OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from Silverwood Lake (San Bernardino County)

Updated March 2021

Fish, Ecotoxicology, and Water Section
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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
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
RWB6	Regional Water Board 6 (Lahontan)
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
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 updated guidelines for eating fish from Silverwood Lake in San Bernardino 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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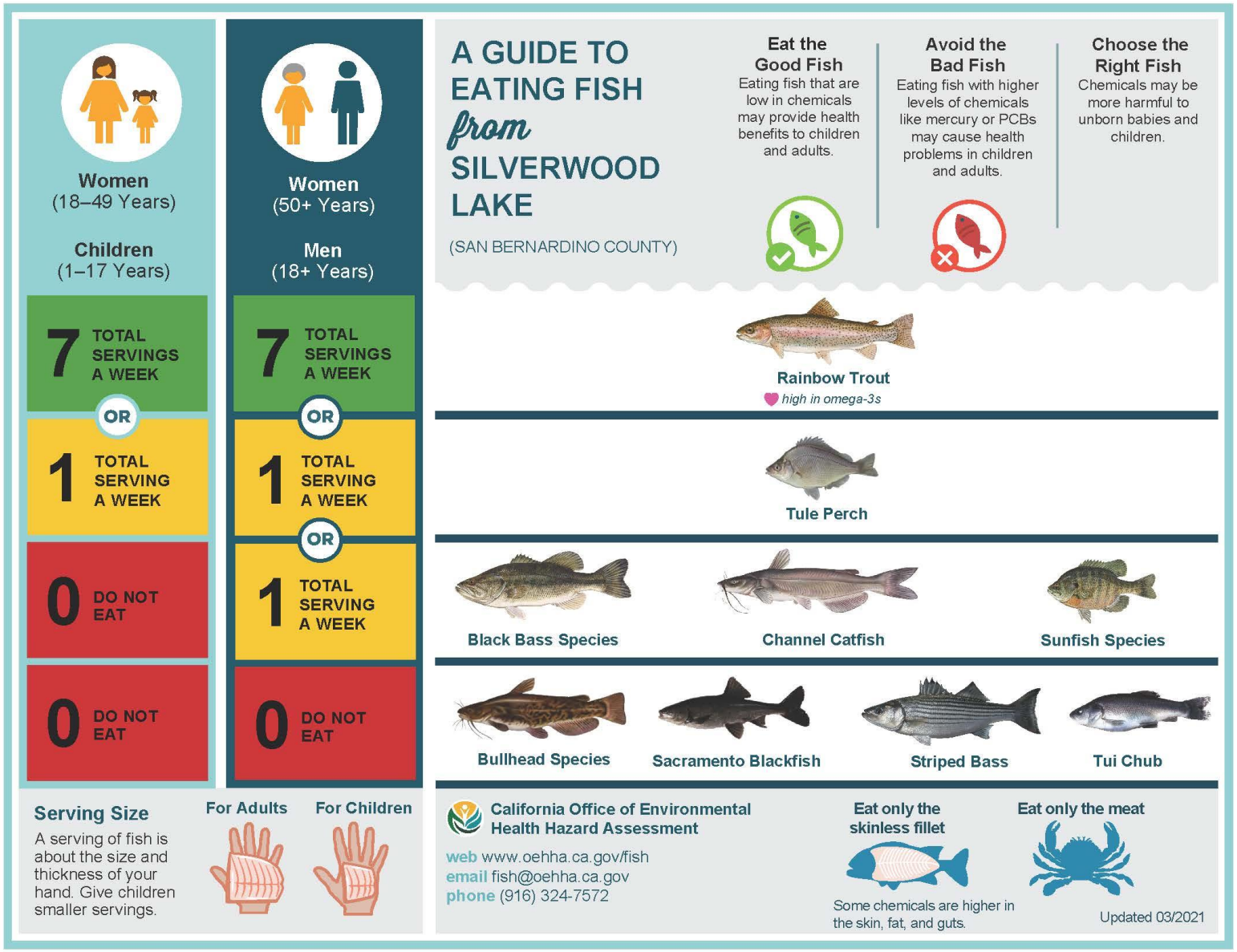

