



Health Advisory and Guidelines for Eating Fish from French Meadows and Hell Hole Reservoirs (Placer County)

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyl dichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
FDA	Food and Drug Administration
Hg	mercury
MDL	method detection limit
mm	millimeters
N	sample size
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PCWA	Placer County Water Agency
ppb	parts per billion
RL	reporting limit
RWB-2	Regional Water Quality Control Board, San Francisco Bay Region
SWAMP	Surface Water Ambient Monitoring Program
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
US EPA	United States Environmental Protection Agency

PREFACE

The Office of Environmental Health Hazard Assessment (OEHHA), a department in the California Environmental Protection Agency, is responsible for evaluating potential public health risks from chemical contamination of sport fish. This task includes issuing fish consumption advisories, when appropriate, for the State of California. OEHHA's authorities to conduct these activities are based on mandates in the:

- California Health and Safety Code
 - Section 59009, to protect public health
 - Section 59011, to advise local health authorities
- California Water Code
 - Section 13177.5, to issue health advisories

The health advisories are published in the California Department of Fish and Wildlife Sport Fishing Regulations in the section on public health advisories.

This report presents guidelines for eating fish from French Meadows and Hell Hole Reservoirs in Placer County. The report provides background information and a description of how the guidelines were developed. The resulting advice is summarized in the illustration after the Table of Contents and List of Figures and Tables.

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A Guide to Eating Fish from French Meadows Reservoir

Women 18 - 45 years and Children 1 - 17 years



Rainbow Trout ♥



Crayfish



Brown Trout ♥

3 servings a week

OR

2 servings a week

OR

1 serving a week

Women 46 years and older and Men 18 years and older



Rainbow Trout ♥



Crayfish



Brown Trout ♥

No fish in this group

7 servings a week

OR

3 servings a week

1 serving a week

What is a serving?



For Adults For Children

A serving is 8 ounces prior to cooking (the size and thickness of your hand for fish fillets). Give children smaller servings.

♥ Why eat fish?

Eating fish is good for your health. Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

♥ = Fish high in Omega-3s








What is the concern?

Some fish have high levels of mercury and PCBs. Mercury can harm the brain, especially in unborn babies and children. PCBs can cause cancer.

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A Guide to Eating Fish from Hell Hole Reservoir

Women 18 - 45 years and Children 1 - 17 years

No fish in this group	 <p>Brown Trout 16 inches or less </p>  <p>Crayfish</p>  <p>Kokanee Salmon </p>	 <p>Brown Trout over 16 inches</p>  <p>Lake Trout</p>
2 servings a week	OR 1 serving a week	Do not eat

Women 46 years and older and Men 18 years and older

 <p>Brown Trout 16 inches or less </p>  <p>Crayfish</p>  <p>Kokanee Salmon </p>	 <p>Lake Trout </p>	 <p>Brown Trout over 16 inches</p>
3 servings a week or 2 servings a week of crayfish	OR 1 serving a week	Do not eat

What is a serving?



For Adults For Children

A serving is 8 ounces prior to cooking (the size and thickness of your hand for fish fillets). Give children smaller servings.

Why eat fish?

Eating fish is good for your health. Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

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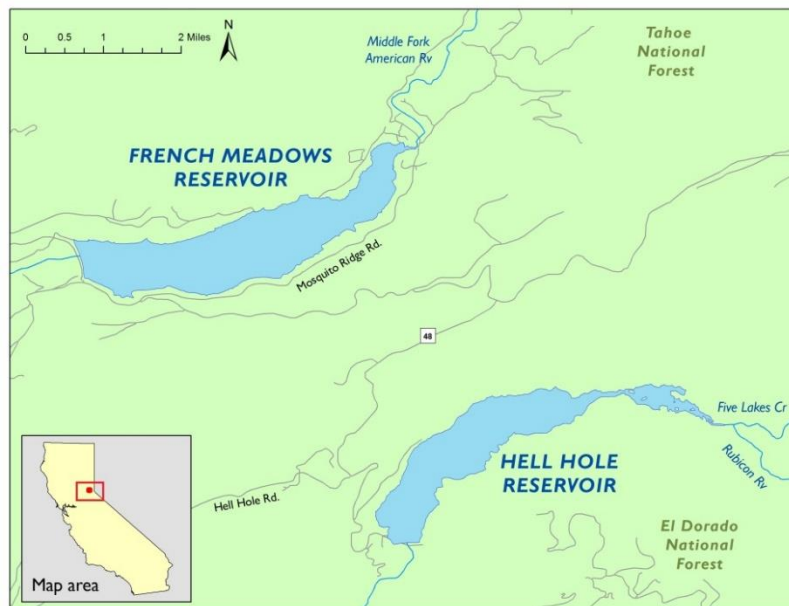
INTRODUCTION

