



Health Advisory and Guidelines for Eating Fish from Elkhorn Slough (Monterey County)

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
CFCP	Coastal Fish Contamination Program
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyl dichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DW	Disc Width: distance from wing tip to wing tip (Bat Ray)
FDA	Food and Drug Administration
Hg	mercury
MDL	method detection limit
mm	millimeters
n	sample size
OEHHA	Office of Environmental Health Hazard Assessment
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
Se	selenium
SMCA	State Marine Conservation Area
SWAMP	Surface Water Ambient Monitoring Program
TSMP	Toxic Substances Monitoring Program
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services

US EPA

United States Environmental Protection Agency

PREFACE

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

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

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

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

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A Guide to Eating Fish from Elkhorn Slough

Women 18 - 45 years and Children 1 - 17 years

 Asian Clam (Corbicula)  Speckled Sanddab  Surfperches	 Bat Ray under 24 inches wide	 Leopard Shark  Bat Ray 24 inches wide or more
<p>7 total servings a week or 3 total servings a week of Surfperches</p>	<p>OR</p> <p>1 serving a week</p>	<p>Do not eat</p>

Women 46 years and older and Men 18 years and older

 Asian Clam (Corbicula)  Speckled Sanddab	 Bat Ray under 24 inches wide  Surfperches	 Leopard Shark  Bat Ray 24 inches wide or more
<p>7 total servings a week</p>	<p>OR</p> <p>4 total servings a week</p>	<p>OR</p> <p>1 serving a week</p>

What is a serving?



For Adults For Children

A serving is 8 ounces prior to cooking (the size and thickness of your hand for fish fillets). Give children smaller servings.

Why eat fish?

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

What is the concern?

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

INTRODUCTION

This report presents guidelines for eating fish from Elkhorn Slough (Figure 1) in Monterey County, California, located between Monterey and Santa Cruz.

