



# Health Advisory and Guidelines for Eating Fish from Pyramid Lake (Los Angeles County)

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## LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
DMA	direct mercury analyzer
EPA	eicosapentaenoic acid
FDA	United States Food and Drug Administration
Hg	mercury
ICP-MS	inductively coupled plasma-mass spectrometry
MDL	method detection limit
MeHg	methylmercury
MPSL	Marine Pollution Studies Laboratory at 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
RWB4	Regional Water Board 4 (Los Angeles)
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
USDA	United States Department of Agriculture
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.<sup>1</sup> 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's (CDFW) Inland and Ocean Sport Fishing Regulations in their respective sections on public health advisories.<sup>2</sup>

This report presents guidelines for eating fish from Pyramid Lake in Los Angeles County. The report provides background information and a technical description of how the guidelines were developed. The resulting advice is summarized in the illustrations after the Table of Contents and the List of Figures and Tables.

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<sup>1</sup> Sport fish includes all fish and shellfish caught from California waters for non-commercial purposes (e.g., recreational, tribal/cultural, and subsistence practices).

<sup>2</sup> CDFW's Inland and Ocean Sport Fishing Regulations can be found online at: <https://wildlife.ca.gov/Fishing/Inland> and <https://wildlife.ca.gov/Fishing/Ocean>, respectively.


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**Women**  
(18-49 Years)  
**Children**  
(1-17 Years)



**Women**  
(50+ Years)  
**Men**  
(18+ Years)

## A GUIDE TO EATING FISH

*from*  
**PYRAMID LAKE**  
(LOS ANGELES COUNTY)

**5** TOTAL SERVINGS A WEEK

OR

**1** TOTAL SERVING A WEEK

OR

**1** TOTAL SERVING A WEEK

**0** DO NOT EAT

**0** DO NOT EAT

**7** TOTAL SERVINGS A WEEK

OR

**3** TOTAL SERVINGS A WEEK

OR


**2** TOTAL SERVINGS A WEEK

OR


**1** TOTAL SERVING A WEEK

**0** DO NOT EAT


**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

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**Sunfish Species**

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**Catfish Species**

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**Black Bass Species**



**Striped Bass**


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**Bullhead 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 Assessment**  
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**Eat only the skinless fillet**



Some chemicals are higher in the skin, fat, and guts.

**Eat only the meat**



Updated 03/2023

## INTRODUCTION

This report updates and supersedes the previous guidelines developed by the Office of Environmental Health Hazard Assessment (OEHHA) in 2013 for eating fish from Pyramid Lake (Figure 1). The collection of additional data made it possible to update this advisory with the inclusion of Striped Bass and sunfish species. Consumption advice for eating black bass species, bullhead species, catfish species, Rainbow Trout, Striped Bass, and sunfish species is based on levels of mercury (Hg) and/or polychlorinated biphenyls (PCBs) found in fish collected from Pyramid Lake.

### LOCATION

Pyramid Lake (Figure 1) is a reservoir on Piru Creek near Castaic, California, in the Angeles and Los Padres National Forests. It is located about 60 miles northwest of Los Angeles. The California Department of Water Resources built Pyramid Dam as part of the California Aqueduct, which is part of the California State Water Project. The dam was completed in 1973. The lake is approximately 1,360 surface acres, with 21 miles of shoreline and a depth of up to 700 feet. The lake serves as water storage for Los Angeles, the Castaic Powerplant, and the Warne Powerplant.<sup>3</sup>

FIGURE 1. LOCATION OF PYRAMID LAKE



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<sup>3</sup> Information regarding Pyramid Lake was obtained from the Department of Water Resources, online at: <https://water.ca.gov/Programs/State-Water-Project/SWP-Facilities/Southern/Pyramid-Dam-Modernization>, <https://water.ca.gov/What-We-Do/Recreation/Pyramid-Lake-Recreation>, and <https://south-swp-hydropower-relicensing.com/project/>.



### *APPROACH USED*

OEHHA used the results from three monitoring studies described in this report to develop the Pyramid 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)<sup>4</sup> 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 includes consideration of health benefits associated with including fish in the diet (OEHHA, 2008). The ATLs should not be interpreted as static “bright lines,” but as one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of the benefits and risks of consuming sport fish.

