OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

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

October 2018

Fish, Ecotoxicology, and Water Section
Pesticide and Environmental Toxicology Branch
Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CEDEN	California Environmental Data Exchange Network
CDFW	California Department of Fish and Wildlife
CFCP	Coastal Fish Contamination Program
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
EMAP	Environmental Monitoring and Assessment Program
EPA	eicosapentaenoic acid
FDA	Food and Drug Administration
Hg	mercury
MDL	method detection limit
MLML	Moss Landing Marine Laboratories
mm	millimeters
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
Se	selenium
SWAMP	Surface Water Ambient 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 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 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 List of Figures and Tables.

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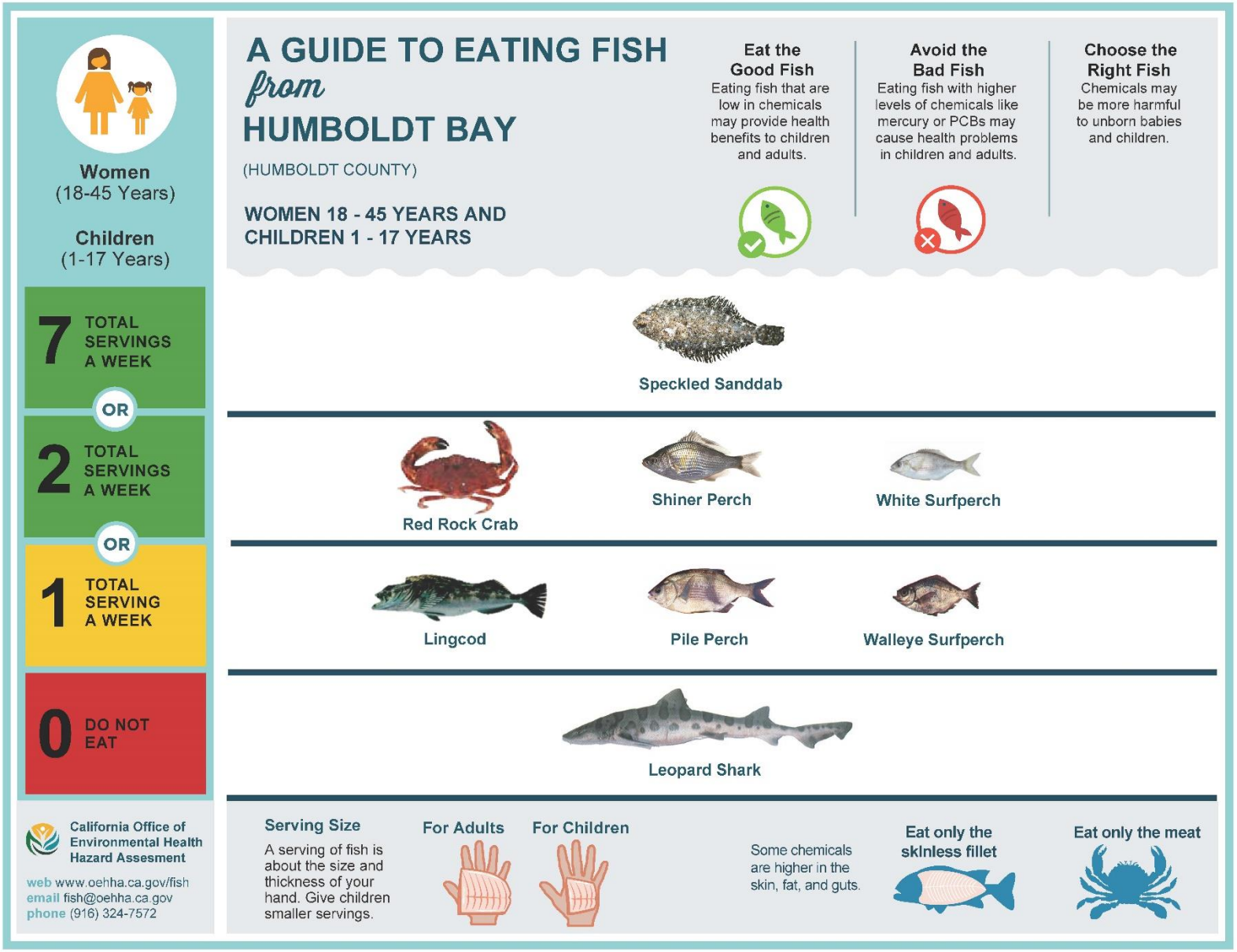
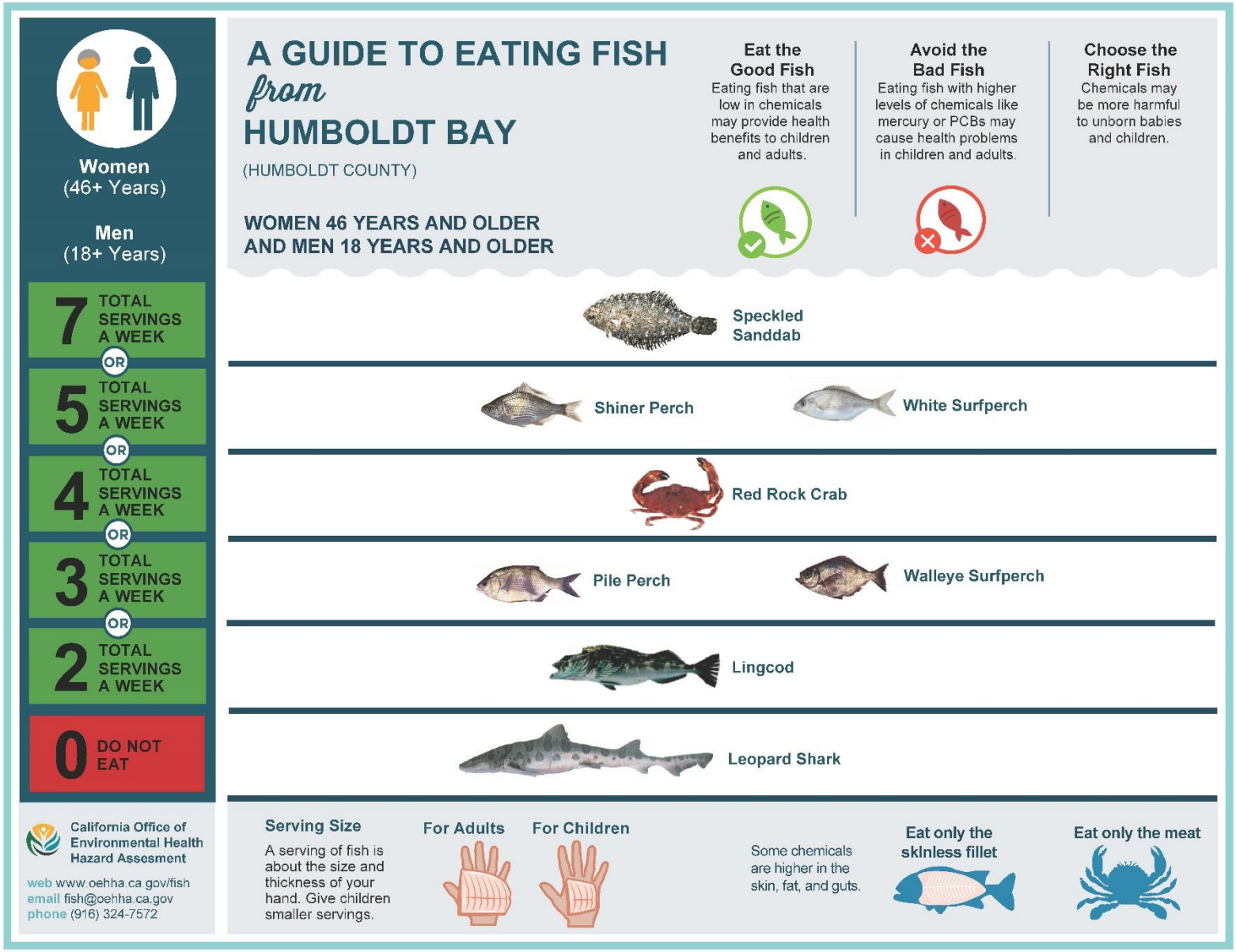

