OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from Lake Natoma (Sacramento County)

September 2021

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

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CalEPA	California Environmental Protection Agency
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
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
UCD	University of California at Davis
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

PREFACE

The Office of Environmental Health Hazard Assessment (OEHHA), a department in the California Environmental Protection Agency (CalEPA), 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 Lake Natoma in Sacramento 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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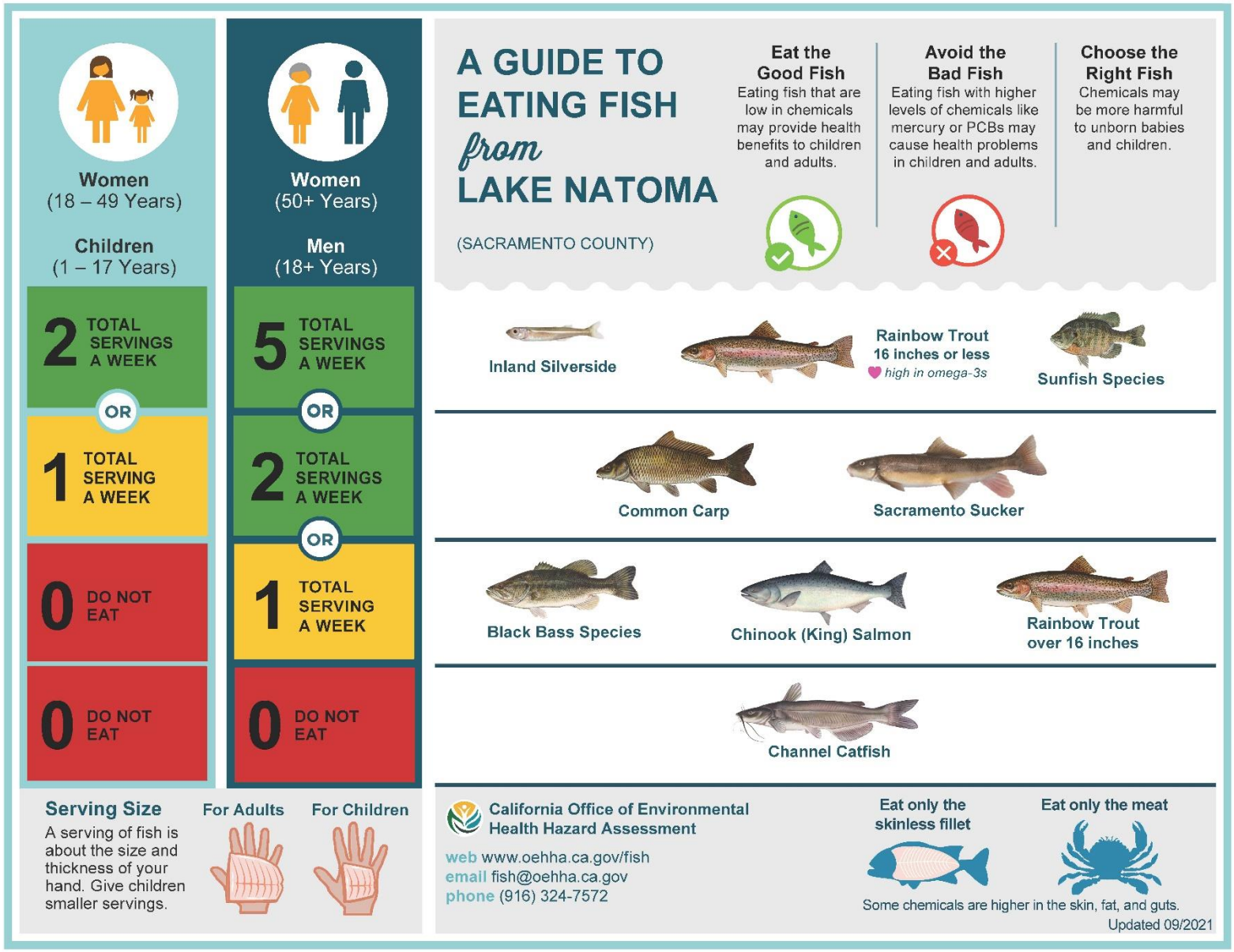

