OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from Humboldt Bay (Humboldt County)

Updated November 2026

Fish, Incident Response, Seafood Safety, and Harmful Algal Bloom Section
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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
Cd	cadmium
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CFCP	Coastal Fish Contamination Program
CVAAS	cold vapor atomic absorption spectrometry
CVAFS	cold vapor atomic fluorescence spectrometry
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DMA	direct mercury analyzer
EMAP	Environmental Monitoring and Assessment Program
FDA	United States Food and Drug Administration
Hg	mercury
HWK	Humboldt Waterkeeper
ICP-MS	inductively coupled plasma-mass spectrometry
MDL	method detection limit
mm	millimeter(s)
MPSL	Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories
NOAA	National Oceanic and Atmospheric Administration
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	part(s) per billion
RL	reporting limit
Se	selenium
SMW	State Mussel Watch Program
SMWE	State Mussel Watch Program Endowment

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
WOHTG	whole organism without head, tail, and guts

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-harvested fish.[1] This includes issuing health advisories for finfish and shellfish consumption, 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 posted on OEHHA's website and 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 fish and shellfish from Humboldt Bay in Humboldt County. 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.

Harmful algal blooms can occur in marine waters at any time of the year, and conditions may change rapidly during an active bloom event. Before visiting Humboldt Bay, OEHHA recommends checking with the California Department of Public Health for the annual mussel quarantine[3], shellfish and seafood biotoxin advisories[4], and other marine shellfish biotoxin-related closures available via the 24-hour Shellfish Biotoxin Information Line: 1-800-553-4133. Check the California Department of Fish and Wildlife's list of biotoxin-related advisories and closures for finfish, shellfish and crustaceans in marine waters[5].

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[1] Sport-harvested fish includes all finfish 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.
[3] Online at: https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/Shellfish/Annual-Mussel-Quarantine.aspx.
[4] Online at: https://www.cdph.ca.gov/Programs/OPA/Pages/Shellfish-Advisories.aspx.
[5] Online at: https://wildlife.ca.gov/fishing/ocean/health-advisories.

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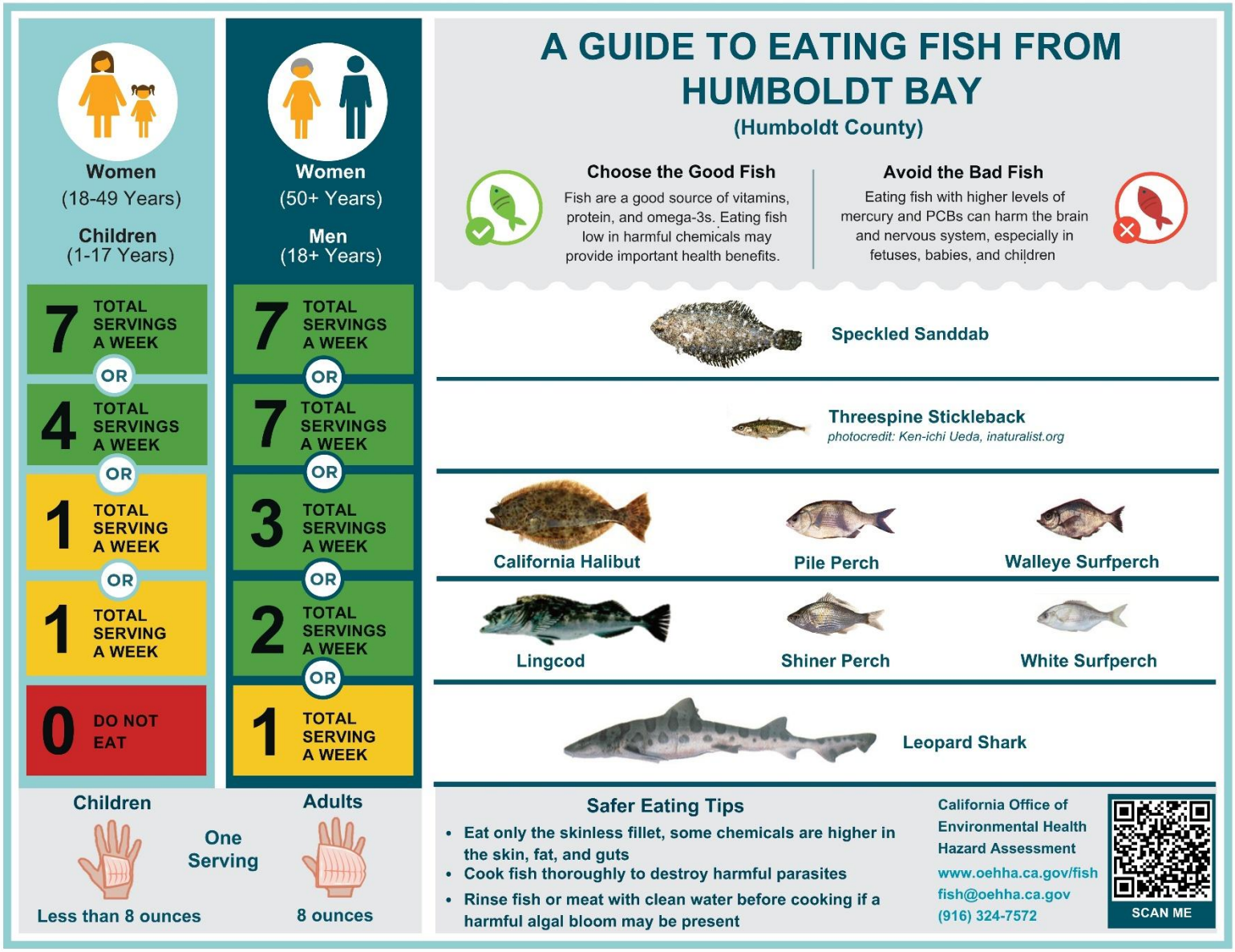
A GUIDE TO EATING FISH FROM HUMBOLDT BAY
(Humboldt County)
Women (18-49 Years)
Children (1-17 Years)
Women (50+ Years)
Men (18+ Years)
7 TOTAL SERVINGS A WEEK
OR
4 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
7 TOTAL SERVINGS A WEEK
OR
7 TOTAL SERVINGS A WEEK
OR
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
Children
Adults
One Serving
Less than 8 ounces
8 ounces
Choose the Good Fish
Fish are a good source of vitamins, protein, and omega-3s. Eating fish low in harmful chemicals may provide important health benefits.
Avoid the Bad Fish
Eating fish with higher levels of mercury and PCBs can harm the brain and nervous system, especially in fetuses, babies, and children
Speckled Sanddab
Threespine Stickleback
photocredit: Ken-ichi Ueda, inaturalist.org
California Halibut
Pile Perch
Walleye Surfperch
Lingcod
Shiner Perch
White Surfperch
Leopard Shark
Safer Eating Tips
Eat only the skinless fillet, some chemicals are higher in the skin, fat, and guts
Cook fish thoroughly to destroy harmful parasites
Rinse fish or meat with clean water before cooking if a harmful algal bloom may be present
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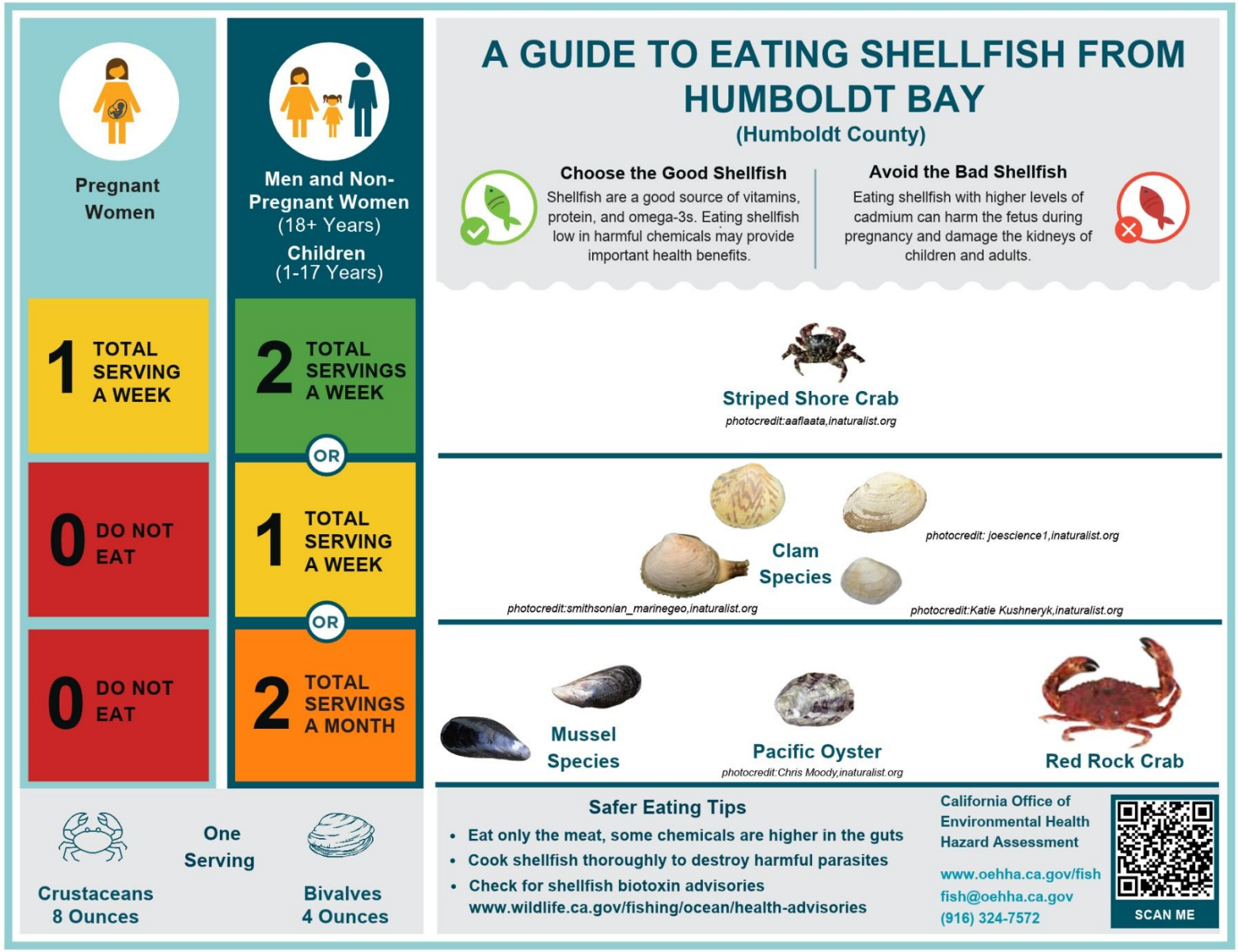
SCAN ME


