

**HEALTH ADVISORY AND
GUIDELINES
FOR EATING FISH FROM
THE UPPER FEATHER RIVER
(Butte and Plumas Counties)**

September 2014



**California Environmental Protection Agency
Office of Environmental Health Hazard Assessment**

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ACKNOWLEDGEMENT

Sampling and analysis of fish for contaminants are critical in the development of fish consumption advice. The Office of Environmental Health Hazard Assessment (OEHHA) acknowledges the contribution of information from the following entities: Department of Water Resources, Pacific Gas and Electric Company, State Water Resources Control Board, University of California at Davis, as well as the California Department of Fish and Wildlife and its Moss Landing Marine Laboratories and Water Pollution Control Laboratory. We thank staff at the Central Valley Regional Water Quality Control Board, especially Michelle Wood for coordinating and providing data. Some of the data used in this report were also obtained from the California Environmental Data Exchange Network (<http://www.ceden.us/AdvancedQueryTool>).

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LIST OF ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
DDTs	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyl- dichloroethylene (DDE)
DWR	Department of Water Resources
MDL	method detection limit
mm	millimeter
OEHHA	Office of Environmental Health Hazard Assessment
PCBs	polychlorinated biphenyls (as congeners)
PG&E	Pacific Gas and Electric Company
ppb	parts per billion
RL	Reporting limit
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
UCD	University of California at Davis
US EPA	U.S. Environmental Protection Agency

PREFACE

The Office of Environmental Health Hazard Assessment (OEHHA), a department within the California Environmental Protection Agency, is responsible for evaluating potential public health risks from chemical contamination of sport fish. This task includes issuing health 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; and
 - 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 booklets in the 'Public Health Advisory on Fish Consumption' section.

This report presents guidelines for eating fish from the Upper Feather River in Butte and Plumas counties, California. It 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.

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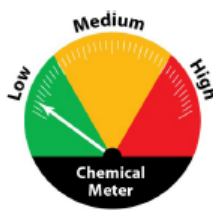

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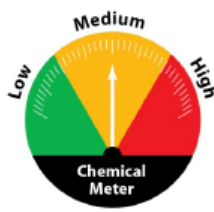

A Healthy Guide to Eating Fish from the Upper Feather River


Women 18-45 years and children 1-17 years

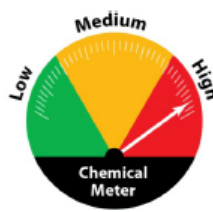




Rainbow, brook, or brown trout 

 = high in omega-3s

Black bass 

Pikeminnow

3 servings a week

1 serving a week

Do not eat

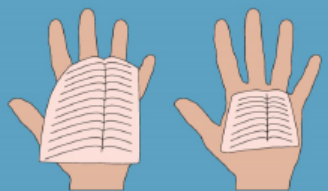
Women over 45 years and men can safely eat more fish

Trout
7 servings a week

Black bass
2 servings a week

Pikeminnow
1 serving a week

What is a serving?



For Adults For Children

The recommended serving is the size and thickness of your hand. 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.

What is the concern?