This report presents guidelines for eating fish from French Meadows and Hell Hole Reservoirs (Figure 1) in Placer County, California, northeast of Auburn and Foresthill.

LOCATION

Managed by Placer County Water Agency, these reservoirs are artificial lakes on the Middle Fork of the American River. French Meadows Reservoir is 60 miles northeast of Auburn at an elevation of 5,200 feet in the lower Sierra Nevada. The reservoir was created in 1964 with the completion of the LL Anderson Dam, has a surface area of about 1,900 acres, and extends for approximately 3.5 miles. Hell Hole Reservoir is 70 miles northeast of Auburn and 10 miles southeast of French Meadows. The Lower Hell Hole Dam, originally built in 1964, created Hell Hole Reservoir on the Rubicon River, a major tributary of the Middle Fork American River. Hell Hole Reservoir is situated in the Sierra Nevada at an elevation of 4,700 feet and has a surface area of about 1,250 acres. The Rubicon River and Five Lakes Creek flow into Hell Hole, whereas the upper Middle Fork of the American River is the primary inflow source for French Meadows. These reservoirs are connected via an underground tunnel and serve as major generators of hydroelectric power as they flow downstream into the greater Middle Fork American River Watershed.¹ This advisory only applies to French Meadows and Hell Hole Reservoirs and not adjacent water bodies.

FIGURE 1. LOCATION OF FRENCH MEADOWS AND HELL HOLE RESERVOIRS IN CALIFORNIA



¹ Information regarding Hell Hole and French Meadows reservoirs obtained from various Placer County Water Agency (PCWA) web pages. Online at <http://www.pcwa.net>.
French Meadows and Hell Hole Reservoirs Fish Advisory

APPROACH USED

OEHHA used the results from two monitoring projects described in this report to develop the fish advisory for French Meadows and Hell Hole Reservoirs. 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) 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 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 and 2011). 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 benefits and risks of consuming sport fish.

CHEMICALS OF POTENTIAL CONCERN

Certain chemicals are considered to be of potential concern for people who eat fish because of their toxicity and their ability to accumulate in fish tissue. The majority of fish consumption advisories in California are issued because of mercury, followed by polychlorinated biphenyls (PCBs), and in a few cases, some legacy pesticides (pesticides that are no longer used but remain in the environment). Polybrominated diphenyl ethers (PBDEs) are an emerging chemical class of concern but, to date, have not been found at levels that impact consumption advice in sport fish caught from California waters.

Mercury is a natural element found in some rock and soil. Human activities, such as burning coal and the 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 methylmercury can harm the brain, especially in fetuses and children as they grow. PCBs are man-made 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

French Meadows and Hell Hole Reservoirs Fish
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accumulate in fish. Depending on the exposure level, PCBs may cause cancer and other health effects in humans, including neurotoxicity. Chlordanes, DDT, and dieldrin are pesticides that were banned from use in 1973 (DDT) and in the late 1980s (chlordanes and dieldrin) but have been found in some fish in certain water bodies in California. Depending on the exposure level, these chemicals may cause cancer or other adverse effects on the nervous system. PBDEs are a class of flame retardants historically used in a variety of products including furniture, textiles, automotive parts and electronics. The use of PBDEs in new products was largely phased out by 2013, but members of this chemical class are environmentally persistent and ubiquitous (OEHHA, 2011). 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” and “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)” (OEHHA, 2008 and 2011).

Fish samples from French Meadows and Hell Hole Reservoirs were analyzed for total mercury (as a measure of methylmercury) or methylmercury, PCBs, PBDEs, PCBs, and the pesticides chlordanes, dieldrin, and DDTs (DDT and its metabolites). Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study.