A GUIDE TO EATING SHELLFISH FROM HUMBOLDT BAY
(Humboldt County)
Choose the Good Shellfish
Shellfish are a good source of vitamins, protein, and omega-3s. Eating shellfish low in harmful chemicals may provide important health benefits.
Avoid the Bad Shellfish
Eating shellfish with higher levels of cadmium can harm the fetus during pregnancy and damage the kidneys of children and adults.
Pregnant Women
Men and Non-Pregnant Women (18+ Years)
Children (1-17 Years)
1 TOTAL SERVING A WEEK
0 DO NOT EAT
0 DO NOT EAT
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
OR
2 TOTAL SERVINGS A MONTH
Striped Shore Crab
photocredit:aaflaata,inaturalist.org
Clam Species
photocredit: joescience1,inaturalist.org
photocredit:smithsonian_marinegeo,inaturalist.org
photocredit:Katie Kushneryk,inaturalist.org
Mussel Species
Pacific Oyster
photocredit:Chris Moody,inaturalist.org
Red Rock Crab
One Serving
Crustaceans 8 Ounces
Bivalves 4 Ounces
Safer Eating Tips
Eat only the meat, some chemicals are higher in the guts
Cook shellfish thoroughly to destroy harmful parasites
Check for shellfish biotoxin advisories www.wildlife.ca.gov/fishing/ocean/health-advisories
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SCAN ME