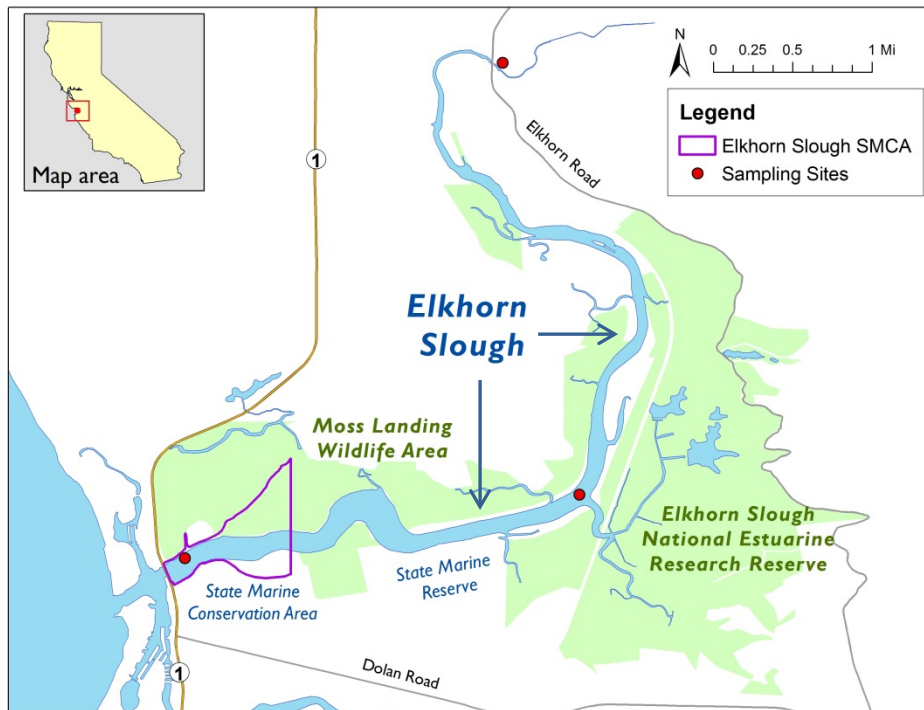
LOCATION

Elkhorn Slough and its surrounding watershed drains into the Pacific Ocean near Monterey Bay and covers over 45,000 acres, making it one of California's largest coastal wetlands (SWRCB, 2009). The Elkhorn Slough watershed is home to the Elkhorn Slough National Estuarine Research Reserve, a protected region administered by the National Oceanic and Atmospheric Administration and managed by the California Department of Fish and Wildlife, in cooperation with the nonprofit conservancy Elkhorn Slough Foundation¹. The main water body known as Elkhorn Slough is located in Monterey County and is characterized by salt marsh, mud flat, freshwater pond, woodland, and grassland areas. The approximately 1,000-acre area surrounding Elkhorn Slough is designated by both the State Marine Reserve and State Conservation Areas. Limited sport fishing is allowed in the Elkhorn Slough State Marine Conservation Area (SMCA). This advisory applies to the Elkhorn Slough SMCA and not the greater watershed region.

The Elkhorn Slough Foundation and the Elkhorn Slough National Estuarine Research Reserve, a partnership that includes the California Department of Fish and Wildlife and the National Oceanic and Atmospheric Administration, collectively manage the fish populations of Elkhorn Slough and its watershed. All species included in this advisory are self-sustaining populations.

¹ Information regarding Elkhorn Slough was obtained from various Elkhorn Slough Foundation and Elkhorn Slough National Estuarine Research Reserve web pages. Online at www.elkhornslough.org.

FIGURE 1. LOCATION OF ELKHORN SLOUGH



APPROACH USED

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) 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 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, followed by polychlorinated biphenyls (PCBs), and in a few cases, selenium or some legacy pesticides (pesticides that are no longer used but remain in the environment).

Mercury is a natural element found in some rock and soil. Human activities, such as burning coal and the use of mercury to mine gold, also add mercury to the environment. If mercury enters waterways, it can be converted to a more toxic form known as methylmercury – which can pass into and build up in fish. High levels of methylmercury can harm the brain, especially in fetuses and children as they grow.

PCBs are man-made 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, some PCBs may cause cancer and other health effects in humans, including neurotoxicity.

Selenium is a naturally occurring metalloid and an essential nutrient for many human health processes, including thyroid regulation and vitamin C metabolism (OEHHA, 2008). Selenium toxicity can occur at relatively low levels and induce symptoms ranging from hair loss and gastrointestinal distress to dizziness and tremors.

Chlordanes, DDT, dieldrin and toxaphene are pesticides that were banned from use in 1973 (DDT), the late 1980s (chlordanes and dieldrin) and 1990 (toxaphene), but have been found in some fish in certain water bodies in California. Depending on the exposure level, these chemicals may cause cancer or other adverse effects on the nervous system. Detailed discussion of the toxicity of these chemicals and references are presented in “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene” (OEHHA, 2008).

Fish samples from Elkhorn Slough were analyzed for total mercury (as a measure of methylmercury), PCBs, selenium, and the pesticides chlordanes, dieldrin, DDTs (DDT and its metabolites), and toxaphene. Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study.

DATA SOURCES

The guidelines for eating fish from Elkhorn Slough are based on chemical analysis of fish samples from the three monitoring studies described below. These studies met OEHHA’s data quality criteria, including adequate documentation of sample collection, fish preparation, chemical analyses, quality assurance, and adequate detection limits.

COASTAL FISH CONTAMINATION PROGRAM (CFCP)

The CFCP (1998-2003) was a state program managed by the State Water Resources Control Board (SWRCB) to assess human health risks from eating sport fish and shellfish caught from California coastal waters (Gassel, 2005). 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 Leopard Shark, surfperches and Speckled Sanddab in 2000-2003 from Elkhorn Slough as part of the program. Fish samples were analyzed for several common fish contaminants (mercury, chlordanes, DDTs, dieldrin, PCBs, selenium and toxaphene).

