OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from Lake Berryessa (Napa County)

Updated September 2024

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

LIST OF CONTRIBUTORS

Office of Environmental Health Hazard Assessment

Project Leads

Loren Chumney, M.S.
Huyen Tran Pham, M.P.H.

Primary Reviewers

Wesley Smith, Ph.D., Section Chief
Shannon R. Murphy, Ph.D.
Susan A. Klasing, Ph.D. (Retired Annuitant)

Final Reviewers

Elaine Khan, Ph.D., Pesticide and Environmental Toxicology Branch Chief
Kannan Krishnan, Ph.D., Assistant Deputy Director for Scientific Programs

Director

David Edwards, Ph.D., Acting Director

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For further information, contact:

Pesticide and Environmental Toxicology Branch
Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

1001 I Street, P.O. Box 4010
Sacramento, CA 95812-4010
Telephone: (916) 324-7572
Email address: fish@oehha.ca.gov

1515 Clay Street, 16th Floor
Oakland, CA 94612
Telephone: (510) 622-3170

LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CVRWQCB	Central Valley Regional Water Quality Control Board (Region 5)
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
mm	millimeters
MPSL	Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
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.[1] 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.[2]

This report presents updated guidelines for eating fish from Lake Berryessa in Napa 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.

[1] Sport fish includes all fish and shellfish caught from California waters for non-commercial purposes (e.g., recreational, tribal/cultural, and subsistence practices).
[2] 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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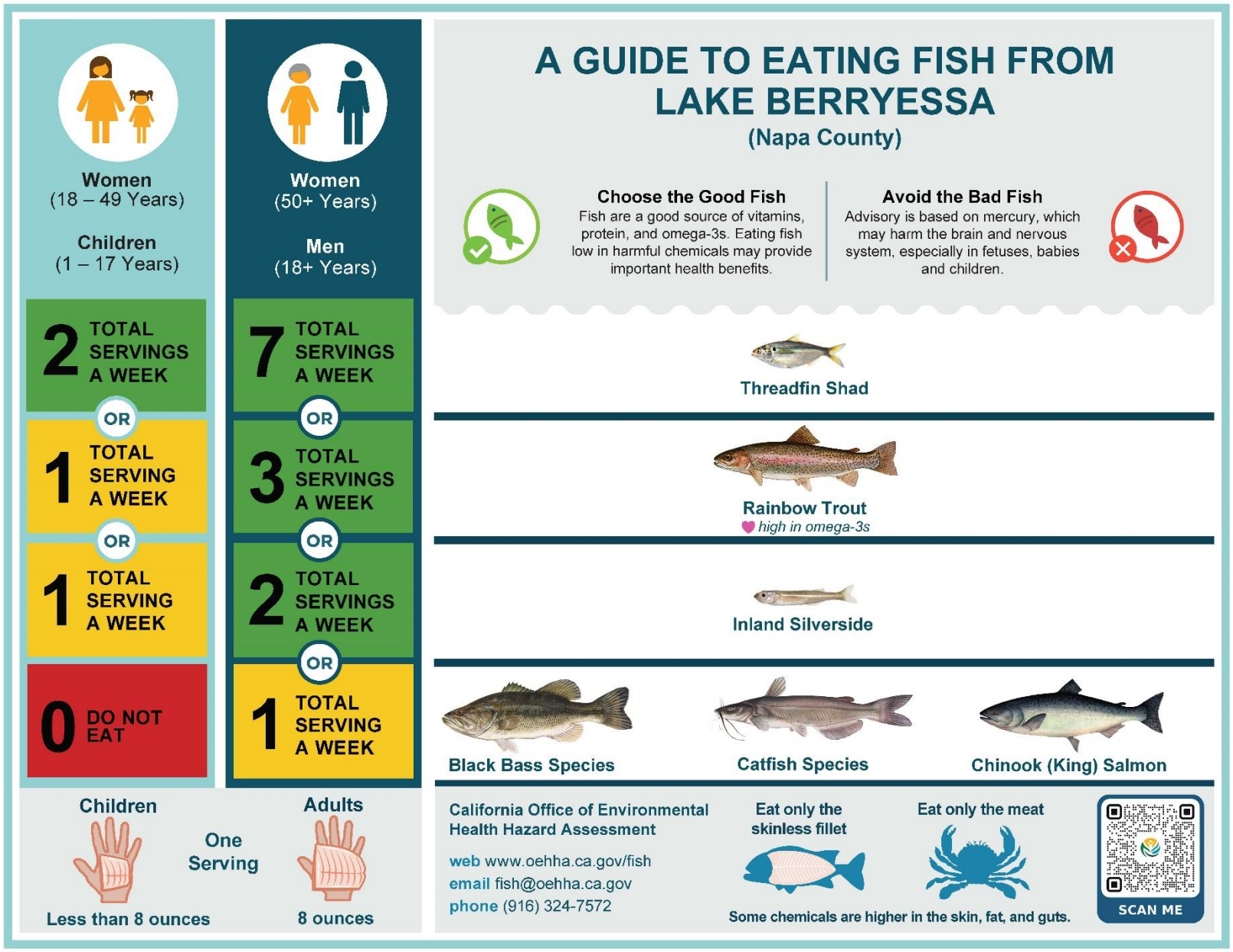