Women
(18 – 49 Years)
Children
(1 – 17 Years)
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
0 DO NOT EAT
Women
(50+ Years)
Men
(18+ Years)
5 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
A GUIDE TO EATING FISH from LAKE NATOMA
(SACRAMENTO COUNTY)
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.
Inland Silverside
Rainbow Trout 16 inches or less
high in omega-3s
Sunfish Species
Common Carp
Sacramento Sucker
Black Bass Species
Chinook (King) Salmon
Rainbow Trout over 16 inches
Channel Catfish
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
Eat only the meat
Some chemicals are higher in the skin, fat, and guts.
Updated 09/2021

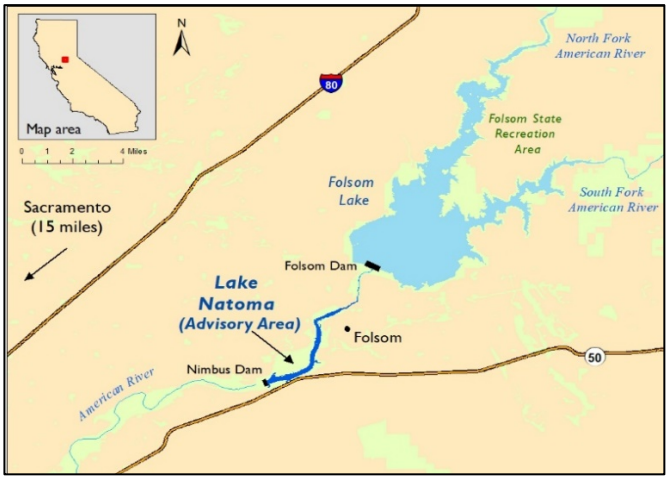
INTRODUCTION

This report updates and supersedes the previous guidelines (2008) for eating fish from Lake Natoma (Figure 1). The collection of additional data made it possible to update this advisory with the inclusion of Common Carp, Inland Silverside, and Sacramento Sucker. Guidelines for all species in this advisory, except for Chinook (King) Salmon and Rainbow Trout, are based on mercury levels in fish caught only from Lake Natoma and not on the combination of data generated for both Folsom Lake and its afterbay, Lake Natoma, as was done in the previous advisory. There were not sufficient data from Lake Natoma to develop advice for Chinook Salmon and Rainbow Trout; however, both species can enter the lake directly from Folsom Lake (S. Perrin, US Bureau of Reclamation, personal communication, May 5, 2021). For this reason, advice for Chinook Salmon at Folsom Lake is extended to Lake Natoma and Rainbow Trout samples collected from Folsom Lake were combined with the single sample collected from Lake Natoma to develop advice for this species.

LOCATION

Lake Natoma is located about 15 miles northeast of Sacramento, CA, and forms the 540 surface-acre afterbay for Folsom Lake as part of the Central Valley Project on the American River. The lake receives release waters from Folsom Lake and is enclosed by two concrete dams constructed in 1955, with Folsom Dam to the northeast and Nimbus Dam to the southwest. The California Department of Parks and Recreation manages Lake Natoma in cooperation with the US Bureau of Reclamation, which manages Folsom Lake, Folsom Dam, and Nimbus Dam.[1]

FIGURE 1. LOCATION OF LAKE NATOMA



[1] Information regarding Lake Natoma was obtained from the California Department of Parks and Recreation and the US Bureau of Reclamation. Online at: https://www.recreation.gov/camping/gateways/2280 and https://www.usbr.gov/projects/index.php?id=222.

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from four monitoring studies described in this report to develop the Lake Natoma 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 an 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 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.

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 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.

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.

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 Lake Natoma and Folsom Lake (Chinook Salmon and Rainbow Trout only) and used in advisory development were analyzed for mercury (as a measure of methylmercury). Common Carp were analyzed for PBDEs and the legacy pesticides chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane), dieldrin, DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]), and Bluegill, Common Carp, Green Sunfish, Inland Silverside, Largemouth Bass, and Sacramento Sucker were also analyzed for selenium. Common Carp and Sacramento Sucker were also analyzed for PCBs. 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 Lake Natoma are based on the chemicals detected in the fish collected for the four monitoring studies described below. These studies met OEHHA's data quality criteria, including adequate documentation of sample collection, fish preparation 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 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 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 Common Carp from Lake Natoma in 2007, which were analyzed for chlordanes, DDTs, dieldrin, mercury, PBDEs, PCBs, and selenium, as part of a SWAMP statewide sampling effort to survey contaminants in sport fish found in California lakes and reservoirs (SWRCB, 2010). Additionally, Largemouth Bass were collected in 2007 and 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 status and trends related to contamination in sport fish from California lakes and reservoirs where bass species reside (Davis et al. 2019). In 2017, the program collected Bluegill, Green Sunfish, Inland Silverside, Largemouth Bass, and Sacramento Sucker from Lake Natoma, which were analyzed for mercury and selenium. Additionally, Sacramento Sucker were analyzed for PCBs.

