OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from San Luis Reservoir and O'Neill Forebay (Merced County)

October 2017

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
CDFW	California Department of Fish and Wildlife
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
EPA	eicosapentaenoic acid
FDA	Food and Drug Administration
FMP	Fish Mercury Project
Hg	mercury
MDL	method detection limit
MLML	Moss Landing Marine Laboratories
mm	millimeters
n	sample size
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
RWB5	Regional Water Board 5
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 San Luis Reservoir and O'Neill Forebay in Merced 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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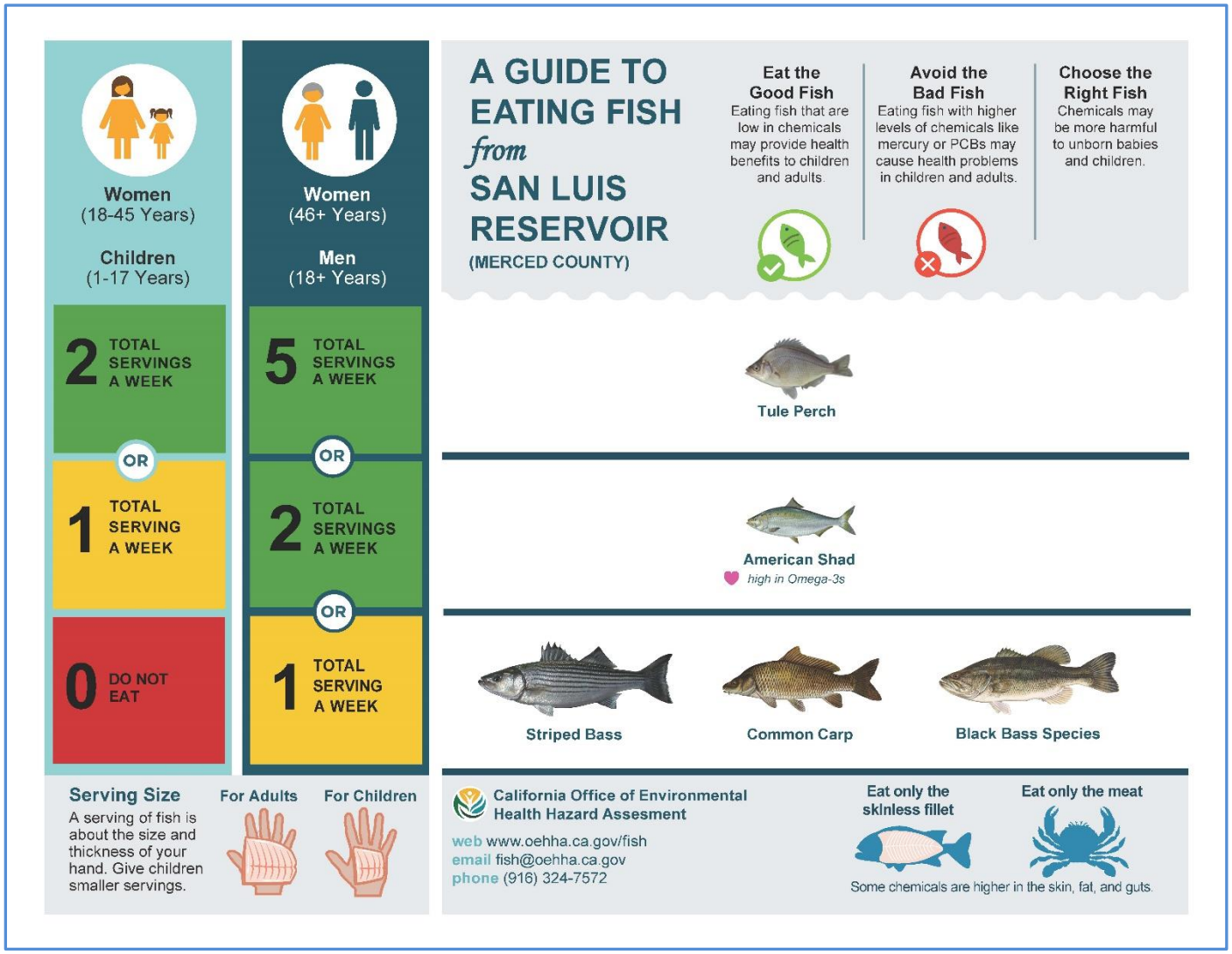
Women
(18-45 Years)
Children
(1-17 Years)
