of Fish	Mean Total Length** (mm)	Range of Total Lengths*** (mm)	PCBs (ppb)	
						Mean	Range
Pile Perch	4	8	35	302	244-372	20	1-95
Rainbow Surfperch	12	13	66	261	185-342	7	0-49
Spotfin Surfperch	1	1	13	129	109-140	1	n/a
White Surfperch	8	10	62	210	150-286	7	2-20
Topsmelt	3	3	31	258	153-380	5	3-8

*Shaded rows denote species or fish groups for which advice was developed.
**Means are an arithmetic average of individual values and/or a weighted average of composites.
***Range of individuals and/or range of the composites.
n/a not applicable due to a single sample

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM THE CALIFORNIA COAST

General Information

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, 2014; American Heart Association, 2014; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish are a significant source of the specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), thought to be associated with these beneficial health effects (USDA/US DHHS, 2015; Weaver et al., 2008).

The 2015-2020 US Dietary Guidelines recommend that 1) the general population "consume eight or more ounces per week (less for young children)" of a variety of seafood[8] "for the total package of nutrients that seafood provides, including its EPA and DHA content" and 2) "women who are pregnant or breastfeeding should consume at least eight and up to 12 ounces of a variety of seafood per week from choices that are lower in methylmercury" (USDA/USDHHS, 2015). 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 FDA and US EPA recommend that women who are pregnant (or might become pregnant) or breastfeeding and young children do not consume shark, swordfish, tilefish, or king mackerel, and limit consumption of white (albacore) tuna to six ounces per week (FDA/US EPA, 2004 and 2014).

In order 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, for each species and at each location, to limit their exposure to these contaminants. Consumers can use

[8] "Marine animals that live in the sea and in freshwater lakes and rivers. Seafood includes fish, such as salmon, tuna, trout, and tilapia, and shellfish, such as shrimp, crab, and oysters" (USDHHS/USDA, 2015).

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 45 years of age) and children, are lower than for women 46 years and older, and men. 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" and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)" (OEHHA, 2008 and 2011). A list of the ATLs used in this report is presented in Appendix II.

For each fish species in this advisory, OEHHA compared the mean levels of mercury, PCBs, selenium, PBDEs, chlordane, dieldrin, DDTs, and toxaphene detected in the fish species or fish group to the ATLs for each of the chemicals to establish the maximum number of servings per week that could be consumed (see Appendix II). The concentrations of selenium, chlordanes, dieldrin, DDTs, PBDEs, and toxaphene for all species were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008 and 2011). As a result, these chemicals were not considered further. For this advisory, consumption advice was based on mercury and PCB concentrations.

The consumption advice for a fish species was initially based on the chemical with the lowest allowable number of fish servings per week. Because both mercury and PCBs are known to affect the nervous system, particularly during brain development, additivity of toxicity is assumed and assessed by using a multiple chemical exposure methodology (US EPA, 1989 and 2000b). The presence of both chemicals in fish tissue might result in advice for the sensitive population to consume fewer meals per week than would be the case for the presence of either chemical alone, in a similar concentration. Details can be found 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).

OEHHA recommends that individuals strive to meet the US Dietary Guidelines seafood consumption recommendations, while also adhering to federal and OEHHA recommendations to limit the consumption of fish with high contaminant levels. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish species from the California coast. People should eat no more than the recommended number of servings for each fish species or

fish group. OEHHA's advice on consuming a particular fish species can be extended to other closely related fish species[9] known to accumulate similar levels of contaminants.

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

CONSUMPTION ADVICE FOR FISH FROM THE CALIFORNIA COAST

As noted above, advice was provided for individual fish species or fish groups that had a minimum of 30 appropriately-sized fish collected from a total of at least three sampling sites (or a minimum of nine fish from at least one site for a species to be included in a group).