US BUREAU OF RECLAMATION, 2004 – 2007 (USBR)

The USBR, in cooperation with the US Geological Survey Columbia Environmental Research Center (USGS-CERC) and the California Department of Fish and Game (CDFG; now known as the California Department of Fish and Wildlife), collected Chinook Salmon (2004, 2007) and Rainbow Trout (2004, 2006, 2007) from Folsom Lake, which were analyzed for mercury. This effort was part of a larger program to assess mercury concentrations in fish and other biota collected from northern California water bodies impacted by historical mining practices or other sources of mercury (May

and Brumbaugh, 2006 and 2007a-b). The salmonid advice developed for Folsom Lake and extended to Lake Natoma is also discussed in OEHHA's "Health Advisory and Guidelines for Eating Fish from Folsom Lake" (OEHHA, 2021a).

US GEOLOGICAL SURVEY, 2000 – 2003 (USGS)

Researchers from USGS and the University of California – Davis (UCD) collected a total of 7 fish species from Lake Natoma from 2000 – 2003, which were analyzed for mercury (Alpers et al., 2005; Saiki et al., 2004). Species collected included Bluegill, Channel Catfish, Green Sunfish, Largemouth Bass, Rainbow Trout, Redear Sunfish, and Spotted Bass. This study was part of an expanded effort to assess the impacts of historical mercury mining practices on mercury bioaccumulation in fish of the lower American River Watershed (Saiki et al., 2004).

FISH SAMPLED FROM LAKE NATOMA

The fish sampling data used in this advisory were retrieved from published USGS reports and supporting data files, and 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 LAKE NATOMA ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[b]
Bluegill	*Lepomis macrochirus*	78	78	USGS	2002	Hg
		1	10	SWAMP	2017	Hg, Se
Channel Catfish	*Ictalurus punctatus*	11	11	USGS	2000, 2003	Hg
Chinook Salmon	*Oncorhynchus tshawytscha*	11	11	USBR	2004, 2007	Hg
Common Carp	*Cyprinus carpio*	2	10	SWAMP	2007	Hg
		1	5	SWAMP	2007	Chlordanes, DDTs, dieldrin, PBDEs, PCBs, Se
Green Sunfish	*Lepomis cyanellus*	3	3	USGS	2002	Hg
		2	10	SWAMP	2017	Hg, Se
Inland Silverside[a]	*Menidia beryllina*	1	10	SWAMP	2017	Hg, Se
Largemouth Bass	*Micropterus salmoides*	23	23	USGS	2000, 2002	Hg
		7	7	SWAMP	2007	Hg
		6	6	SWAMP	2017	Hg
		1	4	SWAMP	2017	Se
Rainbow Trout	*Oncorhynchus mykiss*	20	20	USBR	2004, 2006, 2007	Hg
		1	1	USGS	2002	Hg
Redear Sunfish	*Lepomis microlophus*	10	10	USGS	2002	Hg
Sacramento Sucker	*Catostomus occidentalis*	2	10	SWAMP	2017	Hg, Se
		1	10	SWAMP	2017	PCBs
Spotted Bass	*Micropterus punctulatus*	1	1	USGS	2002	Hg

Samples were analyzed as skinless fillets, with the following exceptions:
[a]Inland Silverside were analyzed as whole organisms.
[b]Organic data (chlordanes, DDTs, dieldrin, PBDEs, PCBs, or toxaphene) generated prior to 2000 were excluded from the analysis because data that are more recent are considered more reliable due to improved analytical methods and are likely to be more representative of fish caught today.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, PBDEs (7 congeners), and PCBs (52-59 congeners)[3]. Among the chemicals analyzed in fish tissue samples from Lake Natoma, only mercury levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets except for Inland Silverside, which were analyzed as whole bodies. 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) and the US Geological Survey Columbia Environmental Research Center, or using cold vapor atomic absorption (CVAA) spectrophotometry at the University of California at Davis (Saiki et al., 2004). The DMA method utilizes thermal decomposition and atomic absorption. The CVAA method determines the concentration of mercury by measuring the amount of radiation it absorbs. 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[4], as well as mercury concentrations in each fish species. The DMA method detection limit (MDL)[5] and the reporting limit (RL)[6] for total mercury were reported at 3, 4, 9, or 12 and 9, 12, or 17 parts per billion (ppb), respectively, depending on the study. Although mercury was detected at commonly found concentrations in the USGS samples analyzed at UCD, the MDL and RL for mercury were not reported.