Women
(18–49 Years)
Children
(1–17 Years)
7 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
0 DO NOT EAT
Women
(50+ Years)
Men
(18+ Years)
7 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
A GUIDE TO EATING FISH from SILVERWOOD LAKE
(SAN BERNARDINO COUNTY)
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.
Rainbow Trout
high in omega-3s
Tule Perch
Black Bass Species
Channel Catfish
Sunfish Species
Bullhead Species
Sacramento Blackfish
Striped Bass
Tui Chub
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 Assessment
web www.oehha.ca.gov/fish
email fish@oehha.ca.gov
phone (916) 324-7572
Eat only the skinless fillet
Some chemicals are higher in the skin, fat, and guts.
Eat only the meat
Updated 03/2021

INTRODUCTION

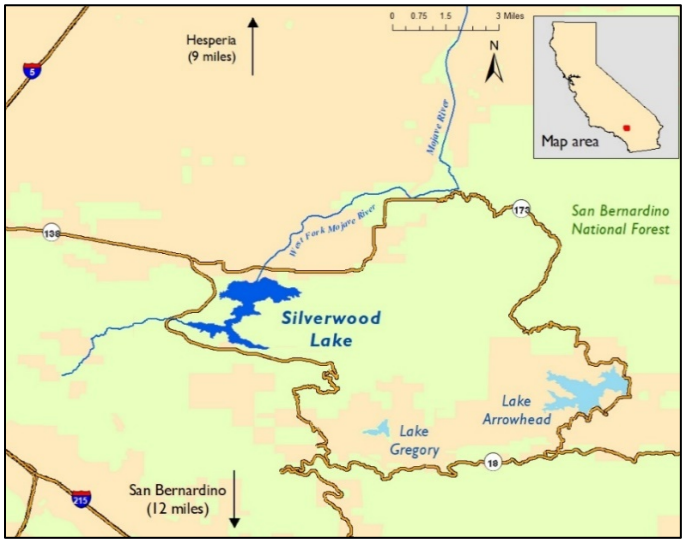
This report updates and supersedes the previous advice for eating fish from Silverwood Lake (Figure 1). The collection of additional data made it possible to update this advisory with the inclusion of bullhead species. Consumption advice is based on levels of mercury and PCBs found in fish collected from Silverwood Lake.

LOCATION

Silverwood Lake is a 976-acre reservoir located approximately 12 miles north of San Bernardino, in the San Bernardino Mountains. The lake was formed in 1971 by construction of Cedar Springs Dam on the West Fork Mojave River, a tributary of the Mojave River. Silverwood Lake is owned and operated by the Department of Water Resources and managed by the California Department of Parks and Recreation.[1]

A survey conducted by the State Water Resources Control Board (SWRCB) from 2007–2008 examined contaminants in sport fish from California's lakes and reservoirs and found high mercury and PCB levels in Largemouth Bass from Silverwood Lake (SWRCB, 2010). Subsequently, the Lahontan Regional Water Quality Control Board (RWB6) conducted a study to further characterize the extent of contamination in black bass and other fish species. The source of the mercury and PCB contamination found in fish tissue from Silverwood Lake is not known.

FIGURE 1. LOCATION OF SILVERWOOD LAKE



[1]Information regarding Silverwood Lake was obtained from the Mojave Water Agency, the California Department of Parks and Recreation, and Wikipedia. Online at: http://www.mojavewater.org/silverwood-lake.html, https://www.parks.ca.gov/?page_id=650, and https://en.wikipedia.org/wiki/Silverwood_Lake.

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from three monitoring studies described in this report to develop the Silverwood Lake Advisory. OEHHA uses the following general process in developing consumption advice for sport fish:

1) Evaluation of all fish contaminant data available from a water body and selection of appropriate data that meet data quality criteria and sampling plan guidelines.
2) Determination of fish species for which adequate data are available to issue fish consumption advice.
3) Calculation of an appropriate measure of central tendency (often a weighted arithmetic mean[2]) and other descriptive statistics of the contaminant data, as appropriate, for a chemical of potential concern for the selected fish species.
4) Comparison of the 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 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), polybrominated diphenyl ethers (PBDEs), 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 historical use of mercury to mine gold, also add mercury to the environment. If mercury enters waterways, it can be converted to a more toxic form

[2] Means are an arithmetic average of individual values and/or a weighted average of composites. A weighted average of composites is calculated by multiplying the chemical concentration in each composite by the number of fish in that composite for each species. Products are then summed and divided by the total number of fish in all composites for that species.