SWAMP CONTAMINANTS IN SPORT FISH SURVEY

The SWAMP (Surface Water Ambient Monitoring Program), operated by 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 Bat Ray (representing both width categories), Leopard Shark, and Shiner Perch from Elkhorn Slough in 2010. These species were analyzed for mercury, chlordanes, dieldrin, DDTs, PCBs and selenium.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP (1976-2003) was a state water quality-monitoring program managed by the SWRCB (2007). Its objective was to provide statewide information on the occurrence of toxic substances by monitoring water bodies with known or suspected water quality impairment. CDFW staff, then known as the California Department of Fish and Game, collected Asian clams in 1999 from Elkhorn Slough as part of the program. Shellfish samples were analyzed for mercury, chlordanes, DDTs, dieldrin, selenium and toxaphene.

FISH AND SHELLFISH SAMPLED FROM ELKHORN SLOUGH

The types and numbers of fish and shellfish samples collected from Elkhorn Slough are shown in Table 1, including the species, number of samples collected, total number of fish or shellfish, project name, year, and contaminants analyzed. All samples collected, except for Bat Ray, met either the CDFW legal size requirements (for Leopard Shark; CDFW, 2016-2017), or OEHHA's criteria for minimum "edible" size based on species size at maturity and professional judgment (as described in OEHHA, 2005). OEHHA generally accepts 610 millimeters (mm) disc width (DW; measured wing tip to wing tip) as the minimum edible size for Bat Ray (CDFW, 2001). However, field reports indicate that Bat Rays are a popular species to catch and eat from Elkhorn Slough. Because only one of the 11 Bat Rays collected from this area met or exceeded a DW of 610 mm (693 mm; 179 parts per billion (ppb) mercury), it implies that fishers are catching and consuming smaller Bat Rays. Thus, consumption advice was developed for those rays

under 610 mm or 24 inches in width (n=10). Additionally, OEHHA thought it important to provide advice for Bat Rays exceeding 610 mm caught from Elkhorn Slough. Because, as noted above, only one Bat Ray of this size was collected from Elkhorn Slough, OEHHA evaluated all available Bat Ray data throughout California. Bat Rays exceeding 610 mm were caught and analyzed from three sites in the state (Elkhorn Slough, n=1; Morro Bay, n=5; and Tomales Bay, n=24); mercury concentrations ranged from 162-906 ppb. These Bat Rays are shown separately in Table 1.

TABLE 1. FISH COLLECTED FROM ELKHORN SLOUGH

Common Name	Scientific Name	Number of Samples	Total Number of Fish/Shellfish	Project	Year	Contaminants Analyzed
Asian Clam	<i>Corbicula fluminea</i>	1	24	TSMP	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Bat Ray under 24 inches wide	<i>Myliobatis californica</i>	10	10	SWAMP	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Bat Ray ^a 24 inches wide or more	<i>Myliobatis californica</i>	6	6	SWAMP	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		14	24	CFCP	1998, 1999, 2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se Toxaphene
Black Perch	<i>Embiotoca jacksoni</i>	2	9	CFCP	2000, 2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Leopard Shark	<i>Triakis semifasciata</i>	12	16	CFCP	2000 - 2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se Toxaphene
		9	9	SWAMP	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Pile Perch	<i>Rhacochilus vacca</i>	2	10	CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene
Shiner Perch	<i>Cymatogaster aggregata</i>	4	63	CFCP	2000 - 2002	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se Toxaphene
		4	40	SWAMP	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
Speckled Sanddab	<i>Citharichthys stigmaeus</i>	2	40	CFCP	2003	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se, Toxaphene

CFCP = Coastal Fish Contamination Program

Hg = Mercury

Se = Selenium

SWAMP = Surface Water Ambient Monitoring Program

TSMP = Toxic Substances Monitoring Program

^aBat Ray collected throughout California (Elkhorn Slough, Morro Bay, and Tomales Bay).