## CHEMICALS OF POTENTIAL CONCERN

Certain chemicals, because of their toxicity and their ability to accumulate in fish tissue, are of potential concern for people who eat fish. The majority of fish consumption advisories in California are issued because of mercury, followed by PCBs and, in a few cases, selenium (Se), polybrominated diphenyl ethers (PBDEs), or some legacy pesticides (pesticides that are no longer used but remain in the environment).

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

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<sup>4</sup> Means are an arithmetic average of individual values and/or composites weighted by number of fish. A weighted average of composites is calculated by multiplying the chemical concentration in each composite by the number of fish in that composite for each species. Products are then summed and divided by the total number of fish in all composites for that species.

methylmercury can harm the brain, especially in fetuses and children, whose brains are still developing.

PCBs are industrial chemicals previously used in electrical transformers, plastics, and lubricating oils, and were often used as flame retardants or electrical insulators. Their use was banned in the 1970s, but they can accumulate in fish because they do not break down easily and they persist in the environment. Depending on the exposure level, PCBs may cause cancer or other health effects, including neurotoxicity, in humans.

Selenium is an element and at low doses is an essential nutrient for many important human health processes, including thyroid regulation and vitamin C metabolism. Higher doses cause selenium toxicity, which can include symptoms ranging from hair loss and gastrointestinal distress to dizziness and tremors.

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.

Chlordanes, dichlorodiphenyltrichloroethane (DDT), dieldrin, and toxaphene are pesticides that were banned from use in 1973 (DDT), the late 1980s (chlordanes and dieldrin) and 1990 (toxaphene), but are still found in some fish in certain California water bodies. Depending on the exposure level, these chemicals may cause cancer or adverse effects on the nervous system.

A detailed discussion of the toxicity of these chemicals 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 Pyramid Lake and used in advisory development were analyzed for mercury. All species except Striped Bass were analyzed for PCBs and some species were also analyzed for PBDEs, selenium, and legacy pesticides as indicated in Table 1.

## DATA SOURCES

The guidelines for eating fish from Pyramid 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. The studies or entities contributing data to this advisory are described below.

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

This survey of inland water bodies, conducted by the State Water Resources Control Board’s (SWRCB) Surface Water Ambient Monitoring Program (SWAMP), was the State’s largest survey of chemical contaminants in sport fish. The survey sampled popular fishing sites at 272 lakes and reservoirs from 2007 to 2008 (SWRCB, 2010). The SWRCB used the data from this survey to characterize statewide water quality conditions. The program collected Brown Bullhead and Largemouth Bass from Pyramid Lake in 2007, which were analyzed for chlordanes, DDTs, dieldrin, mercury, PBDEs, and PCBs. Brown Bullhead were also analyzed for selenium.

*REGIONAL WATER QUALITY CONTROL BOARD, LOS ANGELES FISH CONTAMINATION STUDY, 2010–2013 (RWB4)*

The Los Angeles Regional Water Quality Control Board, Region 4 (RWB4) coordinates ongoing sampling efforts to monitor contaminant levels, including mercury, in sport fish caught from lakes and reservoirs within the region (LARWQCB, 2012). RWB4 collected Bluegill, Channel Catfish, Largemouth Bass, and Rainbow Trout from Pyramid Lake in 2010 and analyzed them for chlordanes, DDTs, dieldrin, mercury, and PCBs. In 2012, RWB4 collected Channel Catfish, Largemouth Bass, and Rainbow Trout from Pyramid Lake. All species collected in 2012 were analyzed for chlordanes, DDTs, dieldrin, mercury, and PCBs with the exception of Rainbow Trout, which were excluded from mercury analysis. In 2013, RWB4 collected Black Bullhead, Channel Catfish, Largemouth Bass, Rainbow Trout, and White Catfish from Pyramid Lake. All species collected in 2013 were analyzed for mercury and PCBs with the exception of Rainbow Trout, which were only analyzed for PCBs.

*LONG-TERM MONITORING OF BASS LAKES AND RESERVOIRS IN CALIFORNIA, 2015–ONGOING (SWAMP)*

This monitoring study is a multi-year effort initiated in 2015 to document the status and trends related to contamination in sport fish from California lakes and reservoirs where bass species reside (Davis et al., 2022). In 2019, the program collected Bluegill, Channel Catfish, Largemouth Bass, and Striped Bass from Pyramid Lake, which were analyzed for mercury and selenium. Several organic contaminants were also analyzed in these species but were not included in the evaluation for Pyramid Lake because of data quality and reliability issues.