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

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. PBDEs were not analyzed in fish samples collected from Silverwood Lake and are therefore not reported in this advisory.

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 Silverwood Lake and used in advisory development were analyzed for mercury (as a measure of methylmercury) and PCBs. Additional species (sculpin and Inland Silverside) were also analyzed for mercury. However, because these species were not analyzed for PCBs, which affected consumption advice for all species included in this advisory, they were excluded. Mercury concentrations in these sculpin and Inland Silverside were low and, thus, advice based only on mercury would likely not be sufficiently health protective. Bluegill, Brown Bullhead, Channel Catfish, Sacramento Blackfish, and Striped Bass were also analyzed for selenium. Tui Chub were further analyzed for the legacy pesticides chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane), dieldrin, and DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and

dichlorodiphenyldichloroethylene [DDE]). Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study. Additionally, some studies do not analyze these chemicals and instead focus only on mercury.

DATA SOURCES

The guidelines for eating fish from Silverwood Lake are based on the chemicals detected in the fish collected for the three monitoring studies described below. These studies met OEHHA's data quality criteria, including adequate documentation of sample collection, fish preparation methods (e.g., skinning or filleting), chemical analyses, quality assurance, and sufficiently low detection limits. "Sample," as used in this report, refers to an individual fish or a composite of multiple fish for which contaminant data were reported. "Sampling" or "sampled" refers to the act of collecting fish for chemical analysis.

CONTAMINANTS IN FISH FROM CALIFORNIA LAKES AND RESERVOIRS, 2007–2008 (SWAMP)

The Surface Water Ambient Monitoring Program (SWAMP), operated by SWRCB, in cooperation with the RWB6, monitors water quality in California's surface waters.

In 2007 and 2008, SWAMP conducted a two-year screening survey to initiate a statewide sampling effort to identify and quantify contaminants in sport fish found in California lakes and reservoirs (SWRCB, 2010) to examine exposure and risk to humans and wildlife. In 2007, the program collected Largemouth Bass from Silverwood Lake, which were analyzed for mercury and PCBs. All samples analyzed for PCBs were composites that included undersized individuals and were therefore not included in any analyses.

LONG-TERM MONITORING OF BASS LAKES AND RESERVOIRS, 2017 (SWAMP)

This SWAMP study was part of a multi-year effort to document status and trends related to contamination in sport fish from California lakes and reservoirs dominated by black bass species (Davis et al. 2019). In 2017, Bluegill, Brown Bullhead, Channel Catfish, Largemouth Bass, Sacramento Blackfish, and Striped Bass were collected from Silverwood Lake for the study and were analyzed for mercury, PCBs, and/or selenium.

LAHONTAN REGIONAL WATER QUALITY CONTROL BOARD, 2011 (RWB6)

RWB6 staff collected Bluegill, Brown Bullhead, Channel Catfish, Largemouth Bass, Rainbow Trout, Sacramento Blackfish, Striped Bass, Tui Chub, and Tule Perch in 2011

from Silverwood Lake to analyze for levels of mercury, PCBs, chlordanes, DDTs, and/or dieldrin.[3]

FISH SAMPLED FROM SILVERWOOD LAKE

The fish sampling data used in this advisory were retrieved from the California Environmental Data Exchange Network (CEDEN), the state's repository for environmental data. Samples were excluded when the fish were not legal size to take or did not meet OEHHA's criteria for minimum "edible" size based on species size at maturity, and professional judgment (as described in OEHHA, 2005). 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 SILVERWOOD LAKE ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed
Bluegill	*Lepomis macrochirus*	2	9	SWAMP	2017	Hg, Se
		3	10	RWB6	2011	Hg, PCBs
Brown Bullhead	*Ameiurus nebulosus*	1	6	SWAMP	2017	Hg, PCBs, Se
		1	3	RWB6	2011	Hg, PCBs
Channel Catfish	*Ictalurus punctatus*	2	9	SWAMP	2017	Hg, Se
		1	9	SWAMP	2017	PCBs
		3	9	RWB6	2011	Hg, PCBs
Largemouth Bass	*Micropterus salmoides*	4	4	SWAMP	2017	Hg
		10	10	RWB6	2011	Hg
		3	9	RWB6	2011	PCBs
		5	5	SWAMP	2007	Hg