A GUIDE TO EATING FISH
from
HUMBOLDT BAY
(HUMBOLDT COUNTY)
WOMEN 18 - 45 YEARS AND
CHILDREN 1 - 17 YEARS
Eat the Good Fish
Eating fish that are low in chemicals may provide health benefits to children and adults.
Avoid the Bad Fish
Eating fish with higher levels of chemicals like mercury or PCBs may cause health problems in children and adults.
Choose the Right Fish
Chemicals may be more harmful to unborn babies and children.
Women
(18-45 Years)
Children
(1-17 Years)
7 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
Speckled Sanddab
Red Rock Crab
Shiner Perch
White Surfperch
Lingcod
Pile Perch
Walleye Surfperch
Leopard Shark
California Office of Environmental Health Hazard Assesment
web www.oehha.ca.gov/fish
email fish@oehha.ca.gov
phone (916) 324-7572
Serving Size
A serving of fish is about the size and thickness of your hand. Give children smaller servings.
For Adults
For Children
Some chemicals are higher in the skin, fat, and guts.
Eat only the skinless fillet
Eat only the meat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Eating fish that are low in chemicals may provide health benefits to children and adults.
Avoid the Bad Fish
Eating fish with higher levels of chemicals like mercury or PCBs may cause health problems in children and adults.
Choose the Right Fish
Chemicals may be more harmful to unborn babies and children.
Women (46+ Years)
Men (18+ Years)
7 TOTAL SERVINGS A WEEK
OR
5 TOTAL SERVINGS A WEEK
OR
4 TOTAL SERVINGS A WEEK
OR
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
0 DO NOT EAT
Speckled Sanddab
Shiner Perch
White Surfperch
Red Rock Crab
Pile Perch
Walleye Surfperch
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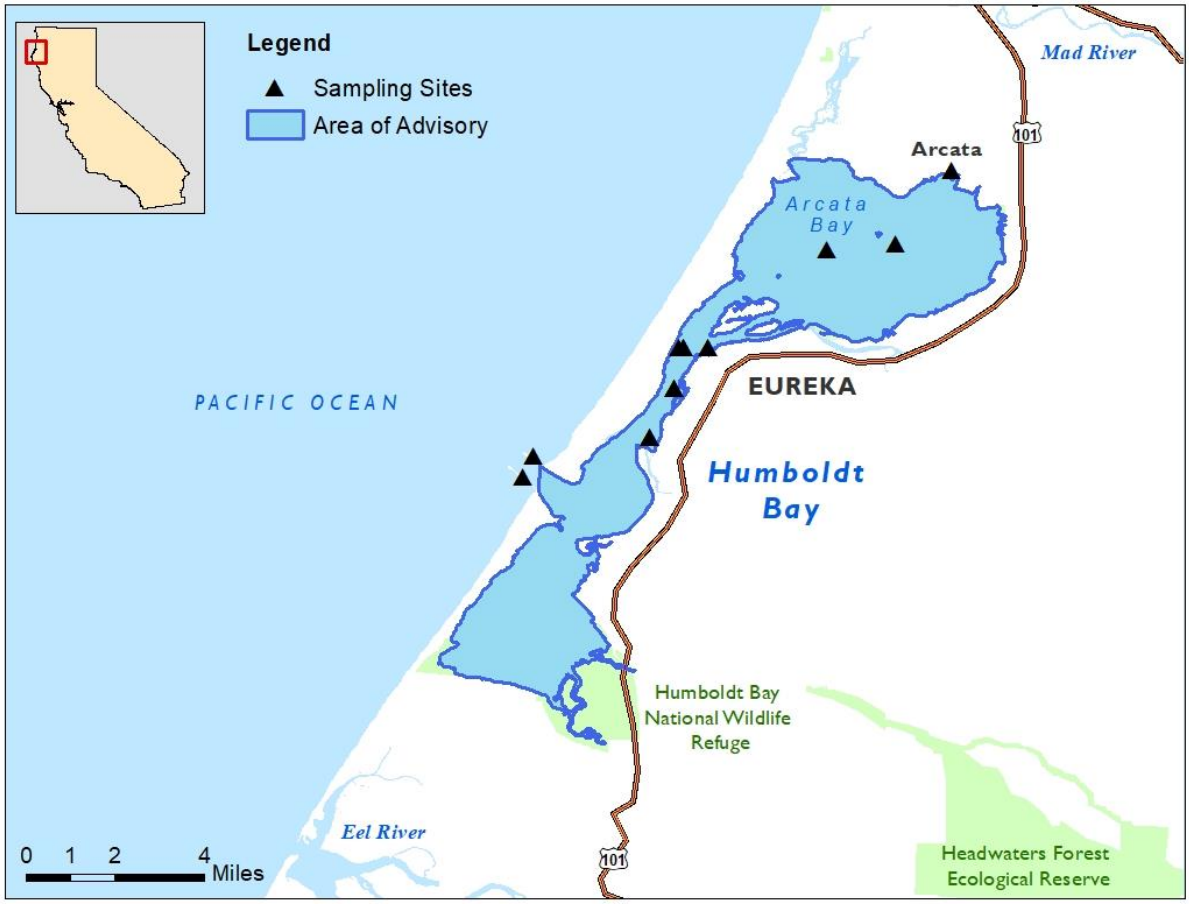
INTRODUCTION