PCBS, PBDES, AND PESTICIDES

Pesticides, PBDEs and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, PCBs, and PBDEs, each of the concentrations presented was the sum of the detected parent compound, congeners, or metabolites, where applicable. 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

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[3] Congeners are related compounds with similar chemical forms. Of the 209 possible PBDE and PCB congeners, 6–7 and 48–54 are generally analyzed, respectively.
[4] 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.
[5] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[6] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

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 CDFW MLML analyzed species collected from Lake Natoma 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. The ICP-MS MDL and RL for total selenium were reported at 100 or 150 and 300 or 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 NATOMA

Species from Lake Natoma	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Black Bass Species	37	37	390	315 – 490	606	268 – 1024
Largemouth Bass	36	36	391	315 – 490	612	268 – 1024
Spotted Bass	1	1	335	n/a	407	n/a
Channel Catfish	11	11	635	505 – 750	1482	1049 – 1887
Chinook Salmon[b]	11	11	376	275 – 553	540	42 – 1000
Common Carp	2	10	574	520 – 595	253	249 – 256
Inland Silverside[a]	1	10	82	75 – 90	70	n/a
Rainbow Trout[b]	21	21	333	254 – 472	175	20 – 910
Rainbow Trout 16 inches or less	19	19	322	254 – 405	121	20 – 440
Rainbow Trout over 16 inches	2	2	440	408 – 472	685	460 – 910
Sacramento Sucker	2	10	493	419 – 551	262	248 – 275
Sunfish Species	94	111	127	100 – 187	104	28 – 388
Bluegill	79	88	124	100 – 174	91	41 – 185
Green Sunfish	5	13	135	105 – 176	192	98 – 248
Redear Sunfish	10	10	147	134 – 187	104	28 – 388

[a]Samples were prepared as skinless fillets, except for Inland Silverside (analyzed as whole bodies).
[b]Samples collected from Folsom Lake (one Rainbow Trout collected from Lake Natoma).
*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 LAKE NATOMA

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[7] 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 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.

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

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 mercury concentrations detected in the fillet to the corresponding ATLs to establish the maximum number of servings per week that could be consumed (see Appendix I). 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 is employed. This may result in advising fewer servings 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 Common Carp and Sacramento Sucker but PCB concentrations in these species did not affect advice. Advice for all species in this advisory was based solely on mercury concentrations without the need to apply the multiple-chemical method.

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[8] 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 NATOMA

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 Lake Natoma, the sample size criterion was met for the following species: black bass species, Channel Catfish, Common Carp, Inland Silverside, Sacramento Sucker, and sunfish species. There were not sufficient data to develop advice for Chinook Salmon and Rainbow Trout caught from Lake Natoma; however, because these species can enter Lake Natoma directly from Folsom Lake, advice for Chinook Salmon developed for Folsom Lake was extended to Lake Natoma and samples of Rainbow Trout collected from Folsom Lake were combined with the single sample collected from Lake Natoma to develop advice for this species.

There were not sufficient data to evaluate other species that may be found in this water body. For fish species found in Lake Natoma that are not included in this advisory, OEHHA recommends following the statewide advisory for lakes and reservoirs without site-specific advice.

The following advice is based solely on mercury 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, Spotted Bass)

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

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

or more of these species were caught from the same water body. Therefore, OEHHA extends the consumption advice for Largemouth Bass and Spotted Bass to other black bass species, including Redeye and Smallmouth Bass.

The mean mercury concentration in black bass species was 606 ppb. Mercury concentrations for individual black bass species were as follows: Largemouth Bass, 612 ppb and for the one Spotted Bass sampled, 407 ppb. OEHHA recommends no consumption of black bass species from Lake Natoma for the sensitive population, and a maximum of one serving a week for the general population.

CHANNEL CATFISH

The mean mercury concentration in Channel Catfish was 1482 ppb. OEHHA recommends no consumption of Channel Catfish for both the sensitive and general populations.