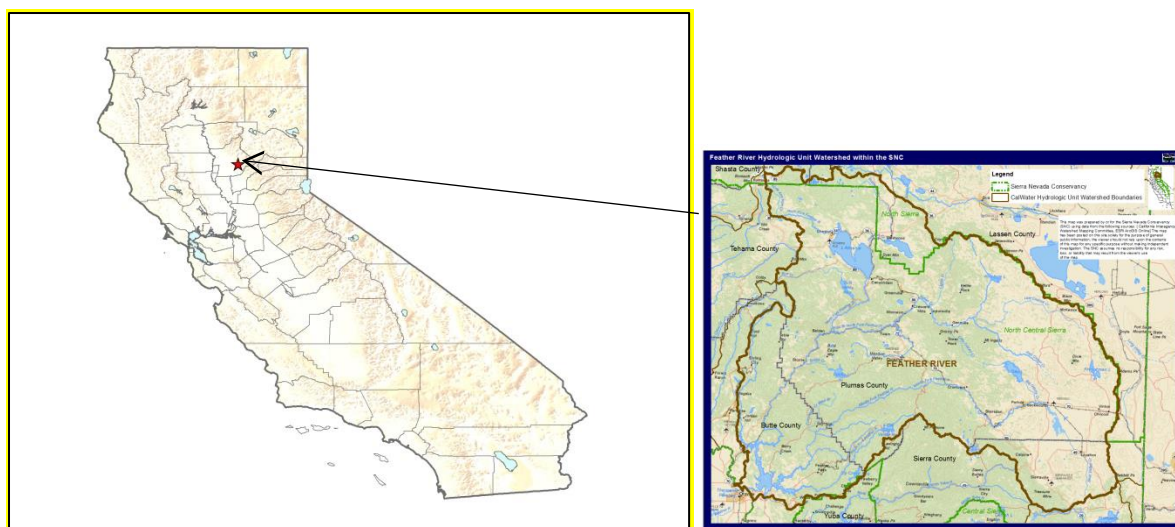
Some fish have high levels of mercury. Mercury can harm the brain, especially in unborn babies and children.

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INTRODUCTION

This report provides guidelines for eating fish caught from tributaries of the Feather River above Lake Oroville in Butte and Plumas Counties in northern California (Figure 1). This area will be collectively referred to as the Upper Feather River. The report presents background information and a description of how the consumption advice was developed. The recommended advice is the maximum number of servings per week for each fish species evaluated. OEHHA has also developed fish consumption guidelines for other water bodies in the Feather River watershed or the Oroville Dam complex. These advisories are: Lake Oroville (OEHHA, 2013), Thermalito Forebay and Thermalito Afterbay (OEHHA, 2014a), and the Lower Feather River (OEHHA, 2014b).

FIGURE 1. LOCATION OF THE UPPER FEATHER RIVER WATERSHED IN NORTHERN CALIFORNIA.



Feather River watershed image from:

<http://www.sierranevadaconservancy.ca.gov/our-region/map-gallery/Feather%20River%20HU.png/view>

The Upper Feather River consists of North Fork Feather River, Middle Fork Feather River, South Fork Feather River, West Branch Feather River, and their associated creeks. The water for the North Fork, Middle Fork, and South Fork originates from multiple sources in the Sierra Nevada range. The water for the West Branch comes from Lassen National Forest. These rivers all drain into Lake Oroville, where the water is released from the Oroville dam into the Lower Feather River in the Sacramento Valley. The Upper Feather River is a major water source for the California State Water Project for flood control and water supply (Sacramento River Watershed Program, 2010). Pacific Gas and Electric Company (PG&E) operates hydropower plants on several reservoirs (Poe Powerhouse, Big Bend, Cresta, and Rock Creek) on the North Fork Feather River.

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from several monitoring projects described in this report to develop this advisory for the Upper Feather River. The basic OEHHA process to develop consumption advice involves these steps:

1. Select the samples, chemical data, and fish species to be evaluated.
2. Calculate average (mean) chemical concentrations and other descriptive statistics as appropriate for each fish species.
3. Compare the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of concern to develop the consumption advice.

OEHHA developed ATLs (Appendix I) that are acceptable exposure levels of specific contaminants in fish tissue based on the toxicity of each chemical for a range of consumption rates. The development of the ATLs included consideration of health benefits linked to eating fish (OEHHA, 2008).

CHEMICALS OF POTENTIAL CONCERN

Fish samples from the Upper Feather River have been analyzed for mercury (as a measure of methylmercury), polychlorinated biphenyl congeners¹ (PCBs), and the persistent pesticides dieldrin, chlordane, and dichlorodiphenyltrichloroethane and its metabolites (DDTs).