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
Women
(46+ Years)
Men
(18+ Years)
5 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
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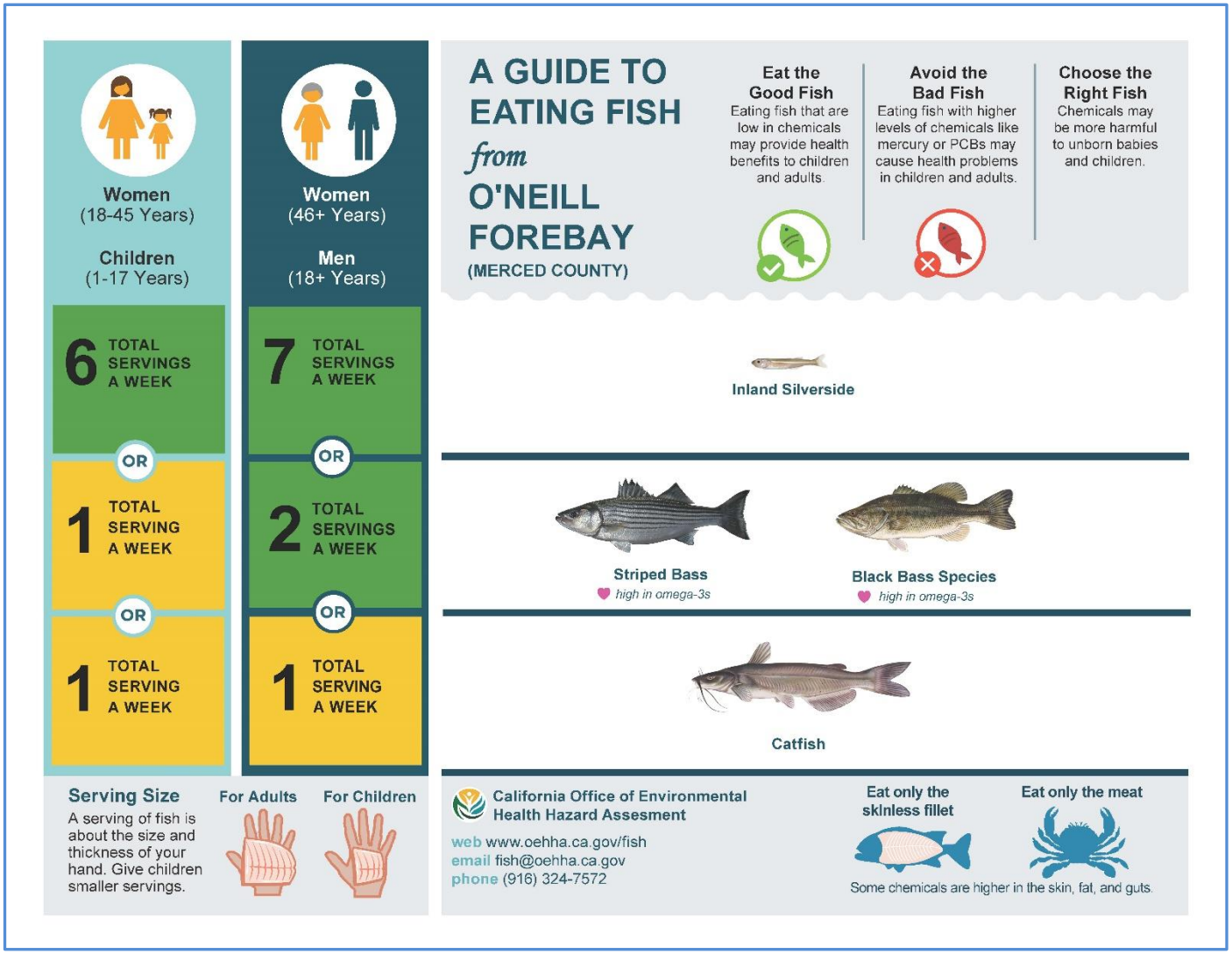
Eating fish with higher levels of chemicals like mercury or PCBs may cause health problems in children and adults.
Choose the Right Fish
Chemicals may be more harmful to unborn babies and children.
Tule Perch
American Shad
high in Omega-3s
Striped Bass
Common Carp
Black Bass Species
Serving Size
A serving of fish is about the size and thickness of your hand. Give children smaller servings.
For Adults
For Children
California Office of Environmental Health Hazard Assesment
web www.oehha.ca.gov/fish
email fish@oehha.ca.gov
phone (916) 324-7572
Eat only the skinless fillet
Eat only the meat
Some chemicals are higher in the skin, fat, and guts.