This report presents a guideline for eating fish from Humboldt Bay (Figure 1) in Humboldt County. Humboldt Bay is adjacent to the city of Eureka, along California's northern coast. Humboldt Bay 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 pertains only to Humboldt Bay (including the Arcata Bay portion of Humboldt Bay) and not to any sloughs or creeks that feed the bay.

FIGURE 1. LOCATION OF HUMBOLDT BAY



APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from four monitoring studies described in this report to develop the Humboldt Bay 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[1]) 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 chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of potential concern.
5) Development of final advice based on a thorough review of the data and best professional judgment relating to the benefits and risks of consuming a particular fish species.

The ATLs (discussed further in a subsequent section of this report) are chemical levels in fish tissue that are considered acceptable, based on chemical toxicity, for a range of consumption rates. Development of the ATLs also included consideration of health benefits associated with including fish in the diet (OEHHA, 2008). The ATLs should not be interpreted as static "bright lines," but one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of the benefits and risks of consuming sport fish.

CHEMICALS OF POTENTIAL CONCERN

Certain chemicals are considered to be of potential concern for people who eat fish because of their toxicity and their ability to accumulate in fish tissue. The majority of fish consumption advisories in California are issued because of mercury (Hg), followed by polychlorinated biphenyls (PCBs) and, in a few cases, selenium (Se) 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 historic 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

[1] 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.

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 industrial 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 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.

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 water bodies in California. Depending on the exposure level, these chemicals may cause cancer or adverse effects on the nervous system.

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

All fish species collected from Humboldt Bay and used in advisory development were analyzed for mercury (as a measure of methylmercury). Leopard Shark, Pile Perch, Red Rock Crab, Shiner Perch, Specked Sanddab, Walleye Surfperch, and White Surfperch were also analyzed for selenium, and legacy pesticides including chlordanes, dieldrin, and DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]), and PCBs. Shiner Perch, Speckled Sanddab, and White Surfperch were further analyzed for PBDEs. All species in this advisory, except for Leopard Shark and Lingcod, were additionally analyzed for toxaphene.