Mercury, a metal, is widely found in nature in rock and soil. Its presence in the aquatic environment is the result of mining activities, such as occurred in the Feather River watershed, and releases into the environment from industrial sources, including the burning of fossil fuels and solid wastes. Mercury in the sediment is transformed by bacteria to the more toxic organic form, methylmercury, which is taken up by aquatic organisms. Methylmercury builds up in fish when they eat smaller aquatic organisms. Depending on how much methylmercury is in fish people eat, changes in the brain may occur, especially in fetuses and children as they grow.

Polychlorinated biphenyls 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 accumulate in fish. Two episodes of PCBs entering the water of the Upper Feather River have been reported (Department of Water Resources, DWR, 2013; PG&E, 2002). PCB-containing oil was applied to a dirt road near the South Fork Feather River upstream of Ponderosa Reservoir in the 1980s. PCBs also contaminated the soil and water at Belden Forebay at the North Fork Feather River after a landslide damaged the powerhouses in 1984. Runoff from these

¹ Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54 are generally reported.

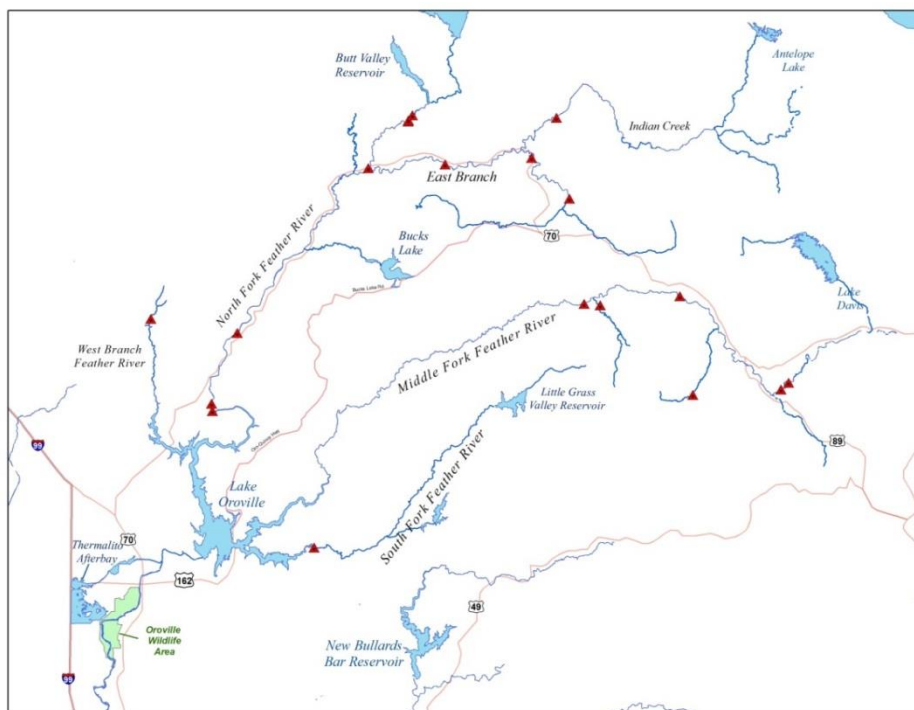
events introduced PCBs into the local waterways. Depending on the exposure level, PCBs can cause cancer and other adverse effects, including neurotoxicity, in humans.

Chlordane, DDT, and dieldrin are pesticides that were banned from use in 1973 (DDT) and in the late 1980s (chlordane and dieldrin) but have been found in some fish in certain water bodies in California. Depending on exposure level, these chemicals may cause cancer or other adverse effects on the nervous system. Detailed discussion of the toxicity of these chemicals is presented in OEHHA (2008).