A GUIDE TO EATING FISH FROM LAKE BERRYESSA
(Napa County)
Women (18 – 49 Years)
Children (1 – 17 Years)
Women (50+ Years)
Men (18+ Years)
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
7 TOTAL SERVINGS A WEEK
OR
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
Choose the Good Fish
Fish are a good source of vitamins, protein, and omega-3s. Eating fish low in harmful chemicals may provide important health benefits.
Avoid the Bad Fish
Advisory is based on mercury, which may harm the brain and nervous system, especially in fetuses, babies and children.
Threadfin Shad
Rainbow Trout
high in omega-3s
Inland Silverside
Black Bass Species
Catfish Species
Chinook (King) Salmon
Children
One Serving
Adults
Less than 8 ounces
8 ounces
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
Eat only the meat
Some chemicals are higher in the skin, fat, and guts.
SCAN ME

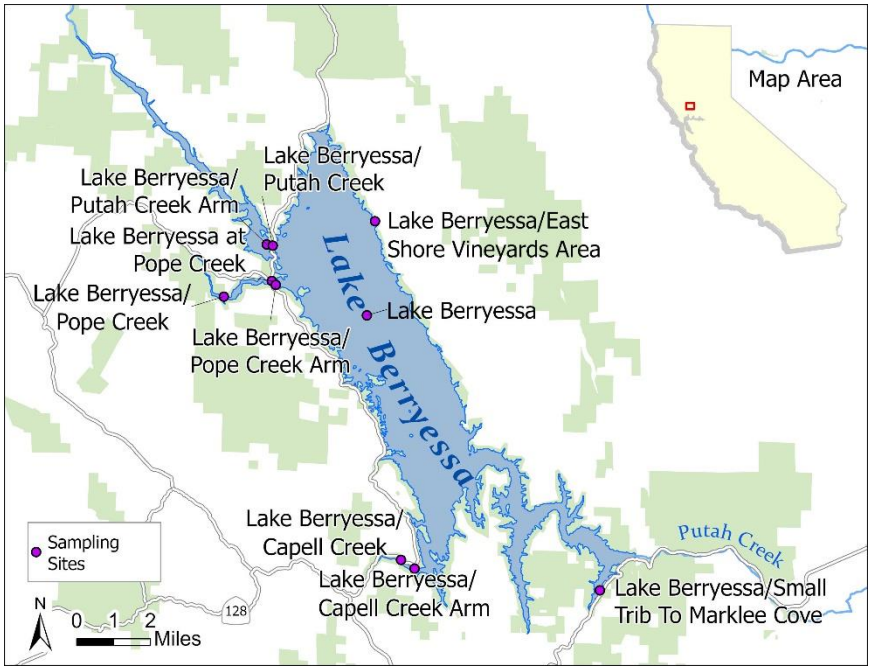
INTRODUCTION

This report updates and supersedes the previous guidelines developed by the Office of Environmental Health Hazard Assessment (OEHHA, 2006 and 2009) for eating fish from Lake Berryessa and Putah Creek including Lake Solano. This report pertains only to Lake Berryessa (Figure 1). Advice for Lower Putah Creek and Lake Solano is published separately (OEHHA, 2024). The collection of additional data made it possible to update this advisory with the inclusion of Inland Silverside and Threadfin Shad. Consumption advice for eating black bass species, catfish species, Chinook (King) Salmon, Inland Silverside, Rainbow Trout, and Threadfin Shad is based on levels of mercury (Hg) found in fish collected from Lake Berryessa.