DATA SOURCES

The guidelines for eating fish from Humboldt Bay are based on the chemicals detected in the fish collected for the four 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. 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, 2005). "Sample," as used in this report, refers to an individual fish or a composite of multiple fish for which contaminant data was reported. "Sampling" or "sampled" refers to the act of collecting fish for chemical analysis. Fish samples analyzed as "whole" or "whole without head, tail, and guts" were included for evaluation of all chemicals except mercury because they bolstered sample sizes without impacting consumption advice. Concentrations of organic contaminants, such as DDTs and PCBs, tend to be higher in whole bodies compared to fillets, so this is a more conservative (health protective) approach for these chemicals. For evaluation of mercury, only fish samples prepared as fillets were used because there was a sufficient number of fillet samples for each species and this is the recommended fish preparation method.

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 program continued for five years until it was halted due to budget constraints. California Department of Fish and Wildlife (CDFW) staff, then known as the California Department of Fish and Game, in cooperation with staff and representatives from SWRCB and the Regional Water Quality Control Boards, collected 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 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 DDTs, dieldrin, selenium, and toxaphene.

HUMBOLDT BAYKEEPER (BAYKEEPER)

Humboldt Baykeeper is a non-profit organization, initiated in 2004, to help protect and conserve coastal resources of northern California. In 2016, Humboldt Baykeeper collected fish and shellfish from Humboldt Bay to analyze mercury levels in commonly fished species. Humboldt Baykeeper issued a report that summarized their findings (Kalt and Taylor, 2018). OEHHA considered only those samples caught within the boundaries of Humboldt Bay, and evaluated the data based on the quality guidelines discussed in the *Approach Used* section above. OEHHA determined that mercury data collected for the Humboldt Baykeeper study from Leopard Shark, Lingcod, and Walleye Surfperch were appropriate and sufficient, and thus were included to develop advice for these species. At this time, OEHHA is not providing consumption advice for bivalve species pending further scientific evaluation.

STATEWIDE COAST SPORTFISH CONTAMINATION STUDY 2010 (SWAMP)

The Surface Water Ambient Monitoring Program (SWAMP), operated by the SWRCB, monitors water quality in California's surface waters. From 2009-2010, the program performed a statewide survey of coastal waters to evaluate contaminants in commonly consumed sport fish and to gain information about contamination in the greater aquatic food web (SWRCB, 2012). The survey collected Leopard Shark and Shiner Perch from Humboldt Bay in 2010, which were analyzed for chlordanes, DDTs, dieldrin, mercury, PCBs, and selenium.

FISH SAMPLED FROM HUMBOLDT BAY

The fish sampling data used in this advisory were obtained from Humboldt Baykeeper and the California Environmental Data Exchange Network (CEDEN), the State's repository for environmental data. A summary of all fish 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 SAMPLES EVALUATED FOR THE HUMBOLDT BAY ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed
Leopard Shark	*Triakis semifasciata*	1	1	Baykeeper	2016	Hg
		8	8	SWAMP	2010	Hg
		1	3	SWAMP	2010	Chlordanes, DDTs, Dieldrin, PCBs, Se
Lingcod	*Ophiodon elongatus*	5	5	Baykeeper	2016-2017	Hg

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed
Pile Perch	*Rhacochilus vacca*	1	3	CFCP[a]	1999	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Red Rock Crab	*Cancer productus*	6	30	CFCP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		3	13	CFCP	1999	PCBs
Shiner Perch	*Cymatogaster aggregata*	1	16	CFCP[a,c]	2003	Chlordanes, DDTs, Dieldrin, PCBs, Se, Toxaphene
		2	34	CFCP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		3	28	CFCP[a]	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		1	4	CFCP[a]	1999	PCBs
		1	15	EMAP[a,d]	1999	DDTs, Dieldrin, Se, Toxaphene
		6	6	SWAMP	2010	Hg
Speckled Sanddab	*Cymatogaster aggregata*	1	80	CFCP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
Walleye Surfperch	*Hyperprosopon argenteum*	5	5	Baykeeper[b]	2017	Hg
		1	5	CFCP[a]	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		1	5	CFCP[a,c]	2003	Chlordanes, DDTs, Dieldrin, PCBs, Se, Toxaphene
		2	12	CFCP[a,c]	2003	Se
White Surfperch	*Phanerodon furcatus*	1	6	CFCP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs, Se, Toxaphene
		1	4	CFCP[a,c]	2003	Chlordanes, DDTs, Dieldrin, PCBs, Se, Toxaphene
		1	4	CFCP[a,c]	2003	Se