[3] Information on the Lahontan Regional Water Quality Control Board may be found online at: https://www.waterboards.ca.gov/lahontan/

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed
Rainbow Trout	*Oncorhynchus mykiss*	3	9	RWB6	2011	Hg, PCBs
Sacramento Blackfish	*Orthodon microlepidotus*	1	2	SWAMP	2017	Hg, Se
		2	7	RWB6	2011	Hg, PCBs
Striped Bass	*Morone saxatilis*	3	3	SWAMP	2017	Hg
		1	3	SWAMP	2017	Se
		3	8	RWB6	2011	Hg, PCBs
Tui Chub	*Gila bicolor*	1	5	RWB6	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs
Tule Perch	*Hysterocarpus traskii*	1	12	RWB6	2011	Hg, PCBs

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, and PCBs (51–59 congeners)[4]. Among the chemicals analyzed in fish tissue samples from Silverwood Lake, only mercury and PCB levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets. Samples were analyzed as individual fish or composites. 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, 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). Table 2 shows the averages and ranges for total length[5], as well as mercury concentrations in

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

each fish species. The DMA method detection limit (MDL)[6] and the reporting limit (RL)[7] for total mercury were reported at 3, 4, or 12 and 9, 12, or 36 parts per billion (ppb), respectively, depending on the study.

PCBs and Pesticides

Some composite samples were analyzed for PCBs and the legacy pesticides (chlordanes, DDTs, and dieldrin). Pesticides and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, and PCBs 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). Table 3 shows the averages and ranges for total length, as well as PCB concentrations in each fish species.

Selenium

The CDFW MLML analyzed species collected from Silverwood Lake 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. Table 4 shows the averages and ranges for total length, as well as selenium concentrations for each species in which it was analyzed.

Concentrations of chlordanes, dieldrin, and DDTs 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.

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

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM SILVERWOOD LAKE

Species from Silverwood Lake	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Bluegill	5	19	168	126–212	268	109–543
Brown Bullhead	2	9	325	300–385	726	703–771
Channel Catfish	5	18	541	452–633	306	226–448
Largemouth Bass	19	19	429	384–513	920	350–1540
Rainbow Trout	3	9	326	299–359	21	20–22
Sacramento Blackfish	3	9	494	462–524	763	706–826
Striped Bass	6	11	527	424–576	873	406–1310
Tui Chub	1	5	389	358–427	632	n/a
Tule Perch	1	12	131	114–179	172	n/a

Samples were prepared as skinless fillets
*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 SILVERWOOD LAKE

Species from Silverwood Lake	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCBs (ppb)	
					Mean*	Range**
Bluegill	3	10	184	147–212	50	47–53
Brown Bullhead	2	9	325	300–385	134	109–147
Channel Catfish	4	18	541	452–633	85	66–104
Largemouth Bass	3	9	427	384–497	70	47–88
Rainbow Trout	3	9	326	299–359	6	4–7
Sacramento Blackfish	2	7	494	462–524	1039	758–1250
Striped Bass	3	8	543	424–576	174	163–188
Tui Chub	1	5	389	358–427	176	n/a
Tule Perch	1	12	131	114–179	69	n/a

Samples were prepared as skinless fillets
*Means are an arithmetic average of individual values and/or a weighted average of composites.
**Range of individuals and/or range of the composites.
n/a = not applicable due to a single sample

TABLE 4. SELENIUM CONCENTRATIONS IN FISH FROM SILVERWOOD LAKE

Species from Silverwood Lake	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Selenium (ppb)	
					Mean*	Range**
Bluegill	2	9	150	126–190	1483	310–2950
Brown Bullhead	1	6	329	300–385	2990	n/a
Channel Catfish	2	9	501	452–600	1011	500–1420
Sacramento Blackfish	1	2	495	n/a	750	n/a
Striped Bass	1	3	483	450–525	560	n/a

Samples were prepared as skinless fillets
*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 SILVERWOOD LAKE

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 beneficial omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) (USDA/USDHHS, 2020; Weaver et al., 2008).