Because mercury was the "risk driver" for almost all species, an initial assessment of the data was performed where an individual sampling site mean mercury concentration for each species was compared to the coastal mean mercury concentration for that species, as well as to the ATL for the sensitive population. The purpose of this comparison was to assess the geospatial variability of contamination for each species across all coastal areas to determine whether separate advisories should be developed for different coastal regions. Although there were no clearly distinct site differences within species or fish groups, Barred Surfperch, Black Rockfish, Brown Rockfish, China Rockfish, and Copper Rockfish showed a trend of higher mercury concentrations in the north and decreasing concentrations toward the south. Davis *et al.* (2016) suggested that this trend may be due to increased bioavailability of methylmercury in coastal areas of northern and central California, as well as the higher prevalence of longer-lived, higher-trophic level species in these areas. OEHHA determined that these differences did not justify separate regional advisories; variability of mercury concentrations among sites could best be addressed on a species-by-species basis. Because of this, and the fact that a single advisory is easier to communicate than multiple coastal advisories, OEHHA decided to develop a single California Coastal Advisory.

When rockfish species were evaluated, it was clear that certain species had significantly higher mercury concentrations than others and that consumption advice based on the mean for all rockfish species would not be appropriate. Thus, OEHHA rank-ordered rockfish species and compared their mean mercury concentrations to the ATLs for the sensitive (women 18 to 45 years and children 1 to 17 years) and general (women 46 years and older and men 18 years and older) populations. The majority of rockfish

[9] Fish species within the same genus are most closely related, and Family is the next level of relationship.

species fell into the one or two servings per week category for the sensitive population. However, two species (Copper Rockfish and China Rockfish) fell into the "do not consume" category for the sensitive population (>440 ppb, with mean concentrations of 692 and 544 ppb, respectively). Two other rockfish species (Black and Yellow Rockfish and Gopher Rockfish) had mean mercury concentrations that approached, but did not exceed, the "do not consume" cutoff (397 and 381 ppb, respectively). Mercury concentrations were highly variable in Gopher Rockfish, ranging from 50 to 1170 ppb. Black and Yellow Rockfish, while not as variable (323-462 ppb mercury), are considered difficult to distinguish from Gopher Rockfish (Lea et al., 1999). For these reasons, OEHHA split the rockfish group into "high-mercury" (Copper, China, Black and Yellow, and Gopher rockfishes) and "medium-mercury" (Black, Blue, Brown, Kelp, Olive, Rosethorn, and Vermillion rockfishes) rockfish groups, for which separate advice was developed. Fish groups were designated as "high-mercury" when OEHHA recommended no consumption for the sensitive population. Fish groups were designated as "medium-mercury" when OEHHA recommended that the sensitive population limit consumption to one meal per week. Blue Rockfish, on the other hand, contained lower levels of mercury than other rockfish species evaluated. See discussion under "Medium-Mercury Rockfish Species" below.

Similar to the case of mercury in rockfish, surfperch species displayed distinct differences in PCB concentrations. First, surfperch data were evaluated to determine whether these differences were geographic in nature or species-related. The differences did not appear to be spatial. Barred Surfperch, Black Perch, Pile Perch, Rainbow Surfperch, Spotfin Surfperch, and White Surfperch were found to have very low levels of PCBs (mean: 12 ppb; range: 0-95 ppb). Shiner Perch, Silver Surfperch, and Walleye Surfperch were found to have somewhat higher PCB levels (mean: 37 ppb; range: 7-74 ppb). The levels in Shiner Perch, Silver Surfperch, and Walleye Surfperch were high enough to affect consumption advice. For that reason, OEHHA split the surfperch group into very low-PCBs and low-PCBs groups. Fish groups were designated as "very low-PCBs" when consumption advice based on PCB concentrations would be four or more servings per week. Fish groups were designated as "low-PCBs" when advice based on PCB concentrations would be two to three servings per week.

Several other species of fish were also combined to form the following fish groups: croakers (Queenfish, White Croaker, and Yellowfin Croaker), sea basses (Barred Sand Bass and Kelp Bass), and small flatfishes (Diamond Turbot, Longfin Sanddab, Speckled Sanddab, and Spotted Turbot). As noted, these groups were formed to maximize the number of species covered in the advisory and to simplify risk communication.