DATA SOURCES

The guidelines for eating fish from French Meadows and Hell Hole Reservoirs are based on chemical analysis of fish samples from the two monitoring studies described below. These studies met OEHHA’s data quality criteria, including adequate documentation of sample collection, fish preparation, chemical analyses, quality assurance, and low detection limits.

SWAMP LAKES AND RESERVOIRS SPORT FISH CONTAMINATION SURVEY

Staff and representatives from the Central Valley Regional Water Board (RWB-5) collected Brown (Hell Hole Reservoir) and Rainbow (French Meadows) Trout to analyze for mercury, PBDEs, PCBs, and the pesticides chlordanes, dieldrin and DDTs in 2007, as part of a SWAMP statewide sampling effort to survey contaminants in sport fish found in California lakes and reservoirs.

PLACER COUNTY WATER AGENCY (PCWA) MIDDLE FORK AMERICAN RIVER PROJECT

The PCWA manages French Meadows and Hell Hole Reservoirs, which serve as both major hydroelectric energy sources and popular recreational sites in Placer County. PCWA designed and conducted a fish tissue sampling study as part of their water quality management program to accomplish two objectives: 1) to determine methylmercury concentrations in sportfish caught in these reservoirs, and 2) generate adequate data to develop safe eating guidelines. PCWA staff collected Brown Trout, French Meadows and Hell Hole Reservoirs Fish
Advisory

Rainbow Trout and crayfish species from French Meadows Reservoir, and Brown and Lake Trout, Kokanee Salmon and crayfish species from Hell Hole Reservoir (PCWA, 2010). Fish and shellfish samples were analyzed for methylmercury.

FISH SAMPLED FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

The fish and shellfish sampled from French Meadows and Hell Hole Reservoirs are shown in Table 1, including the species, number of samples collected, total number of fish or shellfish, project name, year, and contaminants analyzed. The samples collected met OEHHA’s criteria for minimum “edible” size based on species size at maturity and professional judgment (OEHHA, 2005).

TABLE 1. FISH COLLECTED FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

Reservoir	Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year	Contaminants Analyzed
French Meadows	Brown Trout	<i>Salmo trutta</i>	13	17	PCWA	2007-2008	methylmercury
	Crayfish Species	<i>Decapoda</i> (various species)	12	12	PCWA	2008	methylmercury
	Rainbow Trout	<i>Oncorhynchus mykiss</i>	2	10	SWAMP	2007	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs
			9	9	PCWA	2007-2009	methylmercury
Hell Hole	Brown Trout (16 inches or less)	<i>Salmo trutta</i>	2	10	SWAMP	2007	Chlordanes, DDTs, Dieldrin, Hg, PBDEs, PCBs
			3	3	PCWA	2007-2008	methylmercury
	Brown Trout (over 16 inches)		10	14	PCWA	2007-2008	methylmercury
	Crayfish Species	<i>Decapoda</i> (various species)	12	12	PCWA	2008	methylmercury
	Kokanee Salmon	<i>Oncorhynchus nerka</i>	12	12	PCWA	2008	methylmercury
	Lake Trout	<i>Salvelinus namaycush</i>	6	6	PCWA	2007-2009	methylmercury

PCWA = Placer County Water Agency
 SWAMP = Surface Water Ambient Monitoring Program, Hg = Mercury

CHEMICAL CONCENTRATIONS

Fish samples were prepared as skinless fillets or shelled body meat (crayfish species). They were analyzed for mercury (total or methylmercury), legacy pesticides, PBDEs and PCBs (55 congeners²), either as individual fish or composite samples, prepared from equal amounts of tissue from several similarly sized fish of a species. For composite samples, the total length of the smallest fish in the sample must be at least 75% of the length of the largest fish in the composite. OEHHA used the arithmetic mean (average) of the chemical concentrations for each fish species to estimate average human exposure.