## CHANGES FROM THE 2013 ADVISORY

This update includes the following changes and additions to the 2013 Pyramid Lake advisory:<sup>5</sup>

- 1) Consumption advice for Striped Bass and sunfish species was added to the advisory based on data from samples collected by RWB4 and SWAMP. New data for White Catfish were combined with previous Channel Catfish data to develop advice for catfish species combined.
- 2) Rainbow Trout advice changed for the sensitive population from seven to five meals per week.

## FISH SAMPLED FROM PYRAMID LAKE

The fish sampling data used in this advisory were retrieved from the California Environmental Data Exchange Network (CEDEN),<sup>6</sup> the state's repository for environmental data. Samples were excluded when the fish were not legal size to take or did not meet OEHHA's criteria for minimum "edible" size, based on species size at maturity and professional judgment (as described in OEHHA, 2022), except for one Bluegill composite consisting of fish slightly below minimum edible length (i.e., 100 mm). Individual lengths in the composite ranged from 95 to 175 mm. The composite was included in the dataset because it was the sole source of PCB data, which would result in more health-protective advice than based on mercury alone. 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 PYRAMID LAKE ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project <sup>a</sup>	Year Collected	Contaminants Analyzed
Black Bullhead	<i>Ameiurus melas</i>	1	5	RWB4	2013	Hg, PCBs
Bluegill	<i>Lepomis macrochirus</i>	1	4	RWB4	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs
		2	9	SWAMP	2019	Hg, Se

<sup>5</sup> In 2018, OEHHA updated the age ranges for women in each population group. The sensitive population changed from 18–45 years to 18–49 years, and the general population from changed from 46 years and older to 50 years and older.

<sup>6</sup> Online at: <http://ceden.waterboards.ca.gov/AdvancedQueryTool>.

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project <sup>a</sup>	Year Collected	Contaminants Analyzed
Brown Bullhead	<i>Ameiurus nebulosus</i>	2	10	SWAMP	2007	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs
		1	10	SWAMP	2007	Se
Channel Catfish	<i>Ictalurus punctatus</i>	3	15	RWB4	2010	Chlordanes, DDTs, Dieldrin, Hg, PCBs
		1	5	RWB4	2012	Chlordanes, DDTs, Dieldrin, Hg, PCBs
		1	3	RWB4	2013	Hg, PCBs
		1	8	SWAMP	2019	Hg, Se
Largemouth Bass	<i>Micropterus salmoides</i>	2	10	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs
		14	14	SWAMP	2007	Hg
		1	5	RWB4	2010	Chlordanes, DDTs, Dieldrin, PCBs
		5	5	RWB4	2010	Hg
		1	5	RWB4	2012	Chlordanes, DDTs, Dieldrin, PCBs
		5	5	RWB4	2012	Hg
		1	5	RWB4	2013	PCBs
		12	12	RWB4	2013	Hg
		20	20	SWAMP	2019	Hg
		2	20	SWAMP	2019	Se
Rainbow Trout	<i>Oncorhynchus mykiss</i>	3	15	RWB4	2010	Chlordanes, DDTs, Dieldrin, PCBs
		15	15	RWB4	2010	Hg
		1	5	RWB4	2012	Chlordanes, DDTs, Dieldrin, PCBs
		1	5	RWB4	2013	PCBs

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project <sup>a</sup>	Year Collected	Contaminants Analyzed
Striped Bass	<i>Morone saxatilis</i>	10	10	SWAMP	2019	Hg
		1	10	SWAMP	2019	Se
White Catfish	<i>Ameiurus catus</i>	1	5	RWB4	2013	Hg, PCBs

<sup>a</sup>Samples were analyzed as skinless fillets.

## CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes (2–5 congeners), DDTs (6 congeners), dieldrin, PBDEs (7 congeners), and PCBs (54–55 congeners).<sup>7</sup> Among the chemicals analyzed in fish tissue samples from Pyramid Lake, only mercury and PCB levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets.

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

### MERCURY

Samples were analyzed for total mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA) at the Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories (MPSL). 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,<sup>8</sup> as well as mercury concentrations in each fish species. Depending on the study, the DMA

<sup>7</sup> Congeners are related compounds with similar chemical forms. Five and six congeners are typically analyzed for chlordanes and DDTs, respectively. Of the 209 possible PBDE and PCB congeners, 6–7 and 48–54 are generally analyzed, respectively. See the OEHHA (2022) sampling protocol, available online at

<https://oehha.ca.gov/media/downloads/fish/report/fishadvisorysamplinganalysisprotocolreport2022.pdf>.