CHEMICAL CONCENTRATIONS

Fish samples were prepared as skinless fillets (Bat Ray, Black Perch, Leopard Shark, Pile Perch, Shiner Perch), fillets with skin but no scales (Shiner Perch), or eviscerated whole bodies with skin but no scales (Shiner Perch, Speckled Sanddabs). Clams were prepared as shelled body meat. Fish and shellfish were analyzed for mercury (total),

PCBs (54-55 congeners²), legacy pesticides, and selenium, as either individual fish or composite samples. In the development of the guidelines, OEHHA used the arithmetic mean (average) of the chemical concentrations for each fish and shellfish species to estimate average human exposure.

A composite sample is generally prepared from equal amounts of tissue from several similarly sized individual fish or shellfish of a species. The total length of the smallest fish in a composite sample must be at least 75% of the length of the largest fish in the sample (US EPA, 2000a). Composite samples for all species, except Speckled Sanddab, met this requirement. There were two Speckled Sanddab composite samples of 20 fish each (n=40) where the smallest fish in the sample was 65% of the length of the largest fish. Speckled Sanddab comprise a small fraction of the overall Central California Coast sport fish catch but Elkhorn Slough supports a denser population within the estuarine environment, in comparison to the larger Monterey Bay, making it a preferred sport fishing location for this species (ESNERR, 2010). For this reason, OEHHA developed consumption advice for Speckled Sanddab.

MERCURY

The CDFW Moss Landing Marine Laboratories analyzed fish or shellfish species collected from Elkhorn Slough for mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA). The DMA method is an integration of thermal decomposition and atomic absorption to detect mercury concentration of a sample. For this evaluation, OEHHA assumed all mercury detected was methylmercury; methylmercury is the most common form found in fish and is also the more toxic form (Bloom, 1992). Table 2 shows the averages and ranges for total length³ and mercury concentrations in each fish or shellfish species. All data were reported in wet weight. The DMA method detection limit (MDL)⁴ and the reporting limit (RL)⁵ for total mercury were reported at twelve and 36 ppb, respectively.

PCBS AND PESTICIDES

The CDFW Water Pollution Control Laboratory analyzed composite samples of fish or shellfish from Elkhorn Slough for PCBs and legacy pesticides, using the gas chromatography method .

For PCBs, chlordanes, dieldrin, and DDTs, 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, ≤ 0.1 and ≤ 5 ppb, respectively, individual

² Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.

³ 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. For clam species, the shell was measured at the widest part.

⁴ The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.

⁵ The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

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). Total toxaphene concentrations were reported with a MDL/RL value of 20 ppb. All data were reported in wet weight. Table 2 shows the averages and ranges for total length and PCB concentrations in each fish species.

Concentrations of chlordanes, dieldrin, DDTs, and toxaphene were not sufficiently high to alter consumption advice and are not shown.

SELENIUM

The CDFW Moss Landing Marine Laboratories analyzed species collected from Elkhorn Slough for selenium, as either individual fish or composite samples of fish or shellfish, using ICP-MS (inductively coupled plasma mass spectrometry). The ICP-MS method is an integration of desolvation, atomization and ionization with ion separation based on a mass-to-charge ratio to detect the total selenium concentration in a sample. All data were reported in wet weight. The ICP-MS method detection limit (MDL) and the reporting limit (RL) for total selenium were reported at 15 and 40 ppb, respectively. The selenium concentrations were not sufficiently high to alter consumption advice and are not shown.