In two cases, OEHHA listed fish species separately in the pictorial advice even though they were evaluated as part of a fish group. This was done for risk communication purposes. Although Queenfish were included in the croaker fish group for advisory development, not all consumers know that Queenfish are a croaker species. Thus, Queenfish are listed separately from the croaker fish group in the pictorial advice. Additionally, Barred Sand Bass and Kelp Bass were evaluated as a group ("sea

basses"); however, they are listed separately in the pictorial advice so that consumers do not apply this advice to other species commonly referred to as "bass" (e.g., striped bass).

As noted, an advisory already exists for coastal areas from Ventura Harbor to San Mateo Point. That advisory was developed largely using fish sampling data collected as part of the Montrose Settlement Restoration Project, supplemented with CFCP data, as appropriate. Under most circumstances, OEHHA did not include data collected from an area with an existing advisory as part of the data set used to develop the California Coastal Advisory. However, OEHHA considered including samples from Ventura Harbor to San Mateo Point collected by the six monitoring programs used to develop the California Coastal Advisory. The purpose of this would be to increase the total sample size, potentially allowing for advice to be given for more species.

The advisory from Ventura Harbor to San Mateo Point is divided into "red zone" and "yellow zone" areas, with some species collected from the red zone containing higher concentrations of PCBs and/or DDTs than those species collected from the yellow zone. The "red zone" has been more impacted by chemical releases in the past (see OEHHA, 2009, for discussion). For this reason, fish sampling data collected from the yellow zone were included in our data set but data collected from the red zone were not.

The California Coastal Advisory was thus developed by using the fish sampling data collected by the six monitoring programs described above, including data collected from the yellow zone. By using data from the yellow zone, we increased the number of species in the advisory from 28 to 33 with a very minimal (and more health protective) effect on the consumption advice. It is important to note that the consumption advice in the California Coastal Advisory is largely consistent with that of the existing advisory for the yellow zone, but it does not supersede the existing advisory for either the red or yellow zones.

Summary of Species and Fish Groups

CABEZON

Fifty-five Cabezon were collected from 13 locations along the coast from Cape Mendocino to Santa Cruz. The mean mercury and PCB levels were 379 and 0 ppb, respectively. OEHHA recommends a maximum of one serving per week of Cabezon for the sensitive population and two servings per week for the general population, based on mercury concentrations.

CALIFORNIA CORBINA

A total of 39 California Corbina were collected from six locations from Ventura Pier to Newport Beach. The mean mercury and PCB concentrations for California Corbina were 131 and 82 ppb, respectively. OEHHA recommends a maximum of one serving

per week of California Corbina for both the sensitive and general population, based on PCBs.

CROAKER GROUP

For croaker species, sufficient samples were available to provide advice for Queenfish, White croaker, and Yellowfin Croaker. A total of 393 Queenfish, White Croaker, and Yellowfin Croaker, combined, were collected from 37 sites from the Marin County Coast to the California/Mexico border. The mean mercury and PCB concentrations for the croaker group, combined, were 128 and 10 ppb, respectively. OEHHA recommends a maximum of two servings per week for the sensitive population and five servings per week for the general population, based on mercury. Although, the serving guidance for the general population is five servings per week, the Croaker group is listed under four servings per week in the pictorial advice to facilitate risk communication. Mercury and PCB concentrations in individual croaker species are listed below.

QUEENFISH

A total of 19 Queenfish were collected from three locations north of San Diego. The mean mercury and PCB concentrations for Queenfish were 60 and 12 ppb, respectively.

WHITE CROAKER

A total of 364 White Croaker were collected from 35 sites from the Marin County Coast to the California-Mexico border. The mean mercury and PCB concentrations for White Croaker were 133 and 9 ppb, respectively.