<sup>8</sup> 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.

method detection limits (MDLs)<sup>9</sup> for total mercury were reported at 3, 4, or 12 parts per billion (ppb), and the reporting limits (RLs)<sup>10</sup> were reported at 9, 12, or 36 ppb.

#### *PCBS, PBDES, AND PESTICIDES*

Pesticides, PBDEs, and PCBs in composite samples 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. Because the MDLs or RLs were relatively low ( $\leq 5$  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 MPSL analyzed species collected from Pyramid Lake for selenium as composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS). The ICP-MS method uses desolvation, atomization, and ionization with ion separation based on a mass-to-charge ratio to detect the total selenium concentration in a sample. Depending on the study, the MDLs for total selenium were reported at 100 or 230 ppb and the RLs were reported at 300 or 700 ppb.

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

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<sup>9</sup> The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.

<sup>10</sup> The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM PYRAMID LAKE

Species	Number of Samples <sup>a</sup>	Total Number of Fish	Mean <sup>b</sup> Total Length (mm)	Range of Total Lengths <sup>c</sup> (mm)	Mercury (ppb)	
					Mean <sup>b</sup>	Range <sup>c</sup>
Bluegill	3	13	166	95–220	119	107–145
Bullhead Species	3	15	385	314–510	227	187–293
Black Bullhead	1	5	450	396–510	202	n/a
Brown Bullhead	2	10	353	314–417	240	187–293
Catfish Species	7	36	424	303–669	235	73–308
Channel Catfish	6	31	433	303–669	237	73–308
White Catfish	1	5	370	318–450	223	n/a
Largemouth Bass	56	56	391	332–496	573	214–1060
Rainbow Trout	15	15	305	246–430	28	20–82
Striped Bass	10	10	480	398–572	324	134–509

<sup>a</sup>Samples were prepared as skinless fillets

<sup>b</sup>Means are an arithmetic average of individual values and/or a weighted average of composites

<sup>c</sup>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 PYRAMID LAKE

Species	Number of Samples <sup>a</sup>	Total Number of Fish	Mean <sup>b</sup> Total Length (mm)	Range of Total Lengths <sup>c</sup> (mm)	PCBs (ppb)	
					Mean <sup>b</sup>	Range <sup>c</sup>
Bluegill	1	4	131	95–175	17	n/a
Bullhead Species	3	15	385	314–510	163	12–416
Black Bullhead	1	5	450	396–510	12	n/a
Brown Bullhead	2	10	353	314–417	238	60–416
Catfish Species	6	28	428	310–669	26	10–66
Channel Catfish	5	23	440	310–669	30	10–66
White Catfish	1	5	370	318–450	10	n/a
Largemouth Bass	5	25	374	332–411	50	23–86
Rainbow Trout	5	25	313	240–430	3	0–7

<sup>a</sup>Samples were prepared as skinless fillets.

<sup>b</sup>Means are an arithmetic average of individual values and/or a weighted average of composites.

<sup>c</sup>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 PYRAMID 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<sup>[11]</sup> per week. Young children need less, depending on their age and calorie needs.”<sup>12</sup> According to the “Dietary Guidelines for Americans, 2020–2025” (USDA/USDHHS, 2020), “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.” 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 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 (US EPA) recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children avoid consuming shark, Swordfish, tilefish (Gulf of Mexico), Bigeye Tuna, marlin, Orange Roughy, and King Mackerel (FDA/US EPA, 2017).

To address the potential health concerns associated with exposure to contaminants in sport fish, OEHHA has established ATLS for chemicals that are known to accumulate in the edible tissues of fish. ATLS consider both the toxicity of the chemical and potential benefits of eating fish. OEHHA uses the ATLS to determine the maximum number of servings per week that consumers can eat safely, for each species and from each location, to limit their exposure to these contaminants. Consumers can use OEHHA’s guidance when choosing which fish and how much to eat as part of an overall healthy diet.

There are two sets of ATLS for methylmercury in fish because of the age-related toxicity of this chemical (OEHHA, 2008). The fetus and children are more sensitive to the toxic effects of methylmercury. Thus, the ATLS for the sensitive population, including women who might become pregnant (typically 18–49 years of age) and children 1–17 years of age, are lower than those for women 50 years and older and men 18 years and older. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of 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

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<sup>11</sup> Seafood as used here refers to fish and shellfish from freshwater and marine environments.