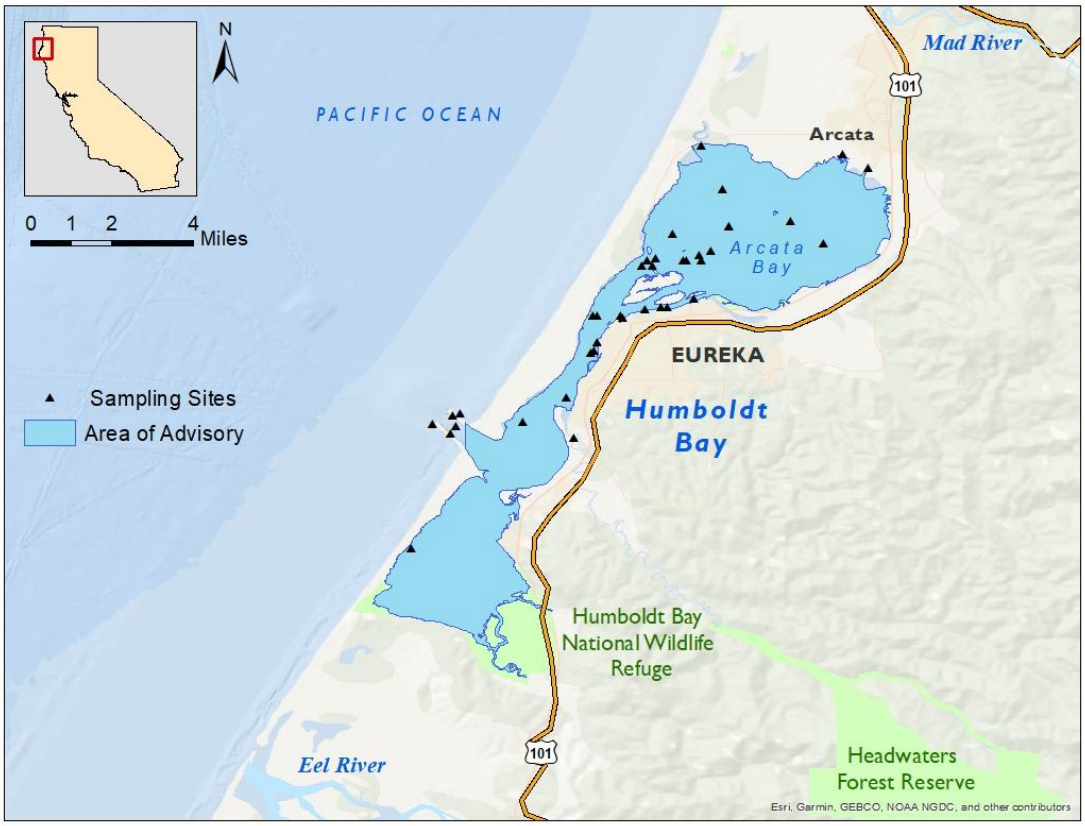
INTRODUCTION

This report updates and supersedes the previous guidelines released in 2018 by the Office of Environmental Health Hazard Assessment (OEHHA) for eating fish from Humboldt Bay (Figure 1). The collection of additional data and the development of consumption guidelines based on cadmium made it possible to update this advisory with the following species: California Halibut, clam species, mussel species, Pacific Oyster, Striped Shore Crab, and Threespine Stickleback. Consumption advice for these species, along with Leopard Shark, Lingcod, Pile Perch, Red Rock Crab, Shiner Perch, Speckled Sanddab, Walleye Surfperch, and White Surfperch is based on levels of cadmium, mercury, and/or polychlorinated biphenyls (PCBs) found in fish and shellfish collected from Humboldt Bay.

LOCATION

Humboldt Bay is adjacent to the city of Eureka, along California's northern coast and is the second largest natural bay in California with a length of approximately 14 miles and a width that varies from 0.5 to 4.2 miles. This advisory is specific to Humboldt Bay (including Arcata Bay) and not to any sloughs or creeks that feed the bay.

FIGURE 1. LOCATION OF HUMBOLDT BAY



APPROACH USED

OEHHA used the results from eight monitoring studies described in this report to update the Humboldt Bay Advisory. OEHHA uses the following general process in developing consumption advice for sport-harvested 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)[6] and other descriptive statistics of the contaminant data, as appropriate, for a chemical of concern for the selected fish species.
4) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of 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.

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 includes 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-harvested fish.

CHEMICALS OF CONCERN

Certain chemicals, because of their toxicity and their ability to accumulate in fish tissue, are of concern for people who eat fish. The majority of fish consumption advisories in California are issued because of mercury, followed by PCBs and, in a few cases, selenium, polybrominated diphenyl ethers (PBDEs), or certain legacy pesticides (pesticides that are no longer used but remain in the environment). Cadmium may be of concern for shellfish species, especially bivalves, which tend to accumulate cadmium at much higher levels compared to finfish species.

Mercury is an element found in some rocks 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 known as methylmercury, which can pass into and build up in fish. High levels of

[6] 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.

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.

Cadmium is a metal found naturally in soil and water and can also be released into the environment through industrial activities such as burning fossil fuels. Cadmium is commonly found in aquatic environments and can accumulate in the internal organs of fish and shellfish. Cadmium can damage the kidneys of children and adults, and cause harm to a fetus by interfering with placental development and function.

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, which can disrupt learning and behavior in children, among other adverse effects.

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.

A detailed discussion of the toxicity of these chemicals is 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), “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)” (OEHHA, 2011), and “Development of Advisory Tissue Levels for California Sport-harvested Finfish and Shellfish: Cadmium” (OEHHA, 2026).

All fish and shellfish species collected from Humboldt Bay and used in advisory development were analyzed for mercury. Some fish and shellfish were analyzed for cadmium, PCBs, PBDEs, selenium, and/or legacy pesticides as indicated in Table 1.

DATA SOURCES

The guidelines for eating fish from Humboldt Bay are based on the chemicals detected in fish collected for the eight 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.

COASTAL FISH CONTAMINATION PROGRAM (CFCP)

The CFCP (1998–2003) was a statewide monitoring program managed by the State Water Resources Control Board (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). The California Department of Fish and Wildlife (CDFW), then known as the California Department of Fish and Game, in cooperation with the SWRCB and the North Coast Regional Water Quality Control Board, collected Gaper Clam, Pacific Littleneck Clam, Pile Perch, Red Rock Crab, Shiner Perch, Speckled Sanddab, Walleye Surfperch, and White Surfperch in 1999, 2001, and 2003 from Humboldt Bay as part of the program. Fish samples were analyzed for cadmium, chlordanes, DDTs, dieldrin, mercury, PCBs, PBDEs, selenium, and/or toxaphene.

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), including Shiner Perch from Humboldt Bay in 1999, which were analyzed for cadmium, chlordanes, DDTs, dieldrin, mercury, selenium, and toxaphene.

HUMBOLDT WATERKEEPER (HWK)

Humboldt Waterkeeper (previously Humboldt Baykeeper) is a non-profit organization, established in 2004, to help protect and conserve coastal resources of northern California. This organization conducted two studies designed to assess mercury concentrations in fish and shellfish throughout the Bay (Kalt and Taylor, 2018; Taylor and Kalt, 2021). California Halibut, Horseneck Clam, Leopard Shark, Lingcod, Martha Washington Clam, Pacific Littleneck Clam, Pacific Oyster, and Walleye Surfperch were collected in 2016, 2017, and 2019 and analyzed for mercury. California Halibut were additionally analyzed for methylmercury.

NOAA Mussel Watch Program (NOAA)

The National Mussel Watch Program[7], administered by the National Oceanic and Atmospheric Administration (NOAA), was initiated in 1986 to monitor the status and trends of chemical contamination in coastal environments. The program measured concentrations of trace metals and legacy organic contaminants in mussels sampled from over 300 stations nationwide. In collaboration with the SWRCB, the program collected mussels from Humboldt Bay from 1986 through 2010, which were analyzed for cadmium, chlordanes, DDTs, dieldrin, mercury, PBDEs, PCBs, and selenium. Because there were sufficient data, only samples collected after 2000 were used to develop advice.

Statewide Coast Sportfish Contamination Study (SWAMP)

The Surface Water Ambient Monitoring Program (SWAMP), operated by the SWRCB, monitors water quality in California's surface waters. The Statewide Coastal Sportfish Contamination Study[8] is a screening survey that occurs every ten years to evaluate contaminants in coastal sport fish known to accumulate high concentrations (Davis, 2010). The survey collected California Halibut, Leopard Shark, Shiner Perch, and White Surfperch from Humboldt Bay in 2010 and/or 2019, which were analyzed for mercury (except White Surfperch). California Halibut and Leopard Shark were additionally analyzed for chlordanes, DDTs, dieldrin, PCBs, and/or selenium. White Surfperch were only analyzed for selenium.

State Mussel Watch (SMW)

The SMW[9] was initiated by the SWRCB in 1977 to detect and evaluate toxic substances in California coastal waters, bays, harbors, and estuaries. The SMW measured trace metals and legacy organic contaminants in transplanted mussels at over 20 stations along the California coast until being discontinued in 2003. As part of this effort, the SMW collected California Mussel, Pacific Oyster, and Striped Shore Crab between 1977 and 2000, which were analyzed for cadmium, chlordanes, DDTs, dieldrin, mercury, selenium, and/or toxaphene.