LOCATION

Lake Berryessa is located about 28 miles northeast of Santa Rosa, CA. The lake was formed in 1957 by the creation of Monticello Dam on Putah Creek. At 23 miles in length and offering 165 miles of shoreline, Lake Berryessa is one of the largest freshwater bodies in the state. The US Bureau of Reclamation owns Lake Berryessa and operates it under a cooperative agreement with the Solano County Water Agency/Solano Irrigation District.[3]

FIGURE 1. LOCATION OF LAKE BERRYESSA



[3] Information regarding Lake Berryessa was obtained from the US Bureau of Reclamation. Online at: https://www.usbr.gov/projects/index.php?id=186 and https://www.usbr.gov/mp/ccao/berryessa/.

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from six monitoring studies described in this report to develop the Lake Berryessa 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)[4] and other descriptive statistics of the contaminant data, as appropriate, for a chemical of concern for the selected fish species.
4) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of 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 CONCERN

Certain chemicals, because of their toxicity and their ability to accumulate in fish tissue, are of concern for people who eat fish. 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 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 (MeHg) – which can pass into and build up in fish. High levels

[4] 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.

of 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 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 is 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 Lake Berryessa and used in advisory development were analyzed for mercury. Largemouth Bass were additionally analyzed for PCBs, PBDEs, selenium, and legacy pesticides, as indicated in Table 1.

DATA SOURCES

The guidelines for eating fish from Lake Berryessa are based on the chemicals detected in the fish collected for the six monitoring studies described below (see Table 1 for data collected since the original advisory). 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.

CALFED Bay-Delta Program (CALFED)

The CALFED Bay-Delta Program was a state and federal interagency group, established in 1994, to develop strategies and provide funding for projects that improve water quality, increase water supply, and support ecosystem restoration and levee improvement in the San Francisco Bay-Delta (CALFED, 2005; Davis et al., 2004). This program was composed of more than 20 state and federal agencies including the California Environmental Protection Agency, the California Department of Fish and Wildlife (then known as the California Department of Fish and Game), US Environmental Protection Agency, and the US Fish and Wildlife Service. CALFED funded Surface Water Ambient Monitoring Program (SWAMP) sampling efforts for historical bioaccumulation studies in fish. Largemouth Bass and White Catfish were collected from Lake Berryessa in 1999 and analyzed for mercury.

Contaminants in Fish from California Lakes and Reservoirs, 2007 – 2008 (SWAMP)

The SWAMP, operated by the State Water Resources Control Board (SWRCB) in cooperation with the Central Valley Regional Water Quality Control Board (RWB5), monitors water quality in California's surface waters. This SWAMP survey of inland water bodies 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 Largemouth Bass from Lake Berryessa in 2007, which were analyzed for chlordanes, DDTs, dieldrin, mercury, PBDEs, PCBs, and selenium.

Survey of Mercury Exposure and Risk in Wildlife in California Lakes and Reservoirs, 2012 (SWAMP)

SWAMP conducted a bird, prey fish, and sport fish sampling survey at lakes and reservoirs throughout California in 2012 and 2013. These data supported the development of a tool that estimates mercury exposure and risk to sport fish and piscivorous wildlife using mercury concentrations in prey fish at a water body (Ackerman et al., 2015). This program sampled Inland Silverside and Largemouth Bass from Lake Berryessa in 2012, which were analyzed for mercury.

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., 2019). In 2015, the program collected Largemouth Bass and Threadfin Shad from Lake Berryessa, which were analyzed for mercury.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP operated from 1976 to 2003 as a state water quality-monitoring program managed by the SWRCB (SWRCB, 2007 and 2013). Its objective was to provide statewide information on the occurrence of toxic substances by monitoring water bodies with known or suspected water quality impairment. CDFW staff collected Channel Catfish and Largemouth Bass from Lake Berryessa in 1985, which were analyzed for mercury.