DATA SOURCES

The guidelines for eating fish from the Upper Feather River were based on chemical analysis of fish samples by the projects as described below. These projects had adequate documentation of sample collection, fish preparation, chemical analyses, and quality assurance, and low detection limits for the contaminants. Fish were collected from various locations on the Upper Feather River as shown in Figure 2. Table 1 shows the common and scientific names of fish species sampled, the projects under which the samples were collected, and the years of sampling.

FIGURE 2. SAMPLING LOCATIONS ON THE UPPER FEATHER RIVER



Red triangle (▲) indicates the sampling locations.

TABLE 1. FISH SAMPLES FROM THE UPPER FEATHER RIVER

Common Name	Scientific Name		Project	Year Sampled
	Family	Genus		
Black Bass (Smallmouth, Spotted)	Centrarchidae	<i>Micropterus</i>	DWR PG&E	2006 2002-2003
Hardhead	Cyrinidae	<i>Mylopharodon</i>	DWR	2006
Pikeminnow	Cyrinidae	<i>Ptychocheilus</i>	DWR PG&E	2006 2003
Sucker	Catostomidae	<i>Catostomus</i>	PG&E	2002-2003
Trout, Brook	Salmonidae	<i>Salvelinus</i>	SWAMP	2011
Trout, Brown	Salmonidae	<i>Salmo</i>	DWR SWAMP	2006 2011
Trout, Rainbow	Salmonidae	<i>Onchorhynchus</i>	DWR PG&E SWAMP UCD	2006 2002-2003 2011 1994

Abbreviations: DWR=Department of Water Resources, PG&E=Pacific Gas and Electric Company, SWAMP=Surface Water Ambient Monitoring Program, UCD=University of California at Davis.

DEPARTMENT OF WATER RESOURCES (DWR)

The Department of Water Resources conducted sampling projects to evaluate chemical contamination of Lake Oroville and water bodies in the vicinity (Feather River, the Oroville Wildlife Area, and Thermalito Forebay and Afterbay) for the Oroville Federal Energy Regulatory Commission Relicensing Project No. 2100 (DWR, 2004 and 2006).

There were two phases to the study: Phase I of the project evaluated contaminants in biota and sediments from the Lower Feather River (DWR, 2004). In 2003, Phase II evaluated sources of the contamination and extent of downstream effects (DWR, 2006). The data for the Upper Feather River came from Phase II of the study. The fish sampled from the Upper Feather River (the North Fork and Middle Fork) were smallmouth bass, spotted bass, hardhead, pikeminnow, and brown trout. The fish fillets were analyzed for mercury and PCBs by the California Department of Fish and Wildlife's (CDFW) Water Pollution Control Laboratory and Moss Landing Marine Laboratories.

PACIFIC GAS AND ELECTRIC COMPANY (PG&E)

The State Water Resources Control Board requested PG&E to conduct a study of tissue contaminants in fish collected from the North Fork Feather River. The first study collected samples in Belden Forebay and Belden Reach (in the North Fork Feather River) because of concerns over the bioaccumulation of silver (from cloud-seeding operations), methylmercury, and PCBs (from the landslide and spill in 1984) (PG&E,

2002). Fish species collected included smallmouth bass, crayfish, rainbow trout, brown trout, and Sacramento sucker. The results for fish are not included in this report because whole fish, instead of fillets, were used in the analysis. The crayfish data are also not used because the mercury data were collected from a single site.

In the second study, samples were collected from sites along the North Fork Feather River including Poe Powerhouse and Belden Forebay (PG&E 2003). Fish species collected included black bass (smallmouth and spotted), pikeminnow, rainbow trout, and Sacramento sucker. Fish fillet samples were analyzed for mercury (all species) and PCBs (some species) by CDFW Water Pollution Control Laboratory and Moss Landing Marine Laboratories.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

A statewide survey of California's rivers and streams was conducted by the State Water Resources Control Board under its SWAMP, which sampled fish from 63 locations in 2011 (Davis et al., 2013). SWAMP collected one sample of largemouth bass, but length (302 millimeter, mm) was less than legal size for caught fish to be kept. Trout (brook, brown, and rainbow trout) were collected from the North Fork (above Beldon Bridge) and Middle Fork (upstream of Clio, at Sloat, and Jamison Creek) of the Feather River. All analyses were performed by CDFW Water Pollution Control Laboratory and Moss Landing Marine Laboratories.