State Mussel Watch Endowment (SMWE)

The SMWE was a joint effort by the SWRCB and CDFW to continue SMW sampling using endowment funds from a legal settlement. The SMWE continued monitoring through 2012 at select stations established by the SMW to extend data on long-term

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[7] Additional information about NOAAs Mussel Watch Program can be found online at: https://coastalscience.noaa.gov/science-areas/pollution/mussel-watch/.
[8] Additional information about SWAMPs Coastal Monitoring Programs can be found online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/coast_study.html.
[9] Additional information about SWAMPs Mussel Watch Program can be found online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/mussel_watch.html.

trends in bioaccumulative contaminants in ambient mussel concentrations (Melwani et al., 2013). The SMWE collected Bay Mussels in 2002 and California Mussels from 2001–2003, which were analyzed for cadmium, chlordanes, DDTs, dieldrin, mercury, selenium, 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 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. As part of the program, CDFW collected Threespine Stickleback from Humboldt Bay from 1989 to 1991, which were analyzed for cadmium, mercury, and selenium.

CHANGES FROM THE 2018 ADVISORY

This update includes the following changes and additions to the 2018 Humboldt Bay advisory:

1) Consumption advice for California Halibut, clam species, mussel species, Pacific Oyster, Striped Shore Crab, and Threespine Stickleback was added to the advisory.
2) Leopard Shark advice changed for the general population from no consumption to 1 serving per week based on the addition of more recent samples with lower mercury concentrations.
3) Red Rock Crab advice changed for both the sensitive and general populations from 2 to 0 servings per week and 4 servings per week to 2 servings per month, respectively, based on a newly developed ATL for cadmium (OEHHA, 2026).
4) Advice for the Shiner and White Surfperch group changed for both the sensitive and general populations because of the exclusion of previously included samples, based on sample preparation (e.g., fillet or whole; see section ‘Chemical Concentrations’).
5) Age ranges for women in the sensitive and general populations changed to 18–49 years and 50+ years, respectively.[10]
6) Consumption advice for shellfish species based on cadmium is provided for two distinct populations, pregnant women and all other non-pregnant individuals.

[10] In 2018, OEHHA updated the age ranges for women in each population group. The sensitive population changed from women ages 18–45 years to 18–49 years, and the general population from women 46 years and older to 50 years and older.

FISH AND SHELLFISH SAMPLED FROM HUMBOLDT BAY

The sampling data used in this advisory were retrieved from Humboldt Waterkeeper and the California Environmental Data Exchange Network (CEDEN),[11] 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). A summary of all fish and shellfish species evaluated for this advisory is shown in Table 1, including the name of the species, number of samples collected, total number of fish, project name, year sampled, and contaminants analyzed.

TABLE 1. FISH AND SHELLFISH SAMPLES EVALUATED FOR THE HUMBOLDT BAY ADVISORY

Common Name	Scientific Name	Number of Samples[a,b]	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c,d]
Bay Mussel	*Mytilus edulis*	1	45	SMWE	2002	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
California Halibut	*Paralichthys californicus*	3	3	HWK	2019	MeHg
		6	6	HWK	2016 – 2017	Hg
		1	2	SWAMP	2010	Chlordanes, DDTs, Hg, PCBs, Se
California Mussel	*Mytilus californianus*	7	315	SMWE	2002 – 2003	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		2	90	SMWE	2001	Chlordanes, DDTs, Dieldrin, Toxaphene
		4	180	SMW	2000	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Gaper Clam	*Tresus nuttallii*	1	5	CFCP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Horseneck Clam	*Tresus capax*	4	4	HWK	2017	Hg

[11] Online at: https://ceden.waterboards.ca.gov/CQT/Home/AqtTool.

Common Name	Scientific Name	Number of Samples[a,b]	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c,d]
Leopard Shark	*Triakis semifasciata*	10	10	SWAMP	2019	Hg
		1	10	SWAMP	2019	Se
		1	1	HWK	2016	Hg
		1	3	SWAMP	2010	Chlordanes, DDTs, Dieldrin, PCBs, Se
		8	8	SWAMP	2010	Hg
Lingcod	*Ophiodon elongatus*	5	5	HWK	2016 – 2017	Hg
Littleneck Clam	*Protothaca species*	1	5	CFCP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Martha Washington Clam	*Saxidomus gigantea*	3	3	HWK	2017	Hg
Mytilus	*Mytilus species*	2	60	NOAA	2009	Chlordanes, DDTs, Dieldrin, PCBs
		4	120	NOAA	2007, 2010	PBDEs
		8	240	NOAA	2001, 2003, 2005, 2007	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se
		4	120	NOAA	2005, 2007	PCBs
Pacific Littleneck Clam	*Protothaca staminea*	3	11	HWK	2017	Hg
Pacific Oyster	*Crassostrea gigas*	3	18	HWK	2017	Hg
		1	45	SMW	1997	Cd, Hg
Pile Perch	*Rhacochilus vacca*	1	3	CFCP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Red Rock Crab	*Cancer productus*	6	30	CFCP	1999	Cd, Chlordanes, DDTs, Diedrin, Hg, Se, Toxaphene
		3	13	CFCP	1999	PCBs

Common Name	Scientific Name	Number of Samples[a,b]	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c,d]
Shiner Perch	*Cymatogaster aggregata*	6	6	SWAMP	2010	Hg
		1	16	CFCP	2003	Cd, Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
		2	34	CFCP	2001	Cd, Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		3	28	CFCP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		1	4	CFCP	1999	PCBs
		1	15	EMAP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Speckled Sanddab	*Citharichthys stigmaeus*	1	80	CFCP	2001	Cd, Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
Striped Shore Crab	*Pachygrapsus crassipes*	4	180	SMW	1996	Cd, Hg, Se
Threespine Stickleback	*Gasterosteus aculeatus*	6	292	TSMP	1989 – 1991	Cd, Hg, Se
Walleye Surfperch	*Hyperprosopon argenteum*	5	5	HWK	2017	Hg
		1	5	CFCP	2003	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		3	17	CFCP	2003	Cd, Hg, Se
		1	5	CFCP	1999	Cd, Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
White Surfperch	*Phanerodon furcatus*	1	7	SWAMP	2019	Se
		1	4	CFCP	2003	Chlordanes, DDTs, Diedrin, PCBs, Toxaphene
		2	8	CFCP	2003	Cd, Hg, Se
		1	6	CFCP	2001	Cd, Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene

Abbreviations: Cd, cadmium; DDTs, dichlorodiphenyltrichloroethanes; Hg, mercury; MeHg, methylmercury; PBDEs, polybrominated diphenyl ethers; PCBs, polychlorinated biphenyls; Se, selenium

[a] Samples were analyzed in various ways (e.g., skinless fillets, whole organism). See Tables 2–4 for the preparation method for each species.

[b] Samples refer to individual fish or composite of multiple fish.

[c] Data for organic chemicals (e.g., chlordanes, DDTs, dieldrin, PCBs or toxaphene) generated prior to 1999 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.
[d] Data for inorganic chemicals and metals/metalloids (e.g., Cd, Hg, or Se) that were generated prior to 2000 were evaluated for temporal changes and not included in the analysis if there was a sufficient number of samples collected after 2000.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: cadmium, total mercury, selenium, chlordanes (five congeners), DDTs (six congeners), dieldrin, toxaphene, PBDEs (5–51 congeners), and PCBs (38–54 congeners).[12] Among the chemicals analyzed in fish tissue samples from Humboldt Bay, only cadmium, mercury, and PCB levels were sufficiently high to impact consumption advice.