MERCURY

Depending on the study, the CDFW Moss Landing Marine Laboratories (SWAMP: total mercury) or Brooks Rand Labs (PCWA: methylmercury) analyzed species collected from French Meadows and Hell Hole Reservoirs for mercury, either as individual fish or composite samples of five fish, using a DMA (direct mercury analyzer) or CVAFS (cold vapor atomic fluorescence spectrometry). The DMA method is an integration of thermal decomposition and atomic absorption and the CVAFS approach combines cold vapor flow injection and fluorescence spectrometry to detect the mercury concentrations. OEHHA assumed all total mercury detected was methylmercury; methylmercury is the most common form found in fish and is also the more toxic form (Bloom, 1992). Table 2 shows the averages and ranges for total length³ and mercury concentrations in each fish species. All data were reported in wet weight. The DMA (SWAMP data) method detection limit (MDL)⁴ and the reporting limit (RL)⁵ for total mercury were reported at 12 parts per billion (ppb). The CVAFS (PCWA data) MDL was 1 ppb and the RL was 3 ppb for methylmercury.

PESTICIDES, PBDEs AND PCBs

Composite samples comprised of 10 individual fish were analyzed for legacy pesticides, PBDEs and PCBs in Rainbow Trout from French Meadows Reservoir and Brown Trout from Hell Hole Reservoir. Pesticides, PBDEs and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory.

For PBDEs, PCBs, chlordanes, dieldrin and DDTs, each of the concentrations presented was the sum of the detected parent compound, congeners, or metabolites,

² Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.

³ 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. For crayfish species, the total carapace length was measured.

⁴ The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.

⁵ The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

where applicable. Since the MDLs or RLs were relatively low, ≤ 0.02 and ≤ 5 ppb, respectively, individual congeners or metabolites with concentrations reported as non-detects were assumed to be zero. This is a standard method of handling non-detect values for PCBs and other chemicals with multiple congeners or metabolites in a given sample when detection levels are adequate (US EPA, 2000a). Table 2 shows the averages and ranges for total length and PCB concentrations in each fish species. Concentrations of chlordanes, dieldrin, DDTs, and PBDEs were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008 and 2011). These chemicals were therefore not considered further for developing consumption advice and are not shown in the table below.

TABLE 2. MERCURY AND PCB CONCENTRATIONS IN FISH FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

Reservoir	Fish Species	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths (mm)	Mercury (ppb)	
						Mean*	Range**
French Meadows	Brown Trout	13	17	452	355-740	203	84-357
	Crayfish Species	12	12	52	47-65	72	38-119
	Rainbow Trout	11	19	308	239-399	64	12-176
Hell Hole	Brown Trout (16 inches or less)	5	13	330	278-402	203	10-662
	Brown Trout (over 16 inches)	10	14	470	360-571	1194	463-2310
	Crayfish Species	12	12	52	40-62	223	111-730
	Kokanee Salmon	12	12	390	365-425	167	50-221
	Lake Trout	6	6	447	350-610	633	217-942
						PCBs (ppb)	
French Meadows	Rainbow Trout	1	10	351	300-399	0.3	***
Hell Hole	Brown Trout (16 inches or less)	1	10	318	278-358	10	***

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

**Range of individuals and/or range of the average of composites.

***Not available; concentration was derived from a composite of 10 fish.

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

GENERAL INFORMATION

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, 2014; American Heart Association, 2014; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish are a significant source of the specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) thought to be associated with these beneficial health effects (USDA/USDHHS, 2015; Weaver et al., 2008).

The 2015-2020 U.S. Dietary Guidelines recommend that 1) the general population “consume eight or more ounces per week (less for young children)” of a variety of seafood⁶ “for the total package of nutrients that seafood provides, including its EPA and DHA content” and 2) “women who are pregnant or breastfeeding should consume at least eight and up to twelve ounces of a variety of seafood per week from choices that are lower in methylmercury” (USDA/USDHHS, 2015). The particular fish that people eat is an important factor in determining the net beneficial effects of fish consumption. For example, studies have shown that children of mothers who ate low-mercury fish during pregnancy scored better on cognitive tests compared to children of mothers who did not eat fish or ate high-mercury fish (Oken et al., 2005, 2008). Accordingly, because of the high mercury content of certain fish species, the Food and Drug Administration and US Environmental Protection Agency recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children do not consume shark, swordfish, tilefish, or king mackerel, and limit consumption of white (albacore) tuna to six ounces per week (FDA/US EPA, 2004; 2014).