<sup>12</sup> Online at: <https://www.myplate.gov/>.

Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)” (OEHHA, 2011). A list of the ATLS used in this report is presented in the Appendix.

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

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of servings per week. Because some chemicals, such as mercury and PCBs, are known to have similar adverse effects, additivity of toxicity is assumed in such cases and may be assessed using multiple chemical exposure methodology (US EPA, 1989 and 2000b). If two or more chemicals with similar adverse effects are present in fish tissue, multiple chemical exposure methodology involving hazard index calculations is employed. This may result in advising fewer servings per week than would be the case for the presence of either chemical alone, in a similar concentration. The potential effect of multiple chemical exposures (mercury and PCBs) was assessed in Bluegill, catfish species, Rainbow Trout, and Striped Bass and affected advice for Bluegill, Rainbow Trout, and Striped Bass. Advice for other species in this advisory was based solely on mercury or PCB concentrations.

OEHHA recommends that individuals strive to meet the US dietary guidelines’ seafood consumption recommendations,<sup>13</sup> 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. When noted, OEHHA’s consumption advice for a particular fish species can be extended to other closely related fish species<sup>14</sup> known to accumulate similar levels of contaminants.

Consumption advice should not be combined. That is, if a person chooses to eat a serving of fish from the “one-serving-a-week” category, then they should not eat any other fish from any source (including commercial) until the next week. If a person chooses to eat a serving of fish from the “two-servings-per-week” category, they can combine fish species from that category, or eat one serving of fish from that category and one from a category that recommends more than two servings per week (if available), for a total of two servings in that week. Then they should not eat any other fish from any source (including commercial) until the following week.

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<sup>13</sup> Online at: <https://www.dietaryguidelines.gov/>.

<sup>14</sup> Fish species within the same genus are most closely related, and family is the next level of relationship.

## CONSUMPTION ADVICE FOR FISH FROM PYRAMID LAKE

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

For Pyramid Lake, the sample size criterion was met for mercury for Bluegill, bullhead species, catfish species, Largemouth Bass, Rainbow Trout, and Striped Bass. However, the advice for sunfish species was fully or partially based on PCBs with only one composite sample of four Bluegill analyzed for PCBs. Although this is much fewer than the preferred number of samples, the data were included because they reduced the number of recommended servings per week for this species for the general population from five to three meals per week compared to the advice based on mercury and were thus more health-protective. There were not sufficient data to evaluate other species that may be found in this water body. For fish species found in Pyramid Lake that are not included in this advisory, OEHHA recommends following the statewide advisory for lakes and reservoirs without site-specific advice.<sup>15</sup>

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

### *BLACK BASS SPECIES (LARGEMOUTH BASS)*

Black bass species are one of the most targeted species of freshwater game fish in California. OEHHA groups black bass species because they have similar predatory diets which suggests a comparable chemical uptake (Long and Fisher, 2000). They are

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<sup>15</sup> Online at: <https://oehha.ca.gov/advisories/statewide-advisory-eating-fish-californias-lakes-and-reservoirs-without-site-specific>.

also known to hybridize (Pierce and Van Den Avyle, 1997), largely due to species introductions for angling purposes and weak genetic barriers between members of the genus (Thongda et al., 2020). OEHHA has also 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.

The mean mercury and PCB concentrations in Largemouth Bass from Pyramid Lake were 573 ppb and 50 ppb, respectively. Based on mercury, OEHHA recommends no consumption of black bass species from Pyramid Lake for the sensitive population. Based on mercury or PCBs, OEHHA recommends a maximum of one serving a week for the general population.

#### *BULLHEAD SPECIES (BLACK BULLHEAD, BROWN BULLHEAD)*

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. Bullhead species are bottom-dwellers, which can expose them to chemical contaminants in bottom sediments. OEHHA groups bullhead species due to a known ability to hybridize in some water bodies where they are co-located (Cingolani et al., 2007). 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 contaminant uptake. For these reasons, OEHHA extends the consumption advice for Brown Bullhead to Black Bullhead.

The mean mercury and PCB concentrations in bullhead species from Pyramid Lake were 227 and 163 ppb, respectively. Mercury concentrations for individual bullhead species were 202 ppb for Black Bullhead and 240 ppb for Brown Bullhead. PCB concentrations for individual bullhead species were 12 ppb for Black Bullhead and 238 ppb for Brown Bullhead. OEHHA recommends no consumption of bullhead species for the sensitive and general populations, based on PCBs.