TABLE 2. MERCURY AND PCB CONCENTRATIONS IN FISH FROM ELKHORN SLOUGH

Fish Species	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths ^a (mm)	Mercury (ppb)	
					Mean*	Range**
Asian Clam	1	24	38	Data Not Available	28	***
Bat Ray under 24 inches wide	10	10	321 ^a	176-590 ^a	152	24-311
Bat Ray ^b 24 inches wide or more	19	29	1274 ^a	615-1840 ^a	-	162-906
Black Perch ^c	2	9	281	241-340	38	5-64
Leopard Shark	21	25	1209	971-1330	995	405-1169
Pile Perch ^c	2	10	335	286-395	129	85-173
Shiner Perch ^c	8	103	109	98-146	50	30-72
Speckled Sanddab	2	40	107	80-140	21	0-41
					PCBs (ppb)	
Bat Ray under 24 inches wide	1	4	277 ^a	247-302 ^a	0.5	***
Bat Ray ^b 24 inches wide or more	4	12	1311 ^a	609-1840 ^a	-	1-2
Black Perch ^c	2	9	281	241-340	2	2-3
Leopard Shark	3	13	1200	1034-1330	3	2-5
Pile Perch ^c	2	10	335	286-395	2	2
Shiner Perch ^c	3	72	111	98-146	19	5-81
Speckled Sanddab	2	40	107	80-140	3	2-4

*Means are an arithmetic average of individual values and/or a weighted average of composites.

**Range of individuals and/or range of the average of composites.

***Not available; concentration was derived from a single composite sample.

^aBat Ray measurements represent disc width (wing tip to wing tip).

^bBat Ray collected statewide (Elkhorn Slough, Morro Bay, and Tomales Bay).

^cBecause surfperch species are closely related and may be difficult to tell apart, consumption advice for Black, Pile and Shiner Perch was combined.

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM ELKHORN SLOUGH

GENERAL INFORMATION

The OEHHA fish advisory process considers the health benefits of fish consumption as well as the risk from exposure to the chemical contaminants found in fish. Benefits are included in the advisory process because there is considerable evidence and scientific consensus that fish should be part of a healthy, well-balanced diet. Fish contain many nutrients that are important for general health and, in particular, help promote optimal growth and development of babies and young children, and may reduce the incidence of heart disease in adults (FDA/US EPA, 2014; American Heart Association, 2014; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish is 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 seafood⁶ “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, 2008). Accordingly, because of the high mercury content of certain fish species, the Food and Drug Administration and US Environmental Protection Agency recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children do not consume shark, swordfish, tilefish, or king mackerel, and limit consumption of white (albacore) tuna to six ounces per week (FDA/US EPA, 2004; 2014).

In order to address the potential health concerns associated with consuming 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

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).

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

There are two sets of ATLs for methylmercury in fish because of the age-related toxicity of this chemical (OEHHA, 2008). The fetus and children are more sensitive to the toxic effects of methylmercury. Thus, the ATLs for the sensitive population, including women who might become pregnant (typically 18 to 45 years of age) and children 1-17 years, are lower than those for women 46 years and older, and men. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLs, are provided in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene" (OEHHA, 2008). 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 or body meat to the corresponding ATLs to establish the maximum number of servings per week that could be consumed (see Appendix I). The mean concentrations of chlordanes, DDTs, dieldrin, selenium and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008). These chemicals were therefore not considered further for developing consumption advice. Consumption advice was based on mercury and PCB concentrations only.

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of fish servings per week. Because both mercury and PCBs are known to affect the nervous system, particularly during brain development, additivity of toxicity is assumed and assessed by using multiple chemical exposure methodology (US EPA, 1989 and 2000b). The presence of both chemicals in fish tissue may result in advising the sensitive population to consume fewer meals per week than would be the case for the presence of either chemical alone, in a similar concentration. For the Elkhorn Slough advisory, the potential effect of multiple chemical exposures was assessed and determined to affect the consumption advice for the surfperch group, based on data from Black, Pile and Shiner Perch.

When OEHHA's consumption advice is followed, the exposure to mercury and PCBs from eating fish caught at Elkhorn Slough would be at or below the average daily reference dose or cancer risk as outlined in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene" (OEHHA, 2008).

OEHHA recommends that individuals strive to meet the US Dietary Guidelines seafood consumption recommendations, while also adhering to federal and OEHHA

recommendations to limit the consumption of fish with higher contaminant levels. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish and shellfish from this water body. People should eat no more than the recommended number of servings for each fish species or species group. OEHHA's advice on consuming a particular fish species can be extended to other closely related fish species⁷ 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 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 for a total of two servings in that week. Then they should not eat any other fish from any source until the following week.