All finfish samples were prepared as skinless fillets or skin-on fillets, except as noted in Tables 2–4. Threespine Stickleback were analyzed whole because of their small size and some samples of Shiner Perch, Walleye Surfperch, and White Surfperch were analyzed whole without head, tail, and guts (WOHTG). Because mercury is known to accumulate in the fillet, including samples analyzed as whole can reduce the concentration of mercury. For this reason, only surfperch samples analyzed as fillets were included in mercury analyses. Conversely, since PCBs are known to accumulate in skin, fat, and internal organs, only surfperch samples analyzed as WOHTG were included for PCB analyses in this update. In the original 2018 Humboldt Bay advisory, both fillet and WOHTG surfperch samples were included in PCB analyses. Using only WOHTG samples did not change the recommended advice for Pile and Walleye Surfperch group. However, including only fillet samples for mercury analyses and WOHTG samples for PCB analyses resulted in more health-protective advice than that recommended in the 2018 advisory for the Shiner and White Surfperch group for both the sensitive and general populations. Crustaceans and bivalves were primarily analyzed as whole without guts or soft tissue, respectively. Samples were analyzed as individual fish or composites.

For this advisory, OEHHA used the weighted (by the number of individual fish) average (arithmetic mean) of the chemical concentrations (in wet weight) for each fish species to estimate average human exposure.

CADMIUM

Species were analyzed for cadmium as composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS) at the Marine Pollution Studies Laboratory

[12] Congeners are related compounds with similar chemical forms. Five and six congeners are typically analyzed for chlordanes and DDTs, respectively. Of the 209 possible PBDE and PCB congeners, 6–7 and 48–54 are generally analyzed, respectively. See the OEHHA (2022) sampling protocol available online at https://oehha.ca.gov/media/downloads/fish/report/fishadvisorysamplinganalysisprotocolreport2022.pdf.

(MPSL) at Moss Landing Marine Laboratories, TDI Brooks International, or another laboratory. The ICP-MS method uses desolvation, atomization, and ionization with ion separation based on a mass-to-charge ratio to detect the total cadmium concentration in a sample. The method detection limits (MDLs)[13] and reporting limits (RLs)[14] for cadmium, with one exception, were below 250 and 2 parts per billion (ppb), respectively. Although the MDL and RL were not reported in several studies, cadmium was detected at concentrations consistent with other studies. For this reason, these data were included in the calculation of sample means. Table 2 shows the sample preparation method, averages and ranges for total length in millimeters (mm),[15] as well as cadmium concentrations in each fish and shellfish species.

Mercury and Methylmercury

Samples were analyzed for total mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA) or cold vapor atomic absorption spectrometry (CVAAS) at MPSL, TDI Brooks International, or another laboratory. Three California Halibut samples were analyzed for methylmercury as individual fish using cold vapor atomic fluorescence spectrometry (CVAFS) at Brooks Applied Labs. The DMA method utilizes thermal decomposition and atomic absorption. The CVAAS method converts mercury into a gas which absorbs light at a specific wavelength. The CVAFS method measures the fluoresced light emitted by mercury atoms. 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). Depending on the study, the DMA MDLs for total mercury were 3 or 12 ppb, and the RLs were 9 or 36 ppb. Depending on the study, the CVAAS MDLs for total mercury were 10, 18, or 30 ppb, and the RLs were unreported. The CVAFS MDLs for methylmercury were 1.4 or 1.5 ppb and the RLs were 2.8 or 3 ppb. Although the MDL and RL were not reported in several studies, mercury was detected at concentrations consistent with other studies. For this reason, these data were included in the calculation of sample means. Table 3 shows the sample preparation method, averages and ranges for total length (mm), as well as mercury concentrations in each fish and shellfish species.

PCBs, PBDEs, and Pesticides

Pesticides, PBDEs, and PCBs in either individual fish or composite samples were analyzed by gas chromatography at MPSL, CDFWs Water Pollution Control Laboratory, TDI Brooks International, or another laboratory. Where applicable, the concentrations presented were the sum of the detected analytes (parent compound, congeners, or metabolites) for chlordanes, DDTs, PCBs, and PBDEs. Individual congeners or metabolites with concentrations reported as non-detects were assumed to be zero (due

[13] The MDL is the lowest amount of a chemical that can be distinguished (as greater than zero) in a sample.
[14] The RL is the lowest amount of a chemical that can be accurately quantified in a sample.
[15] 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.

to MDLs or RLs under 5 ppb, except for a few samples analyzed for toxaphene). 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). Although the MDL and RL were not reported in several studies, these organic compounds were detected at concentrations consistent with other studies. Table 4 shows the sample preparation method, averages and ranges for total length (mm), as well as PCB concentrations in each fish and shellfish species.

SELENIUM

Selenium in either individual fish or composite samples was analyzed at MPSL, TDI Brooks International, or another laboratory. Fish were analyzed for selenium as 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. Depending on the study, the ICP-MS MDLs for selenium ranged from 25 to 230 ppb, and the RLs ranged from 75 to 700 ppb. Although the MDL and RL were not reported in several studies, selenium was detected at concentrations consistent with other studies. For this reason, those data were included in the calculation of sample means.

Concentrations of chlordanes, dieldrin, DDTs, PBDEs, selenium, and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008, 2011, and 2026). Except for assessing multiple chemical exposures, when appropriate, these chemicals were not considered further for developing consumption advice and are not shown in this report.

TABLE 2. CADMIUM CONCENTRATIONS IN FISH AND SHELLFISH FROM HUMBOLDT BAY

Species from Humboldt Bay	Tissue Type[a,b]	Number of Samples[c]	Total Number of Individuals	Mean[d] Total Length (mm)	Range[e] of Total Lengths (mm)	Cadmium (ppb)[f]	
						Mean[d]	Range[e]
Clam Species	Combined	2	10	-	-	344	314 – 373
Gaper Clam	NR	1	5	-	-	314	n/a
Littleneck Clam	soft tissue	1	5	-	-	373	n/a
Mussel Species	Combined	20	780	-	-	696	354 – 1,238
Bay Mussel	soft tissue	1	45	-	-	644	n/a
California Mussel	soft tissue	7	315	-	-	834	545 – 1,028
California Mussel	WOG	4	180	-	-	458	400 – 540
Mytilus Species	NR	8	240[g]	-	-	705	354 – 1,238
Pacific Oyster	WOG	1	45	-	-	550	n/a
Pile and Walleye Surfperch	F, combined	2	8	275	210 – 382	4	3 – 5
Pile Perch	F, skin-off	1	3	362	332 – 382	5	n/a
Walleye Surfperch	F, skin-on	1	5	222	210 – 245	3	n/a
Red Rock Crab	NR	6	30	-	-	295	72 – 678
Shiner and White Surfperch	F, skin-on	6	68	130	103 – 181	10	2 – 42
Shiner Perch	F, skin-on	5	62	126	103 – 149	11	5 – 42
White Surfperch	F, skin-on	1	6	171	161 – 181	2	n/a
Speckled Sanddab	F, skin-on	1	80	107	n/a	7	n/a
Striped Shore Crab	WOG	4	180	-	-	70	30 – 160
Threespine Stickleback	W	6	292	49	46 – 52	1	0 – 10