Women
(18-45 Years)
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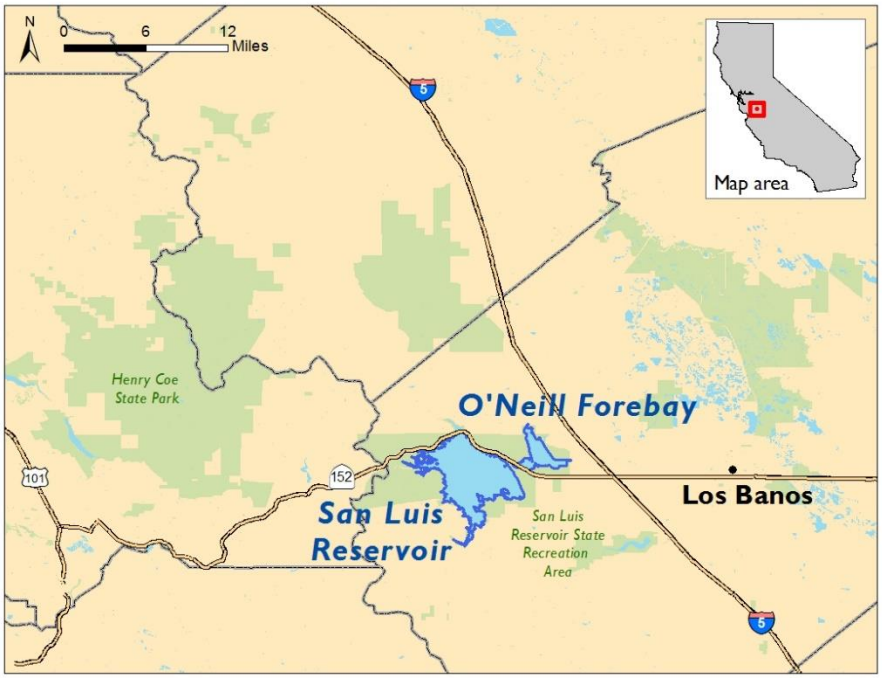
INTRODUCTION

This report presents guidelines for eating fish from San Luis Reservoir and O'Neill Forebay (Figure 1) in Merced County, California, 12 miles west of Los Banos on State Route 152.

LOCATION

The San Luis Reservoir is the largest off-stream reservoir in the United States, with a capacity of 2,027,840 acre-feet.[1] The reservoir was initially filled in 1969 and has been operated jointly by the California Department of Water Resources and the US Bureau of Reclamation. Water enters O'Neill Forebay via the California Aqueduct and the Delta-Mendota Canal. During the winter and spring, water is pumped from the forebay into the reservoir.[2] The reservoir serves as storage for runoff water from the Delta and is used to irrigate almost 1 million acres of farmland in the San Joaquin Valley.[3]

FIGURE 1. LOCATION OF SAN LUIS RESERVOIR AND O'NEILL FOREBAY



[1] Information regarding San Luis Reservoir and O'Neill Forebay was obtained from the California Department of Water Resources web page. Online at: http://www.water.ca.gov/recreation/brochures/pdf/San_Luis_Joint-Use_Complex_6-14.pdf