The US Department of Agriculture (USDA) recommends "including at least 8 ounces of cooked seafood[8] per week. Young children need less, depending on their age and calorie needs" (MyPlate.gov). According to the 2020-2025 Dietary Guidelines, "women who are pregnant or lactating should consume at least 8 and up to 12 ounces of a variety of seafood per week from choices that are lower in methylmercury" (USDA/USDHHS, 2020). Additionally, "based on FDA and EPA's advice, depending on body weight, some women should choose seafood lowest in methylmercury or eat less seafood than the amounts in the Healthy U.S.-Style Dietary Pattern" (USDA/USDHHS, 2020). For more detailed information, see USDA/USDHHS (2020) and other USDA

[8] Seafood food as used here refers to fish and shellfish from freshwater and marine environments.

MyPlate.gov materials. 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 recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children avoid consuming shark, swordfish, tilefish (Gulf of Mexico), bigeye tuna, marlin, orange roughy, and king mackerel (FDA/US EPA, 2017).

To address the potential health concerns associated with exposure to contaminants in sport 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 should 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.

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 49 years of age) and children 1-17 years, are lower than those for women 50 years and older, and men 18 years and older. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of 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 chemical concentration 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 individual fish 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 Bluegill, Channel Catfish, and Tule Perch and affected advice for Bluegill and Channel Catfish. Multiple chemical exposure analysis was not performed for the other species in this advisory because they were low in PCBs (Rainbow Trout) or were already 'do not consume' for the sensitive population; advice for these species 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[9] 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 SILVERWOOD LAKE

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 to develop advice for species that are commonly caught and consumed from a given water body but where available data may be limited. Generally, this practice applies when the advice supports no consumption of that species. For Silverwood Lake, the sample size criterion was met for all species except Tui Chub (Hg and PCB analyses, n=5), and Sacramento Blackfish (PCB analysis, n=7). Although these species had fewer than the preferred number of samples, these data were included due to the high concentrations of mercury and PCBs. Both species were 'do not consume' for the sensitive

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

populations based on mercury and PCBs, and for the general population based on PCBs, and including these data was thus more health protective. There were not sufficient data to evaluate other species that may be found in this water body.

The following advice is based on mercury and PCB concentrations. The sensitive population is defined as women 18 to 49 years and children 1 to 17 years, and the general population is defined as women 50 years and older, and men 18 years and older.

BLACK BASS SPECIES (LARGEMOUTH BASS)

The mean mercury and PCB concentrations in Largemouth Bass from Silverwood Lake were 920 and 70 ppb, respectively. OEHHA recommends no consumption of black bass species from Silverwood Lake for the sensitive population based on mercury, and a maximum of one serving a week for the general population based on mercury or PCBs.

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.

BULLHEAD SPECIES (BROWN BULLHEAD)

The mean mercury, PCB, and selenium concentrations in Brown Bullhead from Silverwood Lake were 726, 134, and 2990 ppb, respectively. OEHHA recommends no consumption of Brown Bullhead for the sensitive population, based on mercury or PCBs, and the general population, based on PCBs.

Black and Brown Bullhead are benthic, opportunistic omnivores, with adults feeding primarily on plants, invertebrates, and small fish. They can tolerate a wide range of conditions, including waters with low oxygenation and high pollution levels[10]. Bullhead species are bottom-dwellers, which can expose them to chemical contaminants in bottom sediments. The species are also known to hybridize in some water bodies where they are co-located (Cingolani, et al.). Although there are not sufficient data to state conclusively, due to their similar diet and habitat preferences, it is expected that Black and Brown Bullhead would have similar levels of PCBs. OEHHA has evaluated mercury concentrations in Black Bullhead and Brown Bullhead in water bodies in

[10] Species profiles for Black and Brown Bullhead can be found on the University of Michigan website, online at: https://animaldiversity.org/accounts/Ameiurus_nebulosus/, and https://animaldiversity.org/accounts/Ameiurus_melas/

California and has found a similar range of mercury concentrations when both of these species were caught from the same water body. For these reasons, OEHHA extends the consumption advice for Brown Bullhead to Black Bullhead.