METHYL MERCURY IN NORTHERN CALIFORNIA MOUNTAIN LAKES, 1982 – 1984 (CDFG[5]-CLEAR LAKE)

The CDFW, in collaboration with the California Department of Health Services, sampled fish in the 1980s from Lake Berryessa, along with Clear Lake and Lake Herman, to learn about methylmercury contamination and to develop initial fish consumption advice for those water bodies (Stratton et al., 1987). Between 1982-1984, the program collected and analyzed mercury in Channel Catfish, Chinook (King) Salmon, Largemouth Bass, Rainbow Trout, Smallmouth Bass, Threadfin Shad, and White Catfish.

CHANGES FROM THE 2009 ADVISORY

This update includes the following changes and additions to the 2009 Lake Berryessa advisory:

1) Consumption advice for Inland Silverside and Threadfin Shad were added to the advisory based on data from samples collected by SWAMP in 2012 and 2015, respectively.
2) Age ranges for women in the sensitive and general populations changed to 18–49 years and 50+ years, respectively, to reflect current fish advisory practices.[6]

FISH SAMPLED FROM LAKE BERRYESSA

The fish sampling data used in this advisory were retrieved from the California Environmental Data Exchange Network (CEDEN),[7] the state's repository for environmental data. Samples were excluded when the fish were not legal size to take or

[5] California Department of Fish and Game (CDFG), now called California Department of Fish and Wildlife (CDFW)
[6] In 2018, OEHHA updated the age ranges for women in each population group. The sensitive population changed from women ages 18–45 years to 18–49 years, and the general population from women 46 years and older to 50 years and older.
[7] Online at: http://ceden.waterboards.ca.gov/AdvancedQueryTool.

did not meet OEHHA's criteria for minimum "edible" size, based on species size at maturity and professional judgment (as described in OEHHA, 2022). 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 LAKE BERRYESSA ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected[d]	Contaminants Analyzed
Channel Catfish	*Ictalurus punctatus*	106	106	CDFG-Clear Lake[a]	1982–1983	Hg
		13	13	TSMP[a]	1985	Hg
Chinook (King) Salmon	*Oncorhynchus tshawytscha*	11	11	CDFG-Clear Lake[a]	1983–1984	Hg
Largemouth Bass	*Micropterus salmoides*	5	5	CALFED[b]	1999	Hg
		26	26	CDFG-Clear Lake[a]	1982–1983	Hg
		1	20	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs, Se
		29	29	SWAMP	2007	Hg
		10	10	SWAMP	2012	Hg
		20	20	SWAMP	2015	Hg
		1	1	TSMP[a]	1985	Hg
Rainbow Trout	*Oncorhynchus mykiss*	29	29	CDFG-Clear Lake[a]	1982–1983	Hg
Inland Silverside	*Menidia beryllina*	10	10	SWAMP[c]	2012	Hg
Smallmouth Bass	*Micropterus dolomieu*	1	1	CDFG-Clear Lake[a]	1982	Hg
Threadfin Shad	*Dorosoma petenense*	1	10	SWAMP[c]	2015	Hg
		2	10	CDFG-Clear Lake[a]	1982	Hg
White Catfish	*Ameiurus catus*	21	21	CDFG-Clear Lake[a]	1983	Hg
		1	1	CALFED	1999	Hg

Samples were analyzed as skinless fillets, with the following exceptions:
[a]Study report did not specify whether skin was removed from fillets prior to tissue analysis.
[b]Samples were analyzed as skin-on fillets.
[c]Samples were analyzed as whole organisms, including head, skin, internal organs, muscle, and bones.
[d]Data for inorganic chemicals (e.g., Hg) that were generated prior to 2000 were evaluated to determine if they should be included in the analysis.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes (5 congeners), DDTs (6 congeners), dieldrin, PBDEs (7 congeners), and PCBs (54 congeners).[8] Among the chemicals analyzed in fish tissue samples from Lake Berryessa, only mercury levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets, except as noted in the Table 1 footnotes. Samples were analyzed as individual fish or composites.