UNIVERSITY OF CALIFORNIA AT DAVIS (UCD)

In 1994, Slotton et al. (1997) at UCD conducted a study to examine the extent of mercury contamination of the aquatic invertebrates and trout in the rivers of gold mining regions. The focus of the study was the region between the Feather River watershed and the American River watershed. For the upper Feather River, rainbow trout were collected from the North Fork branches and creeks (East Branch, West Branch, Indian Creek, Spanish Creek, and Yellow Creek) and Middle Fork (near Clio and at Nelson Creek). The reported fish lengths in the 1997 study were assumed to be total fish lengths.² The samples were analyzed for mercury at Dr. Slotton's laboratory (Saiki et al., 2004). This study provided 37 of the total 70 rainbow trout samples for this report.

² Dr. Slotton could not verify whether the measured length was fork length or total length (Personal Communications, 2013). For this report, the lengths were assumed to be total length and no adjustment was made. In more recent studies, this laboratory measured total fish lengths.

CHEMICAL CONCENTRATIONS

CHEMICAL ANALYSIS

Fish samples were prepared as skinless fillets for analysis of mercury, PCBs, and persistent pesticides. They were analyzed as individual fish or as composite samples from a species. Composite samples are prepared from equal amounts of tissues from several individual fish, all of the same species. Composite sampling is usually done for samples to be analyzed for organics to reduce the cost of analyses. The analytical result from a composite sample represents an average concentration. All results were reported in wet weight.

For total mercury, the samples were analyzed by inductively coupled plasma-mass spectrometry or atomic absorption spectrometry. PCBs and persistent pesticides were detected by gas chromatography. Samples from some species (black bass, pikeminnow, sucker, and rainbow trout) were analyzed for PCBs (45 to 52 congeners for each sample). Only rainbow trout fillets from the SWAMP project were analyzed for DDTs, dieldrin, and chlordanes. The specific chemicals were: PCB congeners; total DDTs including o,p' and p,p' DDT, o,p' and p,p' dichlorodiphenyldichloroethane (DDD), and o,p' and p,p' dichlorodiphenyldichloroethylene (DDE); total chlordanes including cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane; and dieldrin.

SAMPLE SELECTION

Results selected for the chemical concentration calculations were from samples taken from fish that met CDFW's legal size requirement (largemouth bass) or OEHHA's criteria for minimum "edible" size. OEHHA used species size at maturity and professional judgment to set minimum edible sizes (OEHHA, 2005). Fish were measured as total length (in millimeters [mm]).³ For composite samples, the length of the smallest fish in the sample was at least 75 percent of the length of the largest fish in the composite.

SAMPLE CONCENTRATION CALCULATION

OEHHA used the arithmetic mean (average) concentrations of selected samples for each chemical as the representative mean chemical concentration to estimate human exposure. The means were computed (weighted) by taking into account the number of fish in each composite sample. For the calculation of mercury concentrations in fish tissue, OEHHA assumed all total mercury detected was methylmercury, the more toxic form that is present in fish, because nearly all mercury present in fish is methylmercury

³ Total length refers to the length from the tip of the snout to the tip of the longer lobe of the caudal fin. Length measurements from the SRWP were assumed to be total length, since length type was not specified from the data source.