[a] Study report did not specify whether skin was removed prior to tissue analysis.
[b] Samples were analyzed with skin on.
[c] Samples were analyzed whole, with head, tail, and guts removed.
[d] Samples were analyzed whole.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, PBDEs, PCBs (48-54 congeners[2]), and toxaphene. Among the chemicals analyzed in fish tissue samples from Humboldt Bay, only mercury and PCB levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets, except for some samples of Shiner Perch, Walleye Surfperch, and White Surfperch, where the fish were analyzed as whole bodies, or whole bodies with head, tail, and guts removed. Samples were analyzed as individual fish or composites.

Composites were prepared from equal amounts of tissue from several similarly sized individual fish of a species. Ideally, for composite samples, the total length of the smallest fish in a composite sample is at least 75% of the length of the largest fish in the sample (US EPA, 2000a). All composite samples from Humboldt Bay met this guideline, except for a single composite of 20 Shiner Perch where the length of the shortest fish in the sample was 69% of the length of the longest fish in the sample.

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 to estimate average human exposure.

MERCURY

Samples were analyzed for total mercury, as either individual fish or composite samples. Samples collected under the SWAMP study were analyzed using a direct mercury analyzer (DMA) at the CDFW Moss Landing Marine Laboratories (MLML). The DMA method utilizes thermal decomposition and atomic absorption. OEHHA assumed all mercury detected was methylmercury, which is the most common form found in fish and is also the more toxic form (Bloom, 1992). The DMA method detection limit (MDL)[3] and the reporting limit (RL)[4] for total mercury were reported at 12 and 36 parts per billion (ppb), respectively. Samples collected by Humboldt Baykeeper were analyzed using gas chromatography/cold vapor atomic fluorescent spectroscopy at CEBAM Analytical, Inc. The MDL and RL for these samples were reported at 0.5 and 1.5 ppb, respectively. Although mercury was detected at commonly found concentrations in the CFCP study, the methodology, method detection limit (MDL), and reporting limit (RL)

[2] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.
[3] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[4] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

were not reported. Table 2 shows the averages and ranges for total length[5], as well as mercury concentrations in each fish species.

PCBs, PBDEs, Pesticides and Selenium

Some composite samples were analyzed for PCBs, PBDEs, and the legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene). Samples collected under the SWAMP program were analyzed for these chemicals using gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, PCBs, and PBDEs, each of the concentrations presented was the sum of the detected parent compound, congeners, or metabolites, where applicable. Since the MDLs or RLs were relatively low (≤ 5 ppb), individual congeners or metabolites with concentrations reported as non-detects were assumed to be zero. This is a standard method of handling non-detect values for PCBs and other chemicals with multiple congeners or metabolites in a given sample when detection levels are adequate (US EPA, 2000a). Although these chemicals were detected at commonly found concentrations in the CFCP and EMAP studies, the methodology, MDL, and RL were not reported. Table 3 shows the averages and ranges for total length, as well as PCB concentrations in each fish species.

The CDFW MLML analyzed species collected from Humboldt Bay under the SWAMP program for selenium, as composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS). The ICP-MS method utilizes desolvation, atomization and ionization with ion separation based on a mass-to-charge ratio to detect the total selenium concentration in a sample. The ICP-MS MDL and RL for total selenium were reported at 150 and 400 ppb, respectively. Although selenium was detected at commonly found concentrations in the CFCP and EMAP studies, the methodology, MDL, and RL were not reported.

Concentrations of chlordanes, dieldrin, DDTs, PBDEs, selenium, and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008 and 2011). These chemicals were therefore not considered further for developing consumption advice and are not shown in this report.