YELLOWFIN CROAKER

A total of ten White Croaker were collected from Seal Beach. The mean mercury and PCB concentrations for White Croaker were 105 and 62 ppb, respectively.

LINGCOD

Seventy Lingcod were collected from 16 locations from Crescent City to Pismo Beach. The mean mercury and PCB concentrations for Lingcod were 327 and 3 ppb, respectively. OEHHA recommends a maximum of one serving per week for the sensitive population and two servings per week for the general population, based on mercury.

ROCKFISH GROUP

HIGH-MERCURY ROCKFISH GROUP

For rockfish species designated as “high-mercury”, sufficient samples were available to provide advice for Black and Yellow, China, Copper, and Gopher Rockfish. A total of 222 high-mercury rockfish were collected from 31 sites from north of Eureka to San

Diego. The mean mercury and PCB concentrations for the high-mercury Rockfish group, combined, were 447 ppb and 0 ppb, respectively. OEHHA recommends no consumption for the sensitive population and one serving per week for the general population, based on mercury. Mercury and PCB concentrations in individual high-mercury rockfish species are listed below.

BLACK AND YELLOW ROCKFISH

Nineteen Black and Yellow Rockfish were collected at four locations from Point Arena to Diablo Canyon. The mean mercury and PCB concentrations for Black and Yellow Rockfish were 397 and 1 ppb, respectively.

CHINA ROCKFISH

A total of 25 China Rockfish were collected from five locations from Cape Mendocino to Moss Landing. The mean mercury and PCB concentrations for China Rockfish were 544 and 0 ppb, respectively.

COPPER ROCKFISH

A total of 33 Copper Rockfish were collected from six locations from North Humboldt County to Port San Luis. The mean mercury and PCB concentrations for Copper Rockfish were 692 and 1 ppb, respectively.

GOPHER ROCKFISH

A total of 145 Gopher Rockfish were collected from 25 locations from North Humboldt County to Point Loma. The mean mercury and PCB concentrations for Gopher Rockfish were 381 and 0 ppb, respectively.

MEDIUM-MERCURY ROCKFISH GROUP

For medium-mercury rockfish species, sufficient samples were available to provide advice for Black, Blue, Brown, Kelp, Olive, Rosethorn, and Vermillion Rockfish. A total of 475 medium-mercury rockfish were collected from 38 sites from the California/Oregon border to the Channel Islands. The mean mercury and PCB concentrations for the medium-mercury rockfish group, combined, were 155 ppb and 1 ppb, respectively. OEHHA recommends a maximum of one serving per week for the sensitive population and four servings per week for the general population, based on mercury. Blue Rockfish contained lower mercury concentrations than other rockfish species. The sensitive population could consume two servings per week and the general population could consume seven servings per week. However, to simplify risk communication, this species was combined with the medium-mercury rockfish species in the advisory. Mercury and PCB concentrations in individual medium-mercury rockfish species are listed below.

BLACK ROCKFISH

A total of 83 Black Rockfish were collected from 12 locations from Crescent City to Monterey. The mean mercury and PCB concentrations for Black Rockfish were 200 and 1 ppb, respectively.

BLUE ROCKFISH

A total of 204 Blue Rockfish were collected from 27 locations from Crescent City to the Channel Islands. The mean mercury and PCB concentrations for Blue Rockfish were 94 and 0 ppb, respectively.

BROWN ROCKFISH

A total of 42 Brown Rockfish were collected from nine locations from the Sonoma Coast to the Channel Islands. The mean mercury and PCB concentrations for Brown Rockfish were 206 and 1 ppb, respectively.

KELP ROCKFISH

Forty-eight Kelp Rockfish were collected from six sites from the Pacific Grove Coast to the Northern Channel Islands. The mean mercury and PCB concentrations for Kelp Rockfish were 122 and 0 ppb, respectively.

OLIVE ROCKFISH

A total of 45 Olive Rockfish were collected from ten locations from the Del Norte Coast to Goleta. The mean mercury and PCB concentrations for Olive Rockfish were 202 and 1 ppb, respectively.