[a] W= whole organism, WOG= whole organism without guts, F= fillet, NR= not recorded
[b] "Combined" summarizes data for all listed tissue types
[c] Samples refer to individual fish or composite of multiple fish.
[d] Means are an arithmetic average of individual values and/or a weighted average of composites.
[e] Range of individuals and/or range of the composites.
[f] ppb = parts per billion
[g] The NOAA sampling procedure recommended including approximately 30 individuals per sample (Apeti et al., 2012). NOAA did not report the exact number of mussels in each sample in several cases.
n/a = not applicable due to a single sample

TABLE 3. MERCURY CONCENTRATIONS IN FISH AND SHELLFISH FROM HUMBOLDT BAY

Species from Humboldt Bay	Tissue Type[a,b]	Number of Samples[c]	Total Number of Fish	Mean[d] Total Length (mm)	Range[e] of Total Lengths (mm)	Mercury (ppb)[f]	
						Mean[d]	Range[e]
California Halibut	F, Skin-off	10	11	705	579 – 1156	159[g]	51 – 354
Clams Species	Combined	12	28	-	-	29	0 – 68
Gaper Clam	NR	1	5	-	-	0	n/a
Horseneck Clam	soft tissue	4	4	73	54 – 90	42	24 – 60
Littleneck Clam	soft tissue	4	16	–	–	32	0 – 57
Martha Washington Clam	soft tissue	3	3	81	75 – 90	47	36 – 68
Leopard shark	F, Skin-off	19	19	1212	983 – 1,410	1,128	437 – 2,390
Lingcod	F, Skin-off	5	5	657	572 – 739	329	146 – 541
Mussel Species	Combined	20	780	-	-	26	5 – 44
Bay Mussel	soft tissue	1	45	-	-	44	n/a
California Mussel	soft tissue	7	315	-	-	27	15 – 33
California Mussel	WOG	4	180	-	-	31	26 – 38
Mytilus Species	NR	8	240[h]	-	-	17	5 – 32
Pacific Oyster	Combined	4	63	-	60 – 85	37	23 – 41
	WWG	3	18	76	60 – 85	25	23 – 28
	WOG	1	45	-	-	41	n/a
Pile and Walleye	F, combined	7	13	231	150 – 382	184	100 – 262
Pile Perch	F, Skin-off	1	3	362	332 – 382	167	n/a
Walleye Surfperch	F, Skin-on	6	10	192	150 – 245	189	100 – 262
Red Rock Crab	NR	6	30	-	-	134	83 – 246

Species from Humboldt Bay	Tissue Type[a,b]	Number of Samples[c]	Total Number of Fish	Mean[d] Total Length (mm)	Range[e] of Total Lengths (mm)	Mercury (ppb)[f]	
						Mean[d]	Range[e]
Shiner and White Surfperch	F, combined	12	74	128	100 – 181	84	40 – 162
Shiner Perch	F, skin-on	5	62	126	103 – 149	88	66 – 105
Shiner Perch	F, skin-off	6	6	111	100 – 135	91	63 – 162
White Surfperch	F, Skin-on	1	6	171	161 – 181	40	n/a
Speckled Sanddab	F, Skin-on	1	80	107	n/a	13	n/a
Striped Shore Crab	WOG	4	180	-	-	41	19 – 57
Threespine Stickleback	W	6	292	49	46 – 52	55	40 – 80

[a] W= whole organism, WWG= whole with gonads, WOG= whole organism without guts, F= fillet, NR= not recorded
[b] "Combined" summarizes data for all listed tissue types
[c] Samples refer to individual fish or composite of multiple fish.
[d] Means are an arithmetic average of individual values and/or a weighted average of composites.
[e] Range of individuals and/or range of the composites.
[f] ppb = parts per billion
[g] Includes three California Halibut samples analyzed for methylmercury.
[h] The exact number of mussels was not reported, but the study estimated 30 individuals per sample.
n/a = not applicable due to a single sample

TABLE 4. PCB CONCENTRATIONS IN FISH AND SHELLFISH FROM HUMBOLDT BAY

Species from Humboldt Bay	Tissue Type[a]	Number of Samples[b]	Total Number of Fish	Mean[c] Total Length (mm)	Range[d] of Total Lengths (mm)	PCBs (ppb)[e]	
						Mean[c]	Range[d]
California Halibut	F, skin-off	1	2	745	680 – 810	0	n/a
Gaper Clam	NR	1	5	NR	NR	0	n/a
Leopard Shark	F, skin-off	1	3	1318	1,285 – 1,345	0	n/a
Mytilus Species	NR	6	180	NR	NR	2	0 – 3
Pile and Walleye Surfperch	WOHTG	1	5	189	179 – 206	15	n/a
Walleye Surfperch	WOHTG	1	5	189	179 – 206	15	n/a
Red Rock Crab	NR	3	13	NR	NR	0	0 – 1
Shiner and White Surfperch	WOHTG	2	20	152	112 – 243	26	23 – 26
Shiner Perch	WOHTG	1	16	133	112 – 149	26	n/a
White Surfperch	WOHTG	1	4	227	210 – 243	23	n/a
Speckled Sanddab	F, skin-on	1	80	107	n/a	0	n/a

[a] WOHTG= whole without head, tail, guts, F= fillet, NR= not recorded
[b] Samples refer to individual fish or composite of multiple fish.
[c] Means are an arithmetic average of individual values and/or a weighted average of composites.
[d] Range of individuals and/or range of the composites.
[e] ppb = parts per billion
n/a = not applicable due to a single sample

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM HUMBOLDT BAY

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 development 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 and eicosapentaenoic acid (USDA/USDHHS, 2020; Weaver et al., 2008).

As part of a healthy US-style dietary pattern at the 2,000-calorie level, the "Dietary Guidelines for Americans, 2020 – 2025" (USDA/USDHHS, 2020) recommends consuming eight ounces of seafood[16] per week. Young children are advised to eat proportionately smaller amounts. "Women who are pregnant or lactating should consume at least eight and up to 12 ounces of a variety of seafood per week from choices that are lower in methylmercury." Additionally, "based on FDA [US Food and Drug Administration] and EPA's [US Environmental Protection Agency] advice,[17] 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" and avoid certain species (USDA/USDHHS, 2020). The species of 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 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-harvested 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

[16] Seafood as used here refers to fish and shellfish from freshwater and marine environments.
[17] Online at: https://www.fda.gov/food/consumers/advice-about-eating-fish.

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 18–49 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 fetuses and children. Similarly, there are two sets of ATLs for cadmium in fish because of the life stage-related toxicity associated with this chemical (OEHHA, 2026). Exposure to too much cadmium during pregnancy can interfere with the development and function of the placenta and may pose a risk to the fetus. Thus, the ATLs for the sensitive population (defined as pregnant individuals for advice based on cadmium) are lower than those for the general population (defined as non-pregnant individuals, including children, for advice based on cadmium). Tables of the ATLs developed by OEHHA, including the ATLs used in this report, are presented in the Appendix.

For each fish species in this advisory, OEHHA compared the mean chemical concentrations detected in the sample to the corresponding ATLs to establish the maximum number of servings per week (or per month, for certain instances when advice is based on cadmium) that can be safely consumed (see the Appendix). For finfish fillets and crustacean "meat", a serving size is typically considered to be eight 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. Bivalve shellfish advice is provided for a 4-ounce serving size.