[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.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM HUMBOLDT BAY

Species from Humboldt Bay	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Leopard Shark	9	9	1329	1200 - 1410	1616	1050 - 2390
Lingcod	5	5	657	572 - 739	329	146 - 541
Red Rock Crab	6	30	n/a	n/a	134	83 - 246
Speckled Sanddab	1	80	107	n/a	13	n/a
Pile and Walleye Surfperch	7	13	231	150 - 382	184	100 - 262
Pile Perch	1	3	362	332 - 382	167	n/a
Walleye Surfperch	6	10	192	150 - 245	189	100 - 262
Shiner and White Surfperch	12	74	129	100 - 181	84	40 - 162
Shiner Perch	11	68	125	100 - 149	88	63 - 162
White Surfperch	1	6	171	161 - 181	40	n/a

*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 3. PCB CONCENTRATIONS IN FISH FROM HUMBOLDT BAY

Species from Humboldt Bay	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCB (ppb)	
					Mean*	Range**
Leopard Shark	1	3	1318	1285 - 1345	0	n/a
Red Rock Crab	3	13	n/a	n/a	0	0 - 1
Speckled Sanddab	1	80	107	n/a	0	n/a
Pile and Walleye Surfperch	2	8	254	179 - 382	9	n/a
Pile Perch	1	3	362	332 - 382	0	n/a
Walleye Surfperch	1	5	189	179 - 206	15	n/a
Shiner and White Surfperch	6	64	137	103 - 243	11	0 - 26
Shiner Perch	4	54	127	103 - 149	11	3 - 26
White Surfperch	2	10	193	161 - 243	10	0 - 23

*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 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 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 specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), thought to be associated with these beneficial health effects (USDA/USDHHS, 2015; Weaver et al., 2008).

The 2015-2020 U.S. Dietary Guidelines recommend that 1) the general population "consume eight or more ounces per week (less for young children)" of a variety of seafood[6] "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 twelve 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 US Food and Drug Administration (FDA) and the US Environmental Protection Agency (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).

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 OEHHA's guidance when choosing which fish and how much to eat as part of an overall healthy diet.

[6] "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).

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 1-17 years, are lower than those for women 46 years and older, and men 18 years and older. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLs, are provided in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene" (OEHHA, 2008) and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)" (OEHHA, 2011). A list of the ATLs used in this report is presented in Appendix I.

For each fish species in this advisory, OEHHA compared the mean mercury and PCB concentrations detected in the fillet to the corresponding ATLs to establish the maximum number of servings per week that could be consumed (see Appendix I). A serving size is considered to be 8 ounces, prior to cooking, or about the size and thickness of a hand for fish fillets. Children should be given smaller servings. For smaller fish species, several individuals may be required to yield a serving.

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of servings per week. Because some chemicals, such as mercury and PCBs, are known to have similar adverse effects, additivity of toxicity is assumed in such cases and may be assessed using multiple chemical exposure methodology (US EPA, 1989 and 2000b). If two or more chemicals with similar adverse effects are present in fish tissue at levels above the corresponding ATL values for daily consumption, multiple chemical exposure methodology is employed. This may result in advising the sensitive population to consume fewer meals per week than would be the case for the presence of one chemical alone, in a similar concentration. The potential effect of multiple chemical exposures (mercury and PCBs) was assessed in the Shiner and White Surfperch group and the Pile and Walleye Surfperch group and was found to not affect advice. Advice for all species in this advisory was based solely on mercury or PCB concentrations.

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 higher contaminant levels. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish species. People should eat no more than the recommended number of servings for each fish species or species group.

OEHHA's consumption advice for a particular fish species can be extended to other closely related fish species[7] known to accumulate similar levels of contaminants.

Consumption advice should not be combined. That is, if a person chooses to eat a 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 fish from the "two-servings-per-week" category, they can combine fish species from that category, or eat one 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 advisory protocol requires at least nine fish of a species to be collected from a water body before an advisory can be developed for the primary contaminant of concern. This is to ensure the sample dataset is representative of the fish species population in the water body. In some cases, an exception is made for species that are commonly caught and consumed from a given water body but where available data may be limited. For Humboldt Bay, the sample size criterion was met for the following species: Leopard Shark, Pile Perch (combined with Walleye Surperch), Red Rock Crab, Shiner Perch, Speckled Sanddab, and White Surfperch (combined with Shiner Perch). 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-specific Advice[8]. There were not sufficient data to evaluate other species that may be found in this water body. As noted above, OEHHA is not providing consumption advice for bivalve species at this time.