#### *CATFISH SPECIES (CHANNEL CATFISH, WHITE CATFISH)*

The mean mercury and PCB concentrations in catfish species from Pyramid Lake were 235 and 26 ppb, respectively. Mercury concentrations for individual catfish species were 237 ppb for Channel Catfish and 223 ppb for White Catfish. PCB concentrations for individual catfish species were 30 ppb for Channel Catfish and 10 ppb for White Catfish. OEHHA recommends a maximum of one serving per week for the sensitive population, based on mercury, and a maximum of two servings per week for the general population, based on mercury or PCBs.

*RAINBOW TROUT*

The mean mercury and PCB concentrations in catfish species from Pyramid Lake were 28 and 3 ppb, respectively. OEHHA recommends a maximum of five servings per week for the sensitive population, based on multiple-chemical exposure analysis of mercury and PCBs, and a maximum of seven servings a week for the general population, based on PCBs.

*STRIPED BASS*

The mean mercury concentration in Striped Bass from Pyramid Lake was 324 ppb. Although organic chemical analyses were run on these samples, the results were not considered reliable and PCB congener data were not reported. Because PCB concentrations were considerably elevated in some other species collected from this water body, OEHHA used PCB data from the most closely related species (Largemouth Bass; 50 ppb PCBs) to assess the potential risk from PCB exposure in Striped Bass. Thus, OEHHA recommends no consumption of Striped Bass for the sensitive population, based on multiple-chemical exposure analysis of mercury and PCBs, and a maximum of one serving per week for the general population, based on PCBs.

*SUNFISH SPECIES (BLUEGILL)*

OEHHA groups sunfish species due to a known ability to hybridize (Avisé and Smith, 1974) and extensive dietary overlap (Kirby, 1982), which suggests a similar contaminant uptake. 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, due to the similar dietary preferences of sunfish and their ability to hybridize,<sup>16</sup> it is expected that PCB concentrations would be similar between sunfish species. Therefore, OEHHA extends the consumption advice for Bluegill to other sunfish species, including Green Sunfish, Pumpkinseed, and Redear Sunfish.

The mean mercury and PCB concentrations in Bluegill from Pyramid Lake were 119 ppb and 17 ppb, respectively. OEHHA recommends a maximum of one serving a week of sunfish species for the sensitive population, based on multiple-chemical exposure

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<sup>16</sup> 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_macrochirus/), [https://animaldiversity.org/accounts/Lepomis\\_cyanellus/](https://animaldiversity.org/accounts/Lepomis_cyanellus/), [https://animaldiversity.org/accounts/Lepomis\\_gibbosus/](https://animaldiversity.org/accounts/Lepomis_gibbosus/), and [https://animaldiversity.org/accounts/Lepomis\\_microlophus/](https://animaldiversity.org/accounts/Lepomis_microlophus/).

analysis of mercury and PCBs, and a maximum of three servings a week for the general population, based on PCBs.

## RECOMMENDED MAXIMUM NUMBER OF SERVINGS

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

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM PYRAMID 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
Catfish Species	1	2
Rainbow Trout	5	7
Striped Bass	0	1
Sunfish Species	1	3

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## APPENDIX. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs; OEHHA, 2008 and 2011) 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<sup>17</sup> on an average daily basis for chemicals not known to cause cancer, such as methylmercury, or
- For cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer risk level is 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 a water body are followed, exposure to chemicals in fish from that water body would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

## ADVISORY TISSUE LEVELS FOR SELECTED ANALYTES

Contaminant	Consumption Frequency Categories (8-ounce servings/week) <sup>a</sup> 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 ≥ 50 and men ≥ 18)	≤ 94	>94–109	>109–130	>130–160	>160–220	>220–440	>440–1,310	>1,310
PBDEs	≤ 45	>45–52	>52–63	>63–78	>78–100	>100–210	>210–630	>630
PCBs	≤ 9	>9–10	>10–13	>13–16	>16–21	>21–42	>42–120	>120
Selenium	≤ 1,000	>1,000–1,200	>1,200–1,400	>1,400–1,800	>1,800–2,500	>2,500–4,900	>4,900–15,000	>15,000
Toxaphene	≤ 87	>87–100	>100–120	>120–150	>150–200	>200–300	>300–610	>610

<sup>a</sup> 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.

<sup>17</sup> 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.