ROSETHORN ROCKFISH

A total of 20 Rosethorn Rockfish were collected from the San Mateo coastline. The mean mercury and PCB concentrations for Rosethorn Rockfish were 255 and 3 ppb, respectively

VERMILION ROCKFISH

Thirty-three Vermilion Rockfish were collected from eight locations from Shelter Cove to northern Santa Barbara County. The mean mercury and PCB concentrations for Vermillion Rockfish were 273 and 1 ppb, respectively.

SEA BASS GROUP

For sea bass species, sufficient samples were available to provide advice for Barred Sand Bass and Kelp Bass. Seventy-five individual fish of these species were collected from 14 sites from the Oregon/California border to the California/Mexico border. The

sea bass group had a mean mercury and PCB concentrations of 229 and 33 ppb, respectively. As noted above, the consumption advice for these species was calculated as a group; however, they are listed separately in the pictorial advisory for ease of identification. OEHHA recommends one serving per week for the sensitive population and two servings per week for the general population, based on mercury. Mercury concentrations are listed for Barred Sand Bass and Kelp Bass below.

BARRED SAND BASS

Twenty-nine Barred Sand Bass were collected from eight sites from Point Conception to the California/Mexico border. The mean mercury and PCB concentrations for barred sand bass was 268 and 33 ppb, respectively.

KELP BASS

Forty-six Kelp Bass were collected from 13 sites from Goleta to the California/Mexico Border. The mean mercury concentration for Kelp Bass was 205 ppb. PCBs were not measured for this species.

SHARK GROUP

For shark species, sufficient samples were available to provide advice for Brown Smoothhound Shark, Gray Smoothhound Shark, and Leopard Shark. These species are members of the Houndshark (*Triakidae)* family, and thus, were combined to simplify risk communication. As noted previously, shark samples collected from enclosed bays and areas with existing advisories were included in order to increase the number of sharks sufficiently to issue advice. A total of 301 sharks were collected from 32 (primarily bay) sites from Eureka to San Diego. The Shark Group had mean mercury and PCB concentrations of 868 and 15 ppb, respectively. OEHHA recommends no consumption for the sensitive population and one serving per week for the general population, based on mercury concentrations. The mercury and PCB mean concentrations for each individual shark species are shown below.

BROWN SMOOTHHOUND SHARK

A total of 73 Brown Smoothhound were collected from 13 sites from Tomales Bay to Mission Bay. The mean mercury and PCB concentrations were 877 ppb and 28 ppb, respectively.

GRAY SMOOTHHOUND SHARK

A total of 66 Gray Smoothhound were collected from five sites from Mugu Lagoon to San Diego Bay. The mean mercury and PCB concentrations were 486 ppb and 14 ppb, respectively.

LEOPARD SHARK

A total of 162 Leopard Sharks were collected from 20 sites from Humboldt Bay to San Diego Bay. The mean mercury and PCB concentrations were 1020 ppb and 9 ppb, respectively.

SMALL FLATFISH GROUP

For small flatfish species, sufficient samples were available to provide advice for Diamond Turbot, Longfin Sanddab, Speckled Sanddab, and Spotted Turbot. A total of 388 small flatfish were collected from 24 sites from Bodega Bay to San Diego. The small flatfish group had mean mercury and PCB concentrations of 35 ppb and 6 ppb, respectively. OEHHA recommends a maximum of six servings per week for the sensitive and seven servings per week for the general populations, based on mercury. Data for Diamond Turbot and Speckled Sanddab are presented below. Like Croakers, the serving advice for small flatfish was reduced from seven to six servings per week for the general population in the pictorial advisory to simplify risk communication. Mercury and PCB concentrations in individual small flatfish species are listed below.

DIAMOND TURBOT

Thirty-two Diamond Turbot were collected from six sites from the Santa Barbara Jetty and the Oceanside Pier (north of San Diego). The mean mercury and PCB concentrations for Diamond Turbot were 78 and 5 ppb, respectively.