[2] Information regarding San Luis Reservoir and O'Neill Forebay was obtained from the California Department of Parks and Recreation web page. Online at: https://www.parks.ca.gov/?page_id=558

[3] Information regarding San Luis Reservoir and O'Neill Forebay was obtained from the U.S. Bureau of Reclamation web page. Online at: https://www.usbr.gov/projects/index.php?id=427

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from four monitoring studies described in this report to develop San Luis Reservoir and O'Neill Forebay Advisories. 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[4]) 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

[4] 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 San Luis Reservoir and O’Neill Forebay used in advisory development were analyzed for mercury (as a measure of methylmercury). Common Carp from San Luis Reservoir, and Largemouth Bass and Channel Catfish from O’Neill Forebay were additionally analyzed for chlordanes, DDTs, dieldrin, PBDEs, and PCBs. Common Carp from San Luis Reservoir and Channel Catfish from O’Neill Forebay were further analyzed for selenium. Among the chemicals analyzed in fish tissue samples from San Luis Reservoir and O’Neill Forebay, only mercury and PCB levels were sufficiently high to impact consumption advice. For this reason, levels of other contaminants are not shown in this report.

DATA SOURCES

The guidelines for eating fish from San Luis Reservoir and O'Neill Forebay 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. "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.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP (1976-2003) was a state water quality-monitoring program managed by the the State Water Resources Control Board (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. Staff from the California Department of Fish and Wildlife (CDFW), then known as the Department of Fish and Game, collected Striped Bass (1980 and 1984) and White Catfish (1980) from O'Neill Forebay as part of the program. Striped Bass and White Catfish samples were analyzed for mercury.

FISH MERCURY PROJECT (FMP)

The FMP was a three-year (2005 to 2007) sampling program funded by CALFED[5] (SFEI, 2009). Monitoring of sport fish from Central Valley water bodies was planned and conducted by staff at CDFW, OEHHA, California Department of Public Health, University of California at Davis, and the San Francisco Estuary Institute. More than 4,000 fish samples and 31 sport fish species were collected under the project objective to characterize spatial and temporal trends in mercury in fishery resources. American Shad, Common Carp, Largemouth Bass, Striped Bass, and Tule Perch were collected in the San Luis Reservoir and analyzed for total mercury. Common Carp and Largemouth Bass samples were collected in collaboration with SWAMP's Contaminants in Fish from California Lakes and Reservoirs, 2007-2008 study. Channel Catfish, Largemouth Bass, and Striped Bass were collected in O'Neill Forebay and analyzed for total mercury; Channel Catfish were futher analyzed for chlordanes, DDTs, dieldrin, PBDEs, PCBs, and selenium.

[5] The CALFED Bay Delta Program was a state and federal partnership to improve water quality, increase water supply, as well as support ecosystem restoration and levee improvement in the San Francisco Bay-Delta.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP): CONTAMINANTS IN FISH FROM CALIFORNIA LAKES AND RESERVOIRS, 2007-2008

SWAMP, operated by SWRCB in cooperation with the Central Valley Regional Water Quality Control Board (RWB5) staff, monitors water quality in California's surface waters. The program collected Common Carp from San Luis Reservoir and Largemouth Bass from O'Neill Forebay in 2007 to analyze chlordanes, DDTs, dieldrin, mercury, PBDEs, and PCBs as part of a SWAMP statewide sampling effort to survey contaminants in sport fish found in California lakes and reservoirs (SWRCB, 2010). Common Carp from the San Luis Reservoir were further analyzed for selenium.

SWAMP: SURVEY OF MERCURY EXPOSURE AND RISK IN WILDLIFE IN CALIFORNIA LAKES AND RESERVOIRS, 2012

SWAMP conducted a bird, prey fish and sport fish sampling survey at lakes and reservoirs throughout California to estimate mercury concentrations in birds and other wildlife based on mercury levels in fish at different trophic levels. Results of this study are intended to help risk managers understand mercury exposure for wildlife and develop TMDLs for impaired water bodies. This program sampled Largemouth Bass and Inland Silverside from O'Neill Forebay in 2012.