CHANNEL CATFISH

The mean mercury, PCB, and selenium concentrations in Channel Catfish from Silverwood Lake were 306, 85, and 1011 ppb, respectively. OEHHA recommends no consumption of Channel Catfish for the sensitive population based on a combined exposure to mercury and PCBs, and a maximum of one serving a week for the general population, based on PCBs.

RAINBOW TROUT

The mean mercury and PCB concentrations in Rainbow Trout from Silverwood Lake were 21 and 6 ppb, respectively. OEHHA recommends a maximum of seven servings a week for both the sensitive and general populations, based on these relatively low concentrations of mercury or PCBs.

SACRAMENTO BLACKFISH

The mean mercury, PCB, and selenium concentrations in Sacramento Blackfish from Silverwood Lake were 763, 1039, and 750 ppb, respectively. OEHHA recommends no consumption of Sacramento Blackfish for the sensitive population based on mercury or PCBs, and the general population, based on PCBs.

STRIPED BASS

The mean mercury, PCB, and selenium concentrations in Striped Bass from Silverwood Lake were 873, 174, and 560 ppb, respectively. OEHHA recommends no consumption of Striped Bass for the sensitive population, based on mercury or PCBs, and the general population, based on PCBs.

SUNFISH SPECIES (BLUEGILL)

The mean mercury, PCB, and selenium concentrations in Bluegill from Silverwood Lake were 268, 50, and 1483 ppb, respectively. OEHHA recommends no consumption of sunfish species for the sensitive population based on a combined exposure to mercury and PCBs, and a maximum of one serving a week for the general population, based on PCBs.

OEHHA has evaluated mercury concentrations in sunfish 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. There are not sufficient data from high-PCB water bodies in the state to determine whether PCB concentrations would be similar in different sunfish species. However, because sunfish species have

similar habitat and diet preferences[11], and some species are known to hybridize (Avise and Saunders, 1984), it is expected that PCB concentrations would be similar between sunfish species. OEHHA extends the consumption advice for sunfish species (Bluegill) to other sunfish species, including Green Sunfish, Pumpkinseed, and Redear Sunfish.

TUI CHUB

The mean mercury and PCB concentrations in Tui Chub from Silverwood Lake were 632 and 176 ppb, respectively. OEHHA recommends no consumption of Tui Chub for the sensitive population, based on mercury or PCBs, and the general population, based on PCBs.

TULE PERCH

The mean mercury and PCBs concentrations in Tule Perch from Silverwood Lake were 172 and 69 ppb, respectively. OEHHA recommends a maximum of one serving a week for the sensitive population, based on mercury or PCBs, and the general population, based on PCBs.

[11] Species profiles for Bluegill, Green Sunfish, Pumpkinseed, and Redear Sunfish can be found on the University of Michigan website, online at: https://animaldiversity.org/accounts/Lepomis_macrochirus/, https://animaldiversity.org/accounts/Lepomis_cyanellus/, https://animaldiversity.org/accounts/Lepomis_gibbosus/, and https://animaldiversity.org/accounts/Lepomis_microlophus/.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from Silverwood Lake are shown in Table 5.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM SILVERWOOD LAKE

Fish Species	Women 18–49 years and Children 1–17 years	Women 50 years and older and Men 18 years and older
Black Bass Species	0	1
Bullhead Species	0	0
Channel Catfish	0	1
Rainbow Trout	7	7
Sacramento Blackfish	0	0
Striped Bass	0	0
Sunfish Species	0	1
Tui Chub	0	0
Tule Perch	1	1

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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 reference dose[12] on an average daily basis for chemicals not known to cause cancer, such as methylmercury, or
- For cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer 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 Silverwood Lake are followed, exposure to chemicals in fish from Silverwood Lake 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 18-49 and children 1-17)	≤ 31	>31–36	>36–44	>44–55	>55–70	>70–150	>150–440	>440
MeHg (Women > 49 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 over a lifetime.