LONGFIN SANDDAB

A total of 10 Longfin Sanddab were collected from Newport Bay and Dana Point. The mean mercury and PCB concentrations for Longfin Sanddab were 110 and 5 ppb, respectively.

SPECKLED SANDDAB

A total of 324 Speckled Sanddab were collected from 14 locations from Bodega Bay to Point Hueneme Pier. The mean mercury and PCB concentrations for Speckled Sanddab were 27 and 6 ppb, respectively.

SPOTTED TURBOT

Twenty-two Spotted Turbot were collected from four sites from the Channel Islands to San Diego Bay. The mean mercury and PCB concentrations for Spotted Turbot were 43 and 7 ppb, respectively.

SURFPERCH GROUP

LOW-PCB SURFPERCH

For low-PCB surfperch species, sufficient samples were available to provide advice for Shiner Perch, Silver Surfperch, and Walleye Surfperch. A total of 203 surfperches were collected from 20 sites from the Oregon/California border to the California/Mexico border. The surfperches had a mean mercury concentration of 60 ppb and a mean PCB concentration of 37 ppb. OEHHA recommends a maximum of two servings per week for the sensitive and general populations, based on PCBs. The following three surfperch species were combined to develop consumption advice for this group. Individual low-PCB surfperch species mercury and PCB concentrations are reported below.

SHINER PERCH

A total of 124 Shiner Perch were collected from ten locations from Pillar Point Harbor to Catalina Island. The mean mercury and PCB concentrations for Shiner Perch were 37 and 43 ppb, respectively.

SILVER SURFPERCH

Thirty-two Silver Surfperch were collected from four locations from the San Francisco Coastline and the Santa Maria River. The mean mercury and PCB concentrations for Silver Surfperch were 105 and 29 ppb, respectively.

WALLEYE SURFPERCH

Forty-seven Walleye Surfperch were collected from nine locations from Pacifica Pier to Imperial Beach Pier. The mean mercury and PCB concentrations for Walleye Surfperch were 90 and 23 ppb, respectively.

VERY LOW-PCB SURFPERCH

For very low-PCB surfperch species, sufficient samples were available to provide advice for Barred Surfperch, Black Perch, Pile Perch, Rainbow Surfperch, Spotfin Surfperch, and White Surfperch. A total of 523 surfperches were collected from 53 sites from the Oregon/California border to the California/Mexico border. These surfperches had mean mercury and PCB concentrations of 81 ppb and 12 ppb, respectively. OEHHA recommends a maximum of 2 servings per week for the sensitive population and 6 servings per week for the general population, based on mercury. The following six surfperch species were combined to develop consumption advice for this group. Individual species mercury and PCB concentrations for very low-PCB surfperch species are reported below.

BARRED SURFPERCH

A total of 154 Barred Surfperch were collected from 21 locations from the Southern Marin Coast to Imperial Beach Pier. The mean mercury and PCB concentrations for Barred Surfperch were 95 and 10 ppb, respectively.

BLACK PERCH

A total of 151 Black Perch were collected from 16 sites from Pillar Point Harbor to Point Loma. The mean mercury and PCB concentrations for Black Perch were 76 and 17 ppb, respectively.

PILE PERCH

Forty-five Pile Perch were collected from five sites from Princeton Harbor Jetty to San Diego Bay. The mean mercury and PCB concentrations for Pile Perch were 94 and 20 ppb, respectively.

RAINBOW SURFPERCH

A total of 66 Rainbow Surfperch were collected from 12 locations from the San Mateo Coastline to San Diego Bay. The mean mercury and PCB concentrations for Rainbow Surfperch were 94 and 7 ppb, respectively.

SPOTFIN SURFPERCH

Thirteen Spotfin Surfperch were collected from the San Mateo County Coastline. The mean mercury and PCB concentrations for Spotfin Surfperch were 37 and 1 ppb, respectively.