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 (MPSL) at Moss Landing Marine Laboratories. Some studies used other laboratories for analyses. 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,[9] as well as mercury concentrations in each fish species. The DMA method detection limits (MDLs)[10] for total mercury were reported at 4 or 12 parts per billion (ppb), depending on the study. The reporting limits (RLs)[11] were 12 or 36 ppb, depending on the study. Although the MDL and RL were not reported in the CALFED, CDFG-Clear Lake, or TSMP studies, mercury was detected at concentrations consistent with other studies. For this reason, these data were included in the calculation of sample means.

PCBS, PBDES, AND PESTICIDES

Pesticides, PBDEs, and PCBs in either individual fish or composite samples were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. Where applicable, the concentrations presented were the sum of the detected analytes

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[8] 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.

[9] 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.

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

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

(parent compound, congeners, or metabolites) for chlordanes, DDTs, PCBs, and PBDEs. Because 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).

SELENIUM

The MPSL analyzed Largemouth Bass collected from Lake Berryessa for selenium as a composite sample, 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. The MDL and the RL for total selenium were reported at 150 and 400 ppb, respectively, depending on the study.

Concentrations of chlordanes, dieldrin, DDTs, PBDEs, PCBs, 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 not considered further for developing consumption advice and are not shown in this report.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM LAKE BERRYESSA

Species from Lake Berryessa	Number of Samples[a]	Total Number of Fish	Mean[b] Total Length (mm)	Range of Total Lengths[c] (mm)	Mercury (ppb)	
					Mean[b]	Range[c]
Black Bass Species	92	92	371	305 – 620	744	100 – 1,970
Largemouth Bass	91	91	371	305 – 620	742	100 – 1,970
Smallmouth Bass	1	1	357	n/a	930	n/a
Catfish Species	141	141	291	202 – 536	558	110 – 1,900
Channel Catfish	119	119	300	215 – 536	518	110 – 1,900
White Catfish	22	22	244	202 – 520	777	510 – 1,020
Chinook (King) Salmon	11	11	489	357 – 536	483	200 – 700
Inland Silverside	10	10	74	66 – 86	342	182 – 542
Rainbow Trout	29	29	342	280 – 418	172	110 – 260
Threadfin Shad (1982)	2	10	NR	NR	40	40 – 40
Threadfin Shad (2015)	1	10	86	70 – 99	76	n/a

[a]Samples were prepared multiple ways (i.e.,skin-on, skinless fillets, whole) as noted in the footnotes to Table 1.
[b]Means are an arithmetic average of individual values and/or a weighted average of composites.
[c]Range of individuals and/or range of the composites.
n/a = not applicable due to a single sample
NR = Not Reported

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM LAKE BERRYESSA

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).

As part of a healthy US-style dietary pattern at the 2,000-calorie level, the "Dietary Guidelines for Americans, 2020 – 2025" (USDA/USDHHS, 2020) recommends consuming eight ounces of seafood[12] per week. Young children are advised to eat proportionately smaller amounts. "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 [US Food and Drug Administration] and EPA's [US Environmental Protection Agency] advice,[13] 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" and avoid certain species (USDA/USDHHS, 2020). The species of 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 FDA and the 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.

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[12] Seafood as used here refers to fish and shellfish from freshwater and marine environments.
[13] Online at: https://www.fda.gov/food/consumers/advice-about-eating-fish.

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 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, DDTs, and PCBs) was assessed in Largemouth Bass and did not affect advice. Advice for all species in this advisory was based solely on mercury concentrations.

OEHHA recommends that individuals strive to meet the US dietary guidelines' seafood consumption recommendations,[14] 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 listed fish species. People should eat no more than the recommended number of servings for each fish species or species group. When noted,

[14] Online at: https://www.dietaryguidelines.gov/.

OEHHA's consumption advice for a particular fish species can be extended to other closely related fish species[15] 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.