CONSUMPTION ADVICE FOR FISH FROM ELKHORN SLOUGH

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 population in the water body. For Elkhorn Slough, the sample size criterion was met for the following species: Asian Clams, Bat Ray, Leopard Shark, Speckled Sanddab, and surfperches.

ASIAN CLAMS

The mean mercury level in Asian Clams from Elkhorn Slough was 28 ppb. OEHHA recommends a maximum of seven servings a week of Asian Clams for both the sensitive (women 18 to 45 years and children 1 to 17 years) and general (women 46 years and older, and men 18 years and older) populations. Asian Clams from Elkhorn Slough were not analyzed for PCBs.

BAT RAY

Based on the mean mercury and PCB concentrations in Bat Ray under 24 inches wide of 152 ppb and 0.5 ppb, respectively, OEHHA recommends a maximum of one serving per week 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).

In general, mercury is known to increase in a species as they age (and grow). Because mercury levels ranged up to 906 ppb in Bat Rays measuring 24 inches wide or more caught in other California water bodies, and it is possible that they may migrate to

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

Elkhorn Slough, OEHHA recommends no consumption of Bat Rays 24 inches wide or more for the sensitive population (women 18 to 45 years and children 1 to 17 years) and a maximum of one serving a week for the general population (women 46 years and older, and men 18 years and older). PCB concentrations in Bat Ray from Elkhorn Slough and other sites throughout California did not impact consumption advice.

LEOPARD SHARK

The mean mercury and PCB concentrations in Leopard Shark from Elkhorn Slough were 995 and 3 ppb, respectively. OEHHA recommends no consumption of Leopard Shark for the sensitive population (women 18 to 45 years and children 1 to 17 years). A maximum of one serving per week is recommended for women 46 years and older, and men 18 years and older. PCB concentrations in Leopard Shark from Elkhorn Slough did not impact consumption advice.

SPECKLED SANDDAB

The mean mercury and PCB concentrations in Speckled Sanddab from Elkhorn Slough were 21 and 3 ppb, respectively. OEHHA recommends a maximum of seven servings a week of Speckled Sanddab for both the sensitive (women 18 to 45 years and children 1 to 17 years) and general (women 46 years and older, and men 18 years and older) populations. PCB concentrations in Speckled Sanddab from Elkhorn Slough did not impact consumption advice.

SURFPERCHES

Because surfperch species are closely related and may be difficult to tell apart, consumption advice for Black, Pile and Shiner Perch was combined. The mean mercury concentrations for surfperch species were 38, 129, and 50 ppb for Black, Pile and Shiner Perch from Elkhorn Slough, respectively. The grand arithmetic mean for the surfperch group was 56 ppb mercury. Mean PCB concentrations for the three species were 2, 2, and 19 ppb for Black, Pile, and Shiner Perch, respectively. The grand arithmetic mean PCB concentration for the surfperch group was 16 ppb PCBs. OEHHA recommends a maximum of three servings a week of surfperches for the sensitive population (women 18 to 45 years and children 1 to 17 years), based on mercury concentrations, and four servings a week for the general population (women 46 years and older, and men 18 years and older), based on PCB concentrations.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from Elkhorn Slough are shown in Table 3.

TABLE 3. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM ELKHORN SLOUGH

Fish Species	Women 18–45 years and Children 1–17 years	Women 46 years and older and Men 18 years and older
Asian Clams	7	7
Bat Ray under 24 inches wide	1	4
Bat Ray 24 inches wide or more	0	1
Leopard Shark	0	1
Speckled Sanddab	7	7
Surfperches ^a	3	4

^aBecause surfperch species are closely related and may be difficult to tell apart, consumption advice for Black, Pile and Shiner Perch was combined.

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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 dose⁸ 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 Elkhorn Slough are followed, exposure to chemicals in fish from Elkhorn Slough 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
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.

⁸ 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.