WHITE SURFPERCH

A total of 94 White Surfperch were collected from eight locations from Crescent City to Oceanside Harbor. The mean mercury and PCB concentrations for White Surfperch were 56 and 7 ppb, respectively.

TOPSMELT

A total of 38 Topsmelt were collected from four locations from Crescent City to Dana Point Harbor. The mean mercury and PCB concentrations for Topsmelt were 90 and 5 ppb, respectively. OEHHA recommends a maximum of two servings per week for the sensitive population and six servings per week for the general population, based on mercury.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from the California Coast are shown in Table 5. As noted above, consumption advice for the general population was reduced from five to four servings per week for the Croaker Group and from seven to six servings per week for the Small Flatfish Group in the pictorial advisory to simplify risk communication.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THE CALIFORNIA COAST

Fish Species	Women 18–45 years and Children 1–17 years	Women 46 years and older and Men 18 years and older
Cabezon	1	2
California Corbina	1	1
Croaker	2	5
Lingcod	1	2
Rockfish, High-Hg	0	1
Rockfish, Medium-Hg	1	4
Sea Bass Group	1	2
Shark Group	0	1
Small Flatfish Group	6	7
Surfperch Group, Low-PCB	2	2
Surfperch Group, Very Low-PCB	2	6
Topsmelt	2	6

REFERENCES

American Heart Association. 2014. Fish and Omega-3 Fatty Acids. Online at: http://www.americanheart.org/presenter.jhtml?identifier=4632

Bloom, N.S. 1992. On the chemical form of mercury in edible fish and marine invertebrate tissue. Can. J. Fish. Aquat. Sci. 49(5):1010-1017.

CDFW. 2016-2017. 2016-2017 Ocean Sport Fishing Regulations. California Department of Fish and Wildlife. Online at: https://www.wildlife.ca.gov/Regulations

CCRWQCB. 2016. Central Coast Ambient Monitoring Program (CCAMP). Central Coast Regional Water Quality Control Board. Online at: http://www.ccamp.org

Davis, J.A., J.R.M. Ross, S. Bezalel, L. Sim, A. Bonnema, G. Ichikawa, W.A. Heim, K. Schiff, C.A. Eagles-Smith, and J.T. Ackerman. 2016. Hg concentrations in fish from coastal waters of California and Western North America. Sci. Total. Env. *In press*.

FDA/US EPA. 2004. What you need to know about mercury in fish and shellfish (brochure). Advice by FDA and USEPA/March 2004. Online at: http://www.fda.gov/food/resourcesforyou/consumers/ucm110591.htm

FDA/US EPA. 2014. Fish: What pregnant women and parents should know. Draft Updated Advice by FDA and USEPA/June 2014. Online at: http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/Metals/UCM400358.pdf

Gassel, M., R.K. Brodberg, and S. Roberts. 2005. The Coastal Fish Contamination Program: Monitoring of Coastal Water Quality and Chemical Contamination in Fish and Shellfish in California. California and the World Ocean '02: Revisiting and Revising California's Ocean Agenda: 977-990. Magoon, O.T., H. Converse, B. Baird, B. Jines, and M. Miller-Henson (Eds). American Society of Civil Engineers, Reston, VA.

Institute of Medicine. 2007. Seafood choices, balancing benefits and risks. Committee on Nutrient Relationships in Seafood: Selections to Balance Benefits and Risks. Institute of Medicine, Food and Nutrition Board. The National Academies Press, Washington, D.C.

Kris-Etherton, P.M., W.S. Harris, and L.J. Appel. 2002. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. Circ. 106:2747-2757.