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 fewer servings per week than would be the case for the presence of either chemical alone, with a similar concentration. The potential effect of multiple chemical exposures (mercury, PCBs, and DDTs) was assessed for California Halibut, the Pile and Walleye Surfperch group, and the Shiner and White Surfperch group, and affected advice for the Shiner and Walleye Surfperch group. The potential effect of multiple chemical exposures was not assessed in any other species because of very low or non-detectable levels of PCBs and/or DDTs. Advice for other species in this advisory was based solely on mercury, PCB, or cadmium concentrations.

OEHHA recommends that individuals strive to meet the US dietary guidelines' seafood consumption recommendations,[18] 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 listed 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[19] 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.

CONSUMPTION ADVICE FOR FISH FROM HUMBOLDT BAY

OEHHA's sampling and analysis protocol (OEHHA, 2022) requires that a minimum of nine edible-size fish of a species that may be legally caught are collected and analyzed before an advisory can be developed for the primary contaminant of concern. This is to ensure the sample dataset is representative of the fish or shellfish species population in the water body. The majority of fish consumption advisories in California are based on mercury, which is typically analyzed in individual fish, rather than as composites. Mercury analysis is relatively inexpensive and mercury concentrations in fish are more likely to be positively correlated with fish size than other contaminants. Other contaminants, such as cadmium, PCBs, pesticides, and selenium, may also impact advice. These contaminants are often analyzed as a composite of a smaller subset of fish (usually at least five individuals) as a cost-saving mechanism, a common practice that is considered acceptable. In some cases, an exception is made regarding the minimum sample size. This is particularly true if the advice is based on a chemical other than mercury where sample size is often limited, and/or if doing so leads to more health-protective advice than would otherwise be provided.

For Humboldt Bay, the sample size criterion was met for all species or species groups except for Lingcod. Lingcod were included in this advisory despite a sample size of five because the advice for this species matches the advice for Lingcod in OEHHA's Statewide Advisory for Eating Fish from California Coastal Locations without Site-

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

specific Advice[20], which is supported by a much larger sample size. Sufficient data were not available to evaluate other species that may be found in this water body.

For fish species found in Humboldt Bay that are not included in this advisory, OEHHA recommends following the Statewide Advisory for Eating Fish from California Coastal Locations without Site-specific Advice.

The following advice is based solely on cadmium, mercury, and/or PCB concentrations. Legacy pesticides and selenium concentrations were not a risk driver for any species. The "risk driver" is the chemical or chemicals that result in the most health protective advice. Unless otherwise indicated, the sensitive population is typically[21] defined as women ages 18 to 49 years and children ages 1 to 17 years, and the general population is defined as women 50 years and older and men 18 years and older.

California Halibut

California Halibut samples analyzed for methylmercury and mercury were combined to calculate a mean mercury concentration, as shown in Table 3. Advice for California Halibut was not affected by the inclusion of samples analyzed for methylmercury. The mean mercury and PCB concentrations in California Halibut from Humboldt Bay were 159 and 0 ppb, respectively. OEHHA recommends a maximum of one serving a week of California Halibut for the sensitive population, and a maximum of three servings a week for the general population, based on mercury. Although the mean mercury concentration would typically allow four servings per week for the general population, OEHHA recommended three meals per week for the general population because the mean mercury concentration was close to the cutoff and a health-protective approach was warranted.

Clam Species

The mean cadmium, mercury and PCB concentrations in clam species from Humboldt Bay were 344, 29, and 0 ppb, respectively. Cadmium concentrations for individual clam species were as follows: Gaper Clam (314 ppb), and Littleneck Clam (373 ppb). Mercury concentrations for individual clam species were as follows: Gaper Clam (0 ppb), Horseneck Clam (42 ppb), Littleneck Clams (32 ppb), and Martha Washington Clam (47 ppb). PCBs were analyzed for Gaper Clams only (0 ppb). Based on the concentration of cadmium in these clam species, OEHHA recommends no consumption for the sensitive population (pregnant women) and a maximum of one serving a week

[20] OEHHA's Statewide Advisory for Eating Fish from California Coastal Locations Without Site Specific Advice can be found online at: https://oehha.ca.gov/media/downloads/advisories/californiacoastaladvisory110916.pdf.

[21] Population group definitions for "sensitive" or "general" may change when advice is based on certain chemicals (e.g., cadmium, sensitive refers to only pregnant individuals).

for the general population (non-pregnant individuals). OEHHA extends advice for the clam species listed above to all clams that may be found in Humboldt Bay.

Leopard Shark

The mean mercury and PCB concentrations in Leopard Shark from Humboldt Bay were 1,128 and 0 ppb, respectively. OEHHA recommends no consumption of Leopard Shark from Humboldt Bay for the sensitive population, and a maximum of one serving a week for the general population, based on mercury.

Lingcod

The mean mercury concentration in Lingcod from Humboldt Bay was 329 ppb. OEHHA recommends a maximum of one serving a week of Lingcod for the sensitive population, and a maximum of two servings a week for the general population, based on mercury.

Mussel Species

The mean cadmium, mercury and PCB concentrations in mussel species from Humboldt Bay were 696, 26, and 2 ppb, respectively. Cadmium concentrations for individual mussel species were as follows: Bay Mussel (644 ppb), California Mussel (834 and 458 ppb for samples analyzed as soft tissue and WOG, respectively), and individuals reported only by their genus ‘Mytilus’ (705 ppb). Mercury concentrations for individual mussel species were as follows: Bay Mussel (44 ppb), California Mussel (27 and 31 ppb for samples analyzed as soft tissue and WOG, respectively), and individuals reported only by their genus ‘Mytilus’ (17 ppb). PCBs were only analyzed for individuals reported by their genus ‘Mytilus’ (2 ppb). Based on the concentration of cadmium in these mussel species, OEHHA recommends no consumption for the sensitive population (pregnant women) and a maximum of two servings a month for the general population (non-pregnant individuals).

Pacific Oyster

The mean cadmium and mercury concentrations in Pacific Oyster from Humboldt Bay were 550 and 37 ppb, respectively. OEHHA recommends no consumption of Pacific Oyster from Humboldt Bay for the sensitive population (pregnant women), and a maximum of two servings per month for the general population (non-pregnant individuals), based on cadmium.

Surfperch, Pile and Walleye

OEHHA combined data for Pile and Walleye Surfperch from Humboldt Bay to develop this advisory because they had similar levels of mercury. PCBs did not impact advice for either species and therefore did not influence grouping decisions. The sample size for Pile Perch (n=3) was smaller than OEHHA generally requires for providing advice for a species at a water body. However, the mercury concentration in the sample obtained

from Humboldt Bay Pile Perch was higher than in other coastal samples for this species used to develop the Statewide Advisory for Eating Fish from California Coastal Locations Without Site Specific Advice (OEHHA, 2016). Thus, using the Humboldt Bay data for this species rather than referring consumers to the Statewide Advisory, resulted in more health protective advice. When combined with Walleye Surfperch, this group had an adequate sample size. The mean cadmium, mercury, and PCB concentrations in the Pile and Walleye Surfperch group from Humboldt Bay were 4, 184, and 15 ppb, respectively. Individual cadmium, mercury and PCB concentrations for the two species were as follows: Pile Perch (Cd: 5 ppb, Hg: 167 ppb, PCBs: not analyzed), and Walleye Surfperch (Cd: 3 ppb, Hg: 189 ppb, PCBs: 15 ppb). Based on the concentration of mercury in these two species, OEHHA recommends a maximum of one serving a week of Pile or Walleye Surfperch for the sensitive population, and a maximum of three servings a week for the general population.