(Wiener et al., 2007). Table 2 shows the weighted mean total fish lengths and mean mercury concentrations for each fish species collected from the Upper Feather River.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM THE UPPER FEATHER RIVER

Fish Species	Number of Samples	Total Number of Fish ^a	Mean Total Length (mm)	Mercury (ppb)	
				Mean	Range
Bass, Smallmouth	2	2	349	280	200-360
Bass, Spotted	10	10	355	330	190-650
Combined	12	12	354	322	190-650
Hardhead	1	1	253	50	NA
Pikeminnow	11	11	476	536	80-980
Sucker	0	NA	NA	NA	NA
Trout, Brook ^b	2	2	173	47	46-47
Trout, Brown	3	3	248	91	68-116
Trout, Rainbow	66	70	267	64	18-230
Combined	69	73	266	65	18-230

^a The number of fish can be greater than the number of samples because some samples are composites consisting of more than one fish for the chemical analysis.

^b Total fish length less than the mature size of 200 mm; they were 168 mm and 177 mm. These are included in this table for later discussion about combining all trout data. They were not used in calculating the combined values.

NA=Not applicable because no or only one sample was analyzed.

For PCBs, chlordanes, and DDTs, each of the concentrations presented was the sum of the detected parent compound, congeners, and metabolites, where applicable. Since the method detection limits (MDLs) or reporting limits (RLs) were relatively low, ≤ 1 ppb, individual congeners or metabolites with concentrations reported as non-detects were assumed to have no residue (See Appendix II for more information on MDLs and RLs). This is a standard method of handling non-detect samples for PCBs and other chemicals with multiple congeners or metabolites when detection levels are adequate (U.S. Environmental Protection Agency, US EPA, 2000a). Table 3 shows the weighted mean total lengths and mean chemical concentrations for PCBs. Results for pesticides in 4 samples of rainbow trout (20 fish for each analyte group) were: 0.9 ppb for chlordanes, 0.9 ppb for DDTs, and 0.5 ppb for dieldrin.

TABLE 3. PCB CONCENTRATIONS IN FISH FROM THE UPPER FEATHER RIVER

Fish Species	Number of Samples	Number of Fish ^a	Mean Total Length (mm)	PCBs (ppb)	
				Mean	Range
Bass, smallmouth and spotted combined	9	20	351	3.2	<0.6-6.5
Hardhead	1	2	255	8.7	NA
Pikeminnow	2	6	428	9.7	1.4-18
Sucker	10	12	394	4.7	0.6-8.9
Trout, Rainbow	18	43	273	2.9	<0.6-13.2

^a The number of fish (in parenthesis) can be greater than the number of samples because some samples are composites consisting of more than one fish for the chemical analysis.

NA=Not applicable because no or only one sample was analyzed.

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM THE UPPER FEATHER RIVER

GENERAL INFORMATION

The OEHHA advisory process considers the health benefits of fish consumption as well as the risk from exposure to chemical contaminants that may be 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 is a significant source of the specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), thought to be associated with many of these beneficial effects (USDA/USDHHS, 2010; Weaver et al., 2008).

The 2010 U.S. Dietary Guidelines recommend that consumers eat at least eight ounces of cooked seafood⁴ per week (“young children need less depending on age and calorie needs”) and that “women who are pregnant or breastfeeding consume eight to twelve ounces of seafood per week from a variety of seafood types” (USDA/USDHHS, 2010). However, 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

⁴ “Seafood is a large category of 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” (USDA/USDHHS, 2010).

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 these fish species, the Dietary Guidelines recommend that women who are pregnant or breastfeeding do not consume shark, swordfish, tilefish, or king mackerel, and limit consumption of albacore tuna to six ounces per week (USDA/USDHHS, 2010).

Catching and eating sport fish (i.e., fish and shellfish that people catch for themselves, friends or family) can be an important and economical way for consumers to meet the seafood consumption recommendations of the Dietary Guidelines. However, the mercury (and other contaminant) content of sport fish can vary widely by species and location. In order to address the potential health concerns associated with consuming contaminants in sport fish, OEHHA has established ATLS (Advisory Tissue Levels, i.e., acceptable exposure levels) 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, 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 women who might become pregnant (typically 18 to 45 years of age) and children (the sensitive population) are lower than for women over 45 years and men. The lower ATL values for the sensitive population provide 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 available in OEHHA, 2008. A list of ATLS used in this report is presented in Appendix I.