OEHHA. 2005. General Protocol for Sport Fish Sampling and Analysis. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://oehha.ca.gov/media/downloads/fish/document/fishsamplingprotocol2005.pdf

OEHHA. 2008. Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://oehha.ca.gov/media/downloads/fish/report/atlmhgandothers2008c.pdf

OEHHA. 2009. Health Advisory and Safe Eating Guidelines for Fish From Coastal Areas of Southern California: Ventura Harbor to San Mateo Point. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://www.oehha.ca.gov/fish/so_cal/socal061709.html

OEHHA. 2011. Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://oehha.ca.gov/media/downloads/fish/report/pbdes052311.pdf

Oken, E., R.O. Wright, K.P. Kleinman, D. Bellinger, C.J. Amarasiriwardena, H. Hu, J.W. Rich-Edwards, and M.W. Gillman. 2005. Maternal fish consumption, hair mercury, and infant cognition in a US cohort. Environ. Health Perspect. 113(10):1376-1380.

Oken, E., J.S. Radesky, R.O. Wright, D. Bellinger, C.J. Amarasiriwardena, K.P. Kleinman, H. Hu, J.W. Rich-Edwards, and M.W. Gillman. 2008. Maternal fish intake during pregnancy, blood mercury levels, and infant cognition at age 3 years in a US cohort. Am. J. Epidemiol. 167(10):1171-1181.

SWRCB. 2012. Contaminants in Fish from the California Coast, 2009-2010: Summary Report on a Two-Year Screening Survey. Surface Water Ambient Monitoring Program. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/coast_study/bog2012may/coast2012report.pdf

SWRCB. 2013. State Mussel Watch (SMW) Program/Toxic Substances Monitoring (TSM) Program. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/mussel_watch.shtml

USDA/USDHHS. 2015. 2015-2020 Dietary Guidelines for Americans. 8th Edition. US Government Printing Office, Washington, D.C. December. Online at: http://health.gov/dietaryguidelines/2015/guidelines/

US EPA. 1989. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part A) Interim Final. EPA/5401-89/002, December 1989. Office of

Emergency and Remedial Response, US Environmental Protection Agency, Washington, D.C. Online at: https://rais.ornl.gov/documents/HHEMA.pdf

US EPA. 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1. Fish Sampling and Analysis. 3rd Ed. EPA 823-B00-007. Office of Water, US Environmental Protection Agency, Washington, D.C.

US EPA. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 2. Risk Assessment and Fish Consumption Limits, 3rd Edition. EPA 823-B-00-007. Office of Water, US Environmental Protection Agency, Washington, D.C.

US EPA. 2006. Environmental Monitoring & Assessment Program. Office of Water, US Environmental Protection Agency, Washington, D.C. Online at: https://archive.epa.gov/emap/archive-emap/web/html/index-2.html

Weaver, K.L., P. Ivester, J.A. Chilton, M.D. Wilson, P. Pandey, and F.H. Chilton. 2008. The content of favorable and unfavorable polyunsaturated fatty acids found in commonly eaten fish. J. American Dietetic Assoc. 108:1178-1185.

APPENDIX I. METHOD DETECTION LIMITS AND REPORTING LIMITS FOR COASTAL DATA SOURCES

Program	Hg		PCBs	
	MDL (ppb)	RL (ppb)	MDL (ppb)	RL (ppb)
CCAMP	10	30	0.1	0.2
CFCP	15	n/a	0.4	n/a
EMAP	5	15	1	5
RMP (BPTCP)	10	n/a	n/a	n/a
RMP (1997)	4	n/a	n/a	n/a
RMP (2000-2009)	4-12	9-36	0.1-0.3	0.2-0.9
SWAMP Coastal Study	12	36	0.3	0.9
TSMP	20	n/a	not used*	not used*

n/a-not available from CEDEN

*PCB and legacy pesticide data collected prior to 2000 were not used. Analytical methods have improved and older data are considered less reliable.

APPENDIX II. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs) 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 average daily reference dose[10] 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 endpoint 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 the California coast are followed, exposure to chemicals in fish from the California coast 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 18-45 and children 1-17)	≤ 31	>31-36	>36-44	>44-55	>55-70	>70-150	>150-440	>440
MeHg (Women > 45 and men)	≤ 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

[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.

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