CHINOOK SALMON

No Chinook Salmon were available from Lake Natoma, while the mean mercury concentration in Chinook Salmon from Folsom Lake was 540 ppb. OEHHA recommends that advice developed for this species from Folsom Lake be extended to Chinook Salmon caught from Lake Natoma. OEHHA recommends no consumption of Chinook Salmon for the sensitive population, and a maximum of one serving a week for the general population.

COMMON CARP

The mean mercury concentration in Common Carp was 253 ppb. OEHHA recommends a maximum of one serving a week of Common Carp for the sensitive population, and a maximum of two servings a week for the general population.

INLAND SILVERSIDE

The mean mercury concentration in Inland Silverside was 70 ppb. At this concentration, OEHHA would typically recommend a maximum of three servings a week for the sensitive population and a maximum of seven servings a week for the general population. For risk communication purposes on the advisory poster (page 5), OEHHA elected to group this species with the two servings per week species for the sensitive population and the five servings per week species for the general population.

RAINBOW TROUT

The mean mercury concentration in Rainbow Trout from Folsom Lake (n = 20) and Lake Natoma (n = 1) was 175 ppb. The range of mercury concentrations in Rainbow Trout from both water bodies (20 – 910 ppb) spans consumption frequency categories from seven meals per week to “do not consume” for the sensitive population. The majority of

Rainbow Trout samples (90%) collected did not exceed the "do not consume" threshold for the sensitive population (440 ppb) and measured 16 inches (406 mm) or less. In contrast, the two Rainbow Trout measuring over 16 inches in length exceeded the 440 ppb threshold, including one 472 mm fish containing 910 ppb mercury – more than twice the threshold. Lake Natoma and Folsom Lake are locally identified as "trophy" lakes for large fish (i.e., greater than 16 inches), including Rainbow Trout[9] and, thus, larger fish are expected to be found and targeted for catch at these water bodies. Although the data for larger Rainbow Trout are sparse at these water bodies, fish, in general, are known to bioaccumulate mercury as they grow. For these reasons, OEHHA elected to develop size-specific advice for Rainbow Trout at Lake Natoma and Folsom Lake. OEHHA has historically used 16 inches or less as the dividing line when developing size-based consumption advice.

Based on the combined data from Folsom Lake and Lake Natoma, OEHHA recommends a maximum of two servings a week of Rainbow Trout 16 inches or less for the sensitive population, and a maximum of five servings a week for the general population, based on a mean mercury concentration of 121 ppb. For Rainbow Trout measuring more than 16 inches, OEHHA recommends no consumption for the sensitive population and a maximum of one serving a week for the general population, based on a mean mercury concentration of 685 ppb.

SACRAMENTO SUCKER

The mean mercury concentration in Sacramento Sucker was 262 ppb. OEHHA recommends a maximum of one serving a week of Sacramento Sucker for the sensitive population, and a maximum of two servings a week for the general population.

SUNFISH SPECIES (BLUEGILL, GREEN SUNFISH, REDEAR SUNFISH)

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. Therefore, OEHHA extends the consumption advice for Bluegill, Green Sunfish, and Redear Sunfish to other sunfish species, including Pumpkinseed.

The mean mercury concentration in sunfish species from Lake Natoma was 104 ppb. Mercury concentrations for individual sunfish species were as follows: Bluegill, 91 ppb; Green Sunfish, 192 ppb; and Redear Sunfish, 104 ppb. Based on the weighted average concentration of mercury in these sunfish species, OEHHA recommends a maximum of two servings a week of sunfish species from Lake Natoma for the sensitive population. At this concentration, OEHHA would typically recommend a maximum of six servings a week for the general population. For risk communication purposes on the

[9] Information about Lake Natoma and Folsom Lake Fishing online at: http://www.californiasgreatestlakes.com/folsom/folsom_fishing.html

advisory poster (page 5), OEHHA elected to group this species with the five servings per week species for the general population.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

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

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

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
Channel Catfish	0	0
Chinook Salmon	0	1
Common Carp	1	2
Inland Silverside	2	5
Rainbow Trout 16 inches or less	2	5
Rainbow Trout over 16 inches	0	1
Sacramento Sucker	1	2
Sunfish Species	2	5

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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[10] 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 are followed, exposure to chemicals in fish 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 ≥ 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	≤ 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.

[10] 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.