In order to address the potential health concerns associated with consuming 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

⁶ “Marine animals that live in the sea and in freshwater lakes and rivers. Seafood includes fish, such as salmon, tuna, trout, and tilapia, and shellfish, such as shrimp, crab, and oysters” (USDHHS/USDA, 2015).

maximum number of servings per week that consumers can eat, for each species and at each location, to limit their exposure to these contaminants. Consumers can use OEHHA's guidance when choosing which fish and how much to eat as part of an overall healthy diet.

There are two sets of ATLS for methylmercury in fish because of the age-related toxicity of this chemical (OEHHA, 2008). The fetus and children are more sensitive to the toxic effects of methylmercury. Thus, the ATLS for the sensitive population, including women who might become pregnant (typically 18 to 45 years of age) and children (1-17 years of age), are lower than for women 46 years and older, and men (18 years and older). The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLS, are provided in "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene" (OEHHA, 2008). A list of the ATLS used in this report is presented in Appendix I.

For each fish species in this advisory, OEHHA compared the mean mercury and PCB concentrations detected in the fillet or body meat to the ATLS for each of the chemicals to establish the maximum number of servings per week that could be consumed (see Appendix I). The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of fish servings per week. Because both mercury and PCBs are known to affect the nervous system, particularly during brain development, additivity of toxicity is assumed and assessed by using a multiple chemical exposure methodology (US EPA, 1989 and 2000b). The presence of both chemicals in fish tissue may result in advice for the sensitive population to consume fewer meals per week than would be the case for the presence of either chemical alone, in a similar concentration. For the French Meadows and Hell Hole Reservoirs advisory, the potential effect of multiple chemical exposures were assessed and determined not to affect consumption advice for the species that were evaluated. When consumption advice is followed, the exposure to mercury and PCBs from eating fish caught at French Meadows and Hell Hole Reservoirs would be at or below the average daily reference dose or cancer risk as outlined 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).

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 from this water body. People should eat no more than the recommended number of servings for each fish species or species

group. OEHHA's advice on consuming a particular fish species can be extended to other closely related fish species⁷ known to accumulate similar levels of contaminants.

Consumption advice should not be combined. That is, if a person chooses to eat a fish from the "one-serving-a-week" category, then they should not eat any other fish from any source until the next week. If a person chooses to eat a fish from the "two-servings-per-week" category, they can combine fish species from that category for a total of two servings in that week. Then they should not eat any other fish from any source until the following week.

CONSUMPTION ADVICE FOR FISH FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

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 an attempt to ensure that the sample dataset is representative of the population in the water body. In some cases, an exception is made for species that are commonly caught and consumed from a given water body but where the available data may be limited. Hell Hole Reservoir is locally identified as a "trophy" lake, particularly for Lake Trout; however, its geography and location can pose accessibility and fishing challenges, limiting the ability to collect the typical minimum number of fish. Although only six Lake Trout were collected from Hell Hole Reservoir, OEHHA considers it health protective to offer consumption advice for this species at this reservoir because of its popularity and relatively high mercury concentration. Sample sizes were thus considered sufficient to develop advice for French Meadows for Brown Trout, crayfish species, and Rainbow Trout, and for Hell Hole Reservoir for Brown Trout, crayfish species, Kokanee Salmon, and Lake Trout.

The California Department of Fish and Wildlife manages the fish populations in both reservoirs.⁸ At French Meadows Reservoir, the Brown Trout, crayfish and Rainbow Trout populations are self-sustaining with additional planting of "catchable" sized, hatchery raised Rainbow Trout. Hell Hole Reservoir's Brown Trout, crayfish and Lake Trout populations are self-sustaining with additional planting of "catchable" sized, hatchery raised Brown Trout. Kokanee Salmon fingerlings are regularly planted at Hell Hole Reservoir.⁹

⁷ Fish species within the same genus are most closely related, and Family is the next level of relationship.

⁸ CDFW oversees the planting schedule and practices at Hell Hole Reservoir, as indicated on CDFW's online, map-based "Fishing Guide", available at <https://map.dfg.ca.gov/fishing/>.

⁹ Information about planting and specie management practices at French Meadows and Hell Hole Reservoirs was provided to OEHHA by Ben Ransom, Senior Environmental Scientist at PCWA. Personal email communication, April 11, 2016.