FISH SAMPLED FROM SAN LUIS RESERVOIR AND O'NEILL FOREBAY

The fish sampling data used in these advisories were retrieved from the California Environmental Data Exchange Network (CEDEN). Samples were excluded that are not legal 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). A summary of all fish species evaluated for these advisories 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 SAN LUIS RESERVOIR AND THE O'NEILL FOREBAY ADVISORIES

Waterbody	Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed*
San Luis Reservoir	American Shad	*Alosa sapidissima*	9	9	FMP	2007	Hg
	Common Carp	*Cyprinus carpio*	3	31	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs
			12	40	FMP/ SWAMP	2007	Hg
			1	31	SWAMP	2007	Se
	Largemouth Bass	*Micropterus salmoides*	27	27	FMP/ SWAMP	2007	Hg
	Striped Bass	*Morone saxatilis*	5	5	FMP	2007	Hg
	Tule Perch	*Hysterocarpus traskii*	10	10	FMP	2007	Hg
O'Neil Forebay	Channel Catfish	*Ictalurus punctatus*	1	5	FMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, Selenium
			12	20	FMP	2007	Hg
			2	10	FMP	2007	PCBs
	Largemouth Bass	*Micropterus salmoides*	1	5	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs
			10	10	SWAMP	2007	Hg
			8	8	SWAMP	2012	Hg
			5	5	FMP	2007	Hg
	Silverside	*Menidia beryllina*	10	10	SWAMP[a]	2012	Hg
	Striped Bass	*Morone saxatilis*	1	1	TSMP[b]	1980	Hg
			1	2	TSMP[b]	1984	Hg
			9	9	FMP	2007	Hg
	White Catfish	*Ameiurus catus*	1	6	TSMP[b]	1980	Hg

[a] Samples were analyzed as whole organisms, including head, skin, internal organs, muscle, and bones.
[b] Study did not specify whether skin was removed from fillets prior to tissue analysis.
[c]Organic data (chlordanes, DDTs, dieldrin, PCBs or toxaphene) generated prior to 2000 were excluded from the analysis because more recent data are considered more reliable because of improved analytical methods.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for total mercury, selenium, chlordanes, DDTs, dieldrin, PBDEs, and PCBs (54-55 congeners[6]). The preparation method for Striped Bass and White Catfish was not reported. All other fish samples used in the analyses were prepared as skinless fillets except Inland Silverside. Inland Silverside are a small prey fish which are typically analyzed as whole organisms because of their small size. 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). This information is not available for Striped Bass samples collected for the TSMP program; however, OEHHA assumes that the data are in compliance with the 75% rule. All composite samples from both water bodies met this requirement, except for a single composite of 5 Channel Catfish collected from O'Neill Forebay where the length of the shortest fish in the sample was 62% of the length of the longest fish in the sample. All 5 Channel Catfish met the OEHHA minimum length of 200 millimeters (mm), and provided a more robust sample for PCB analysis for Channel Catfish collected from O'Neill Forebay. As PCBs were a driver for consumption advice for Channel Catfish collected from O'Neill Forebay and they met OEHHA's minimum quantity (n=9) and length requirements, OEHHA elected to include this sample in the dataset to develop advice for Channel Catfish.

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, either as individual fish or composite samples, using a direct mercury analyzer (DMA). The DMA method is an integration of thermal decomposition and atomic absorption and the FIMS approach combines cold vapor flow injection and amalgamation concentration with atomic absorbance. 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 length[7] as well as mercury concentrations in each fish species. The DMA method detection limit (MDL)[8] and the reporting limit (RL)[9] for total

[6] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.
[7] 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.
[8] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[9] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

mercury were reported at 12 and 12 or 36 parts per billion (ppb), respectively. Although mercury was detected at commonly found concentrations in the TSMP study, the MDL and RL for mercury were not reported.