Red Rock Crab

The mean cadmium, mercury, and PCB concentrations in Red Rock Crab from Humboldt Bay were 295, 134 and 0 ppb, respectively. Based on the concentration of cadmium in this species, OEHHA recommends no consumption of Red Rock Crab for the sensitive population (pregnant women), and a maximum of two servings a month for the general population (non-pregnant individuals).

Surfperch, Shiner and White

OEHHA combined data for Shiner and White Surfperch from Humboldt Bay to develop this advisory because they had similar levels of contaminants. The sample size for White Surfperch was smaller than OEHHA generally requires for providing advice for a species at a water body. However, advice based on the chemical concentrations in the sample obtained from Humboldt Bay White Surfperch was the same as the Statewide Advisory for the general population and more restrictive than the Statewide Advisory for the sensitive population due to a multiple chemical exposure analysis. The sample size was adequate when combined with Shiner Perch. The mean cadmium, mercury, and PCB concentrations in the Shiner and White Surfperch group from Humboldt Bay were 10, 84, and 26 ppb, respectively. Individual cadmium, mercury and PCB concentrations for the two species were as follows: Shiner Perch (Cd: 11 ppb, Hg: 88 ppb, PCB: 26 ppb), and White Surfperch (Cd: 2 ppb, Hg: 40 ppb, PCB: 23 ppb). OEHHA recommends a maximum of one serving a week of Shiner or White Surfperch for the sensitive population based on a multiple chemical exposure analysis of DDTs, mercury, and PCBs, and a maximum of two servings a week for the general population, based on PCBs.

Speckled Sanddab

The mean cadmium, mercury, and PCB concentrations in Speckled Sanddab from Humboldt Bay were 7, 13, and 0 ppb, respectively. OEHHA recommends a maximum of

seven servings a week of Speckled Sanddab for both the sensitive population and general populations, based on the low levels of all contaminants.

Striped Shore Crab

The mean cadmium and mercury concentrations in Striped Shore Crab from Humboldt Bay were 70 and 41 ppb, respectively. Based on the level of cadmium in this species, OEHHA recommends a maximum of one serving a week of Striped Shore Crab for the sensitive population (pregnant women) and a maximum of two servings a week for the general population (non-pregnant individuals).

Threespine Stickleback

The mean cadmium and mercury concentrations in Threespine Stickleback from Humboldt Bay were 1 and 55 ppb, respectively. OEHHA recommends a maximum of four servings a week of Threespine Stickleback for the sensitive population and a maximum of seven servings a week for the general population, based on mercury.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish and shellfish from Humboldt Bay are shown in Table 5.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS FOR FISH AND SHELLFISH FROM HUMBOLDT BAY

Fish Species	Sensitive Population[a]		General Population[b]	
	Number of Servings[c]	Risk Driver[d]	Number of Servings[c]	Risk Driver[d]
California Halibut	1	Hg	3	Hg
Clam Species	0	Cd	1	Cd
Leopard Shark	0	Hg	1	Hg
Lingcod	1	Hg	2	Hg
Mussel Species	0	Cd	2 per month	Cd
Pacific Oyster	0	Cd	2 per month	Cd
Pile and Walleye Surfperch	1	Hg	3	Hg
Red Rock Crab	0	Cd	2 per month	Cd
Shiner and White Surfperch	1	Hg or PCBs	2	PCBs
Speckled Sanddab	7	–	7	–
Striped Shore Crab	1	Cd	2	Cd
Threespine Stickleback	4	Hg	7	–

[a] Sensitive population is defined as women ages 18 to 49 years and children ages 1 to 17 years except when Cd is the risk driver, in which it is defined as pregnant women.
[b] General population is defined as women 50 years and older and men 18 years and older except when Cd is the risk driver, in which it is defined as non-pregnant individuals.
[c] Servings are per week unless otherwise specified. A serving size is 8-ounces for uncooked finfish and crustaceans, and 4-ounces for bivalve shellfish.
[d] The risk driver is the contaminant that results in the fewest recommended servings per week.
Abbreviations: Cd, cadmium; Hg, mercury; PCBs, polychlorinated biphenyls
"–" denotes that all chemicals analyzed were below levels that would restrict consumption to less than seven servings a week

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APPENDIX. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs; OEHHA, 2008, 2011, and 2026) guide the development of advice for people eating sport-harvested 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[22] 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 chosen based on OEHHA's policy to balance the benefits and risks of fish consumption.

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

TABLE A1. 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[b]
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[c] (Women 18–49 and children 1–17 years)	≤ 31	> 31–36	> 36–44	> 44–55	> 55–70	> 70–150	> 150–440	> 440
MeHg (Women ≥ 50 and men ≥ 18 years)	≤ 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.
[b] Represents the 'do not consume' value (i.e. 0 servings).

[22] 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.

[c] All mercury detected is assumed to be methylmercury (MeHg), which is the most common form found in fish and is also the more toxic form (Bloom, 1992).

TABLE A2. ADVISORY TISSUE LEVELS FOR CADMIUM FOR CRUSTACEAN AND FINFISH ADVISORIES

Consumption Frequency Categories (8-ounce servings per week or month)[a] and ATLs (in ppb)[b] for Pregnant and Non-Pregnant Individuals										
Population Group	**Servings per Week**							**Servings per Month**		
	7	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**1**	**0**[c]
Pregnant Individuals	≤20	>20–23	>23–28	>28–34	>34–46	>46–69	>69–140	n/a	n/a	>140
Non-pregnant Individuals	≤20	>20–23	>23–28	>28–34	>34–46	>46–92	>92–280	>280–550	>550– 1,100	>1,100

[a] Serving size (prior to cooking, wet weight) consumed by an average 160-pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts. OEHHA fish advisories provide guidance about serving sizes for children that considers their relatively smaller body size. The serving size for crustaceans and finfish is 8-ounces.
[b] ppb = parts per billion
[c] Represents the 'do not consume' value (i.e. 0 servings).
n/a = not applicable

TABLE A3. ADVISORY TISSUE LEVELS FOR CADMIUM FOR BIVALVE SHELLFISH ADVISORIES

Consumption Frequency Categories (4-ounce servings per week or month)[a] and ATLs (in ppb)[b] for Pregnant and Non-Pregnant Individuals										
Population Group	**Servings per Week**							**Servings per Month**		
	7	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**1**	**0** [C]
Pregnant Individuals	≤39	>39–46	>46–55	>55–69	>69–92	>92–140	>140–280	n/a	n/a	>280
Non-pregnant Individuals	≤39	>39–46	>46–55	>55–69	>69–92	>92–180	>180–550	>550 – 1,100	>1,100–2,200	>2,200

[a] Serving size (prior to cooking, wet weight) consumed by an average 160-pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts. OEHHA fish advisories provide guidance about serving sizes for children that considers their relatively smaller body size. The serving size for bivalve shellfish is 4-ounces.
[b] ppb = parts per billion
[c] Represents the 'do not consume' value (i.e., 0 servings).
n/a = not applicable