FRENCH MEADOWS RESERVOIR: BROWN TROUT

Based on the mean mercury concentration in Brown Trout (203 ppb), OEHHA recommends a maximum of one serving per week for the sensitive population (women 18 to 45 years and children 1 to 17 years) and a maximum of three servings a week for the general population (women 46 years and older, and men 18 years and older). All Brown Trout data from French Meadows Reservoir were evaluated together and not separated into two length categories, as was the case for Hell Hole Reservoir, because the advice for the two size categories did not differ. Brown Trout from French Meadows Reservoir were not analyzed for PCBs.

FRENCH MEADOWS RESERVOIR: CRAYFISH SPECIES

The mean mercury level in crayfish species from French Meadows Reservoir was 72 ppb. OEHHA recommends a maximum of two servings (8 ounce serving prior to cooking) a week of crayfish species for the sensitive population (women 18 to 45 years and children 1 to 17 years) and seven servings a week for women 46 years and older, and men 18 years and older. Crayfish species from French Meadows Reservoir were not analyzed for PCBs.

FRENCH MEADOWS RESERVOIR: RAINBOW TROUT

The mean mercury and PCB concentrations in Rainbow Trout from French Meadows Reservoir were 64 and 0.3 ppb, respectively. OEHHA recommends a maximum of 3 servings per week of Rainbow Trout for the sensitive population (women 18 to 45 years and children 1 to 17 years). Seven servings per week are recommended for women 46 years and older, and men 18 years and older.

HELL HOLE RESERVOIR: BROWN TROUT

Based on the range of mercury levels in Brown Trout (10-2310 ppb), OEHHA performed a regression analysis to determine if mercury concentration correlated with total fish length. An analysis of individual Brown Trout from Hell Hole Reservoir (N=12) showed that 57% of the increase in mercury concentration was attributable to an increase in total fish length ($R^2=0.57$). This relationship is identical to that observed in individual Brown Trout (N=16, $R^2=0.57$) collected from lakes throughout California and analyzed individually for mercury to develop statewide consumption advice (OEHHA, 2013). The statewide OEHHA advisory report also determined that when Brown Trout “were at or under 16 inches in length, the mercury levels were lower than the 440 ppb threshold” (OEHHA, 2013). The report further discussed that mercury levels observed in Brown Trout greater than 16 inches (406 mm) in length showed increased variability and were more likely to exceed the mercury threshold for the sensitive population, 440 ppb (OEHHA, 2013).

OEHHA observed a similar relationship between length and mercury concentrations in Brown Trout collected from Hell Hole Reservoir, although the analysis is less robust French Meadows and Hell Hole Reservoirs Fish Advisory

because of the compositing of some samples. Evaluating individual samples, only one of three Brown Trout measuring 16 inches or less but all nine fish greater than 16 inches in length exceeded the 440 ppb mercury threshold for the sensitive population. Composited samples showed the same trend. Two composited samples of five Brown Trout 16 inches or less had an average mercury concentration of 161 ppb, whereas one composite of five Brown Trout where four of the five fish were over 16 inches had a mercury concentration of 1070 ppb. OEHHA determined that the composite sample of five Brown Trout with individual lengths ranging from 360 to 485 mm (14.2-19.1 inches) should be included in the final analysis. However, the average mercury concentration in Brown Trout over 16 inches may potentially be underestimated because the data set includes a fish from the shorter length category.

Based on the mean mercury concentration of 203 ppb in Brown Trout measuring 16 inches or less collected from Hell Hole Reservoir, OEHHA recommends a maximum of one serving a week for the sensitive population (women 18 to 45 years and children 1 to 17 years) and a maximum of three servings a week for the general population (women 46 years and older, and men 18 years and older).

Based on the mean mercury concentration of 1194 ppb in Brown Trout measuring greater than 16 inches collected from Hell Hole Reservoir, OEHHA recommends no consumption for either the sensitive (women 18 to 45 years and children 1 to 17 years) or general (women 46 years and older, and men 18 years and older) populations. Although the mean mercury value did not exceed the 1310 ppb mercury ATL threshold for no consumption for the general population (OEHHA, 2008), OEHHA recommends no consumption of Brown Trout over 16 inches for this population because the mean value neared, and one-third of individual fish samples exceeded, this threshold. Additionally, the maximum value of 2310 ppb mercury in a 510 mm Brown Trout from this reservoir exceeded the no consumption threshold for the general population by 76%.