PCBs, PBDEs, and Pesticides

Samples were analyzed for PCBs, PBDEs, and the legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene). Pesticides, PBDEs and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, PCBs, and PBDEs, each of the concentrations presented was the sum of the detected parent compound, congeners, or metabolites, where applicable. Since the MDLs or RLs were relatively low, ≤ 0.5 and ≤ 5 ppb, respectively, 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). Tables 3 shows the averages and ranges for total length[7] as well as PCB concentrations in each fish species. Concentrations of chlordanes, DDTs, dieldrin, PBDEs, and toxaphene were not sufficiently high to alter consumption advice and are not shown.

Selenium

The CDFW Moss Landing Marine Laboratories (MLML) analyzed composite samples of Common Carp collected from San Luis Reservoir and Channel Catfish from O'Neill Forebay for selenium using inductively coupled plasma-mass spectrometry (ICP-MS). 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. The ICP-MS MDL and the RL for total selenium were reported at 100 and 300 ppb, respectively. The selenium concentrations were not sufficiently high to alter consumption advice and are not shown.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM SAN LUIS RESERVOIR AND O'NEILL FOREBAY

Waterbody	Fish Species	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
						Mean*	Range**
San Luis Reservoir	American Shad	9	9	464	400-584	225	105-444
	Common Carp	12	40	757	671-886	309	194-547
	Largemouth Bass	27	27	353	306-442	605	293-864
	Striped Bass	5	5	569	516-611	782	525-1000
	Tule Perch	10	10	168	158-185	114	86-139
O'Neill Forebay	Catfish Species	13	26	483	320-688	138	65-219
	Channel Catfish	12	20	531	423-688	128	65-219
	White Catfish	1	6	320	NA	170	NA
	Largemouth Bass	23	23	396	309-501	254	114-565
	Silverside	10	10	57	48-66	36	31-45
	Striped Bass	11	12	554	496-612	355	200-598

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

TABLE 3. PCB CONCENTRATIONS IN FISH FROM THE SAN LUIS RESERVOIR AND THE O'NEILL FOREBAY

Waterbody	Fish Species	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCB (ppb)	
						Mean*	Range**
San Luis Reservoir	Common Carp	3	31	760	671-886	69	42-133
O'Neill Forebay	Channel Catfish	2	10	531	423-688	62	57-67
	Largemouth Bass	1	5	362	347-392	8	NA

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

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM SAN LUIS RESERVOIR AND O'NEILL FOREBAY

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, 2014; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish are a significant source of the specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), thought to be associated with these beneficial health effects (USDA/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[10] "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 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.

[10] "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).

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. For the San Luis Reservoir and O"Neill Forebay Advisories, the concentrations of chlordanes, DDTs, dieldrin, PBDEs, selenium, and toxaphene were below the corresponding ATL values for daily consumption. Thus, the potential effect of multiple chemical exposures was only evaluated for mercury and PCBs. The potential additive effect of mercury and PCBs was examined for Common Carp in San Luis Reservoir and Channel Catfish in O'Neill Forebay, and affected the advice only for the former. The potential additive effect of mercury and PCBs was not examined for Largemouth Bass from O'Neill Forebay because the concentration of PCBs was below the corresponding ATL value for daily consumption. Advice for all species in these advisories was based on mercury and/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 advice on consuming a particular fish species can be extended to other closely related fish species[11] 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 SAN LUIS RESERVOIR AND O'NEILL FOREBAY

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. Advice for Striped Bass (n=5) from San Luis Reservoir and White Catfish (n=6) from O'Neill Forebay was included due to the high levels of mercury. For San Luis Reservoir, the sample size criterion was met for the primary contaminant for American Shad, Common Carp, Largemouth Bass, and Tule Perch. For O'Neill Forebay, the sample size criterion was met for Channel Catfish, Largemouth Bass, Inland Silverside, and Striped Bass. There were not sufficient data to evaluate other species that may be found in these water bodies.

SAN LUIS RESERVOIR

AMERICAN SHAD

The mean mercury level in American Shad from San Luis Reservoir was 225 ppb. OEHHA recommends a maximum of one serving a week of American Shad 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.