CONSUMPTION ADVICE FOR FISH FROM LAKE BERRYESSA

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 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. For Lake Berryessa, the sample size criterion was met for the following species: black bass species, catfish species, Chinook (King) Salmon, Inland Silverside, Rainbow Trout, and Threadfin Shad. For fish species found in Lake Berryessa that are not included in this advisory, OEHHA recommends following the statewide advisory for lakes and reservoirs without site-specific advice.[16]

Mercury data collected pre- and post- 2000 for Largemouth Bass and Threadfin Shad were evaluated to determine if there was any significant change in mercury concentration between time periods. Advice for Threadfin Shad was based solely on samples collected in 2015, as shown in Table 2, because it resulted in one fewer serving per week for the sensitive population and was therefore more health protective. These samples were analyzed whole, which is a more typical preparation method for this species due to their small size, versus the 1982 samples that were analyzed as fillets. Mercury concentrations in Largemouth Bass samples collected pre- and post-2000 did not change significantly over time, and advice remained unchanged.

OEHHA elected to offer advice for catfish species, Chinook (King) Salmon, and Rainbow Trout based on pre-2000 data because mean mercury concentrations in the aforementioned species are higher than statewide mean concentrations and mean mercury concentrations are not expected to change significantly over time.

The following advice is based solely on mercury concentrations. The sensitive population is defined as women ages 18 to 49 years and children ages 1 to 17 years,

[15] Fish species within the same genus are most closely related, and family is the next level of relationship.
[16] Online at: https://oehha.ca.gov/advisories/statewide-advisory-eating-fish-californias-lakes-and-reservoirs-without-site-specific.

and the general population is defined as women 50 years and older and men 18 years and older.

Black Bass Species (Based on Largemouth Bass, Smallmouth 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 and likely comparable chemical uptake (Long and Fisher, 2000). They are 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 and Smallmouth Bass to other black bass species, including Redeye and Spotted Bass.

Mercury concentrations for individual bass species were 742 ppb for Largemouth Bass and 930 ppb for Smallmouth Bass. Based on the mean mercury concentration of 744 ppb, OEHHA recommends no consumption of black bass species from Lake Berryessa for the sensitive population, and a maximum of one serving a week for the general population.

Catfish Species (Based on Channel Catfish, White Catfish)

Mercury concentrations for individual catfish species were 518 ppb for Channel Catfish and 777 ppb for White Catfish. Based on the mean mercury concentration of 558 ppb, OEHHA recommends no consumption of catfish species from Lake Berryessa for the sensitive population, and a maximum of one serving a week for the general population.

Chinook (King) Salmon

The mean mercury concentration in Chinook (King) Salmon from Lake Berryessa was 483 ppb. OEHHA recommends no consumption of Chinook (King) Salmon for the sensitive population, and a maximum of one serving a week for the general population.

Inland Silverside

The mean mercury concentration in Inland Silverside from Lake Berryessa was 342 ppb. OEHHA recommends a maximum of one serving a week of Inland Silverside for the sensitive population, and a maximum of two servings a week for the general population.

Rainbow Trout

The mean mercury concentration in Rainbow Trout from Lake Berryessa was 172 ppb. OEHHA recommends a maximum of one serving a week of Rainbow Trout for the

sensitive population, and a maximum of three servings a week for the general population.

Threadfin Shad

The mercury concentration in Threadfin Shad collected in 2015 from Lake Berryessa was 76 ppb. Based on these more recent data, OEHHA recommends a maximum of two servings a week of Threadfin Shad for the sensitive population, and a maximum of seven servings a week for the general population.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

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

TABLE 3. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM LAKE BERRYESSA

Fish Species	Women 18–49 years and Children 1–17 years		Women 50 years and older and Men 18 years and older	
	Number of Servings	Risk Driver	Number of Servings	Risk Driver
Black Bass Species	0	Hg	1	Hg
Catfish Species	0	Hg	1	Hg
Chinook (King) Salmon	0	Hg	1	Hg
Inland Silverside	1	Hg	2	Hg
Rainbow Trout	1	Hg	3	Hg
Threadfin Shad	2	Hg	7	Hg

Hg, mercury

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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[17] 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)[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[b] (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

[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.
[b]All mercury detected is assumed to be methylmercury, which is the most common form found in fish and is also the more toxic form (Bloom, 1992).

[17] 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.