The mean concentration of PCBs in Brown Trout from Hell Hole Reservoir was 10 ppb and did not impact consumption advice for either population.

HELL HOLE RESERVOIR: CRAYFISH SPECIES

The mean mercury level in crayfish species from Hell Hole Reservoir was 223 ppb. OEHHA recommends a maximum of one serving (8 ounce serving prior to cooking) a week of crayfish species for the sensitive population (women 18 to 45 years and children 1 to 17 years) and two servings a week for women 46 years and older, and men 18 years and older. Crayfish species from Hell Hole Reservoir were not analyzed for PCBs.

HELL HOLE RESERVOIR: KOKANEE SALMON

The mean mercury level in Kokanee Salmon was 167 ppb. OEHHA recommends a maximum of one serving a week of Kokanee Salmon for the sensitive population (women

18 to 45 years and children 1 to 17 years) and three servings a week for women 46 years and older, and men 18 years and older. Kokanee Salmon were not analyzed for PCBs.

HELL HOLE RESERVOIR: LAKE TROUT

The mean mercury concentration in Lake Trout from Hell Hole Reservoir was 633 ppb. OEHHA recommends no consumption of Lake Trout from Hell Hole Reservoir for the sensitive population (women 18 to 45 years and children 1 to 17 years) and a maximum of one serving a week for the general population (women 46 years and older, and men 18 years and older). Lake Trout were not analyzed for PCBs.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from French Meadows and Hell Hole Reservoirs are shown in Table 3.

TABLE 3. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM FRENCH MEADOWS AND HELL HOLE RESERVOIRS

Reservoir	Fish Species	Women 18–45 years and Children 1–17 years	Women 46 years and older and Men 18 years and older
French Meadows	Brown Trout (<i>any length</i>)	1	3
	Crayfish Species	2	7
	Rainbow Trout	3	7
Hell Hole	Brown Trout (<i>16 inches or less</i>)	1	3
	Brown Trout (<i>over 16 inches</i>)	0	0
	Crayfish Species	1	2
	Kokanee Salmon	1	3
	Lake Trout	0	1

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APPENDIX I. Advisory Tissue Levels

Advisory Tissue Levels (ATLs) guide the development of advice for people eating sport fish. ATLs are levels of contaminants found in fish that correspond to the maximum numbers of recommended fish servings. OEHHA uses ATLs to provide advice to prevent consumers from being exposed to:

- More than the average daily reference dose¹⁰ for chemicals not known to cause cancer, such as methylmercury, or
- For cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer endpoint is the maximum acceptable risk level recommended by the US EPA (2000b) for fish advisories.

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for one to seven eight-ounce servings per week. The most health-protective ATLs for each chemical, selected from either cancer or non-cancer based risk, are shown in the table below for zero to seven servings per week. When the guidelines for eating fish from French Meadows and Hell Hole Reservoirs are followed, exposure to chemicals in fish from French Meadows and Hell Hole Reservoirs 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 ^b (in ppb)							
	7	6	5	4	3	2	1	0
Chlordanes	≤ 80	>80-90	>90-110	>110-140	>140-190	>190-280	>280-560	>560
DDTs	≤ 220	>220-260	>260-310	>310-390	>390-520	>520-1,000	>1,000-2,100	>2,100
Dieldrin	≤ 7	>7-8	>8-9	>9-11	>11-15	>15-23	>23-46	>46
MeHg (Women 18-45 and children 1-17)	≤ 31	>31-36	>36-44	>44-55	>55-70	>70-150	>150-440	>440
MeHg (Women > 45 and men)	≤ 94	>94-109	>109-130	>130-160	>160-220	>220-440	>440-1,310	>1,310
PBDEs	≤ 45	>45-52	>52-63	>63-78	>78-100	>100-210	>210-630	>630
PCBs	≤ 9	>9-10	>10-12	>12-15	>15-21	>21-42	>42-120	>120

^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 during a lifetime.