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

Common Carp

The mean mercury and PCB levels in Common Carp from San Luis Reservoir were 309 and 69 ppb, respectively. OEHHA recommends no consumption of Common Carp for the sensitive population (women 18 to 45 years, and children 1 to 17 years), based on a combined exposure to mercury and PCBs, and a maximum of one serving a week for the general population (women 46 years and older, and men 18 years and older), based on PCBs.

Black Bass Species

The mean mercury level in Black Bass species from San Luis Reservoir was 605 ppb. OEHHA recommends no consumption of Black Bass species 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), based on mercury.

OEHHA has evaluated mercury concentrations in black bass species in many water bodies in California and has found a similar range of mercury concentrations when two or more of these species were caught from the same water body. Therefore, OEHHA extends the consumption advice for Largemouth Bass to other black bass species, including Redeye, Smallmouth, and Spotted Bass.

Striped Bass

The mean mercury level in Striped Bass from San Luis Reservoir was 782 ppb. OEHHA recommends no consumption of Striped Bass for the sensitive population (women 18 to 45 years, and children 1 to 17 years) and maximum of one serving a week for the the general population (women 46 years and older, and men 18 years and older), based on mercury.

Tule Perch

The mean mercury level in Tule Perch from San Luis Reservoir was 114 ppb. OEHHA recommends a maximum of two servings a week for the sensitive population (women 18 to 45 years, and children 1 to 17 years) 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 mercury.

O'Neill Forebay

Catfish Species

The mean mercury concentration in catfish species, combined, was 138 ppb. The mean mercury concentration in individual catfish speces was 128 ppb (Channel Catfish) and 170 ppb (White Catfish). The mean PCB concentration in Channel Catfish was 62

ppb; PCBs were not analyzed in White Catfish from O'Neill Forebay. OEHHA recommends a maximum of one serving a week of catfish species 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 PCBs.

When the two catfish species were analyzed separately, the advice of one serving a week was the same for Channel Catfish (based on PCBs) and White Catfish (based on mercury) for the sensitive population. For this reason, OEHHA elected to combine the advice for Channel Catfish and White Cafish to be health protective and to simplify risk communication.

Black Bass Species

The mean mercury and PCB levels in Black Bass species from O'Neill Forebay was 254 and 8 ppb, respectively. OEHHA recommends a maximum of one serving a week of Black Bass Species 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. PCB concentrations did not impact advice for Black Bass species in O'Neill Forebay.

OEHHA has evaluated mercury concentrations in black bass species in many water bodies in California and has found a similar range of mercury concentrations when two or more of these species were caught from the same water body. Therefore, OEHHA extends the consumption advice for Largemouth Bass to other black bass species, including Redeye, Smallmouth, and Spotted Bass.

Inland Silverside

The mean mercury level in Inland Silverside from O'Neill Forebay was 36 ppb. OEHHA recommends a maximum of six servings a week of Inland Silverside for the sensitive population (women 18 to 45 years, and children 1 to 17 years) and a maximum of seven servings a week for the general population (women 46 years and older, and men 18 years and older), based on mercury.

Striped Bass

The mean mercury level in Striped Bass from O'Neill Forebay was 355 ppb. OEHHA recommends a maximum of one serving a week of Striped Bass 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.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from San Luis Reservoir and O'Neill Forebay are shown in Table 4.

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THE SAN LUIS RESERVOIR AND THE O'NEILL FOREBAY

Waterbody	Fish Species	Women 18–45 years and Children 1-17 years	Women 46 years and older and Men 18 years and older
San Luis Reservoir	American Shad	1	2
	Common Carp	0	1
	Largemouth Bass	0	1
	Striped Bass	0	1
	Tule Perch	2	5
O'Neill Forebay	Catfish	1	1
	Largemouth Bass	1	2
	Silverside	6	7
	Striped bass	1	2

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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[12] 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 San Luis Reservoir and O'Neill Forebay are followed, exposure to chemicals in fish from these water bodies 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.

[12] 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.