LEOPARD SHARK

The mean mercury and PCB concentrations in Leopard Shark from Humboldt Bay were 1616 and 0 ppb, respectively. OEHHA recommends no consumption of Leopard Shark from Humboldt Bay for both the sensitive population (women 18 to 45 years and children 1 to 17 years), and the general population (women 46 years and older, and men 18 years and older), based on mercury.

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

[8] 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.

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 (women 18 to 45 years and children 1 to 17 years), and a maximum of two servings a week for the general population (women 46 years and older, and men 18 years and older), based on mercury.

RED ROCK CRAB

The mean mercury and PCB concentrations in Red Rock Crab from Humboldt Bay were 134 and 0 ppb, respectively. OEHHA recommends a maximum of two servings a week of Red Rock Crab for the sensitive population (women 18 to 45 years and children 1 to 17 years), and a maximum of four servings a week for the general population (women 46 years and older, and men 18 years and older), based on mercury.

SPECKLED SANDDAB

The mean mercury and PCB concentrations in Speckled Sanddab from Humboldt Bay were 13 and 0 ppb, respectively. OEHHA recommends a maximum of seven servings a week of Speckled Sanddab for both the sensitive population (women 18 to 45 years and children 1 to 17 years) and the general population (women 46 years and older, and men 18 years and older), based on mercury.

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. Although Pile and Walleye Surfperch had different PCB concentrations, PCBs did not impact advice and therefore did not influence grouping decisions. The sample size for Pile Surfperch was smaller than OEHHA generally requires to provide 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. Thus, using the Humboldt Bay data for this species, rather than referring consumers to the Statewide Advisory, resulted in more health protective advice.

The mean mercury and PCB concentrations in the Pile and Walleye Surfperch group from Humboldt Bay were 184 ppb and 9 ppb, respectively. Individual mercury and PCB concentrations for the two species were as follows: Pile Perch (Hg: 167 ppb, PCB: 0 ppb), Walleye Surfperch (Hg: 189 ppb, PCB: 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 (women 18 to 45 years and children 1 to 17 years), and a maximum of three servings a week for the general

population (women 46 years and older, and men 18 years and older), based on mercury. PCBs did not impact advice.

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 mercury and PCBs. Although the sample size for White Surfperch was low for mercury analysis (n = 6), it was sufficient for PCB analysis (n = 10). The advice for White Surfperch from Humboldt Bay was the same as the Statewide Advisory for the sensitive population and more restrictive than the Statewide Advisory for the general population. Advice for the general population was based on PCBs, for which the sample size was adequate. For this reason, advice for White Surfperch was included in this advisory.

The mean mercury and PCB concentrations in the Shiner and White Surfperch group from Humboldt Bay were 84 ppb and 11 ppb, respectively. Individual mercury and PCB concentrations for the two species were as follows: Shiner Perch (Hg: 88 ppb, PCB: 11 ppb), White Surfperch (Hg: 40 ppb, PCB: 10 ppb). OEHHA recommends a maximum of two servings a week of Shiner or White Surfperch for the sensitive population (women 18 to 45 years and children 1 to 17 years) based on mercury, and a maximum of five servings a week for the general population (women 46 years and older, and men 18 years and older), based on PCBs.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from Humboldt Bay are shown in Table 4.

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM HUMBOLDT BAY

Fish Species	Women 18–45 years and Children 1-17 years	Women 46 years and older and Men 18 years and older
Leopard Shark	0	0
Lingcod	1	2
Red Rock Crab	2	4
Pile and Walleye Surfperch	1	3
Shiner and White Surfperch	2	5
Speckled Sanddab	7	7

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APPENDIX I. 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[9] 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 Humboldt Bay are followed, exposure to chemicals in fish from Humboldt Bay 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	>1,000-1200	>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.

[9] 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.