Data for fish species may be combined as a single group based on their taxonomy (i.e., they are in the same taxonomical Family and/or genus) and other considerations when specified in the following discussion of the water-body specific advice. For each fish species or group of related species in this advisory⁵, OEHHA compared the average concentration of each chemical detected in fish fillet to the ATL for that chemical in order to establish the maximum number of servings per week that could be consumed. When there is more than one chemical of concern, OEHHA provides advice based on the chemical that leads to the most restrictive consumption advice (i.e., the lowest number of servings per week). In addition, because mercury and PCBs cause similar adverse effects in the sensitive population (developmental neurotoxicity), OEHHA uses multiple chemical exposure methodology (US EPA, 1989 and 2000b) to minimize potential additive effects of these chemicals. Thus, consumption advice may be more

⁵ A species group includes related species. Fish species within the same genus are most closely related, and Family is the next level of relationship.

restrictive for the sensitive population when both chemicals are present in the same fish than it would be for either chemical alone.

OEHHA recommends that individuals strive to meet the U.S. Dietary Guidelines seafood consumption recommendations, while also adhering to federal and OEHHA recommendations to limit the consumption of high-contaminant fish. 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. 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 next week.

CONSUMPTION ADVICE FOR FISH FROM THE UPPER FEATHER RIVER

OEHHA determined the following advice for each species or species group after comparing the mean mercury and PCB concentrations to the ATLS. The advice, summarized in Table 4, shows the maximal number of servings. The concentrations of the tested pesticides were close to or lower than the ATL threshold value for daily consumption (OEHHA, 2008). These pesticides were therefore not considered further for developing consumption advice.

BLACK BASS

In spotted bass and smallmouth bass, the mean concentrations were 322 ppb mercury. OEHHA’s recommended advice for the sensitive population is one serving per week. Women over 45 years and men can eat two servings per week.

There was only one individual fish sample of largemouth bass; this was not shown in Table 2 because its total length (302 mm) was less than legal size of 305 mm. The mercury concentration was low (67 ppb). OEHHA is extending the advice to largemouth bass, because this species is in the same family and genus as spotted and smallmouth bass and they have been generally grouped together in OEHHA advisories.

HARDHEAD

Consumption advice was not established for hardhead because only one individual sample was analyzed for mercury (50 ppb) and only one sample of two hardhead was analyzed for PCBs (8.7 ppb). While hardhead is of the same family as the pikeminnow, the result for these two species could not be grouped together because the hardhead mercury level (50 ppb) was different than for the pikeminnow samples (mercury range of 80-980 ppb).

PIKEMINNOW

Pikeminnow contained high levels of mercury with mean concentration of 536 ppb but low levels of PCBs (mean, 10 ppb). Thus, the advice for both populations was based on mercury. OEHHA recommends the sensitive population should not eat pikeminnow. For women over 45 years and men, the advice is one serving per week.

SUCKER

For sucker, there were no data for mercury and the mean PCB concentration was 4.7 ppb. Since the evidence available from the other species sampled showed that the chemical of concern for the Upper Feather River is mercury, OEHHA decided not to provide advice for this fish since only PCB data were available.

TROUT (RAINBOW TROUT, BROOK TROUT, AND BROWN TROUT)

There were insufficient numbers of fish to meet the minimum criterion of nine fish for brook trout and brown trout to develop individual advice. There were sufficient data available on rainbow trout. OEHHA decided to combine the rainbow trout data with those for brook trout and brown trout for the following reasons for these two species: (1) They are in the same family as rainbow trout, (2) The available data indicated that they would have chemical concentrations similar to those for rainbow trout for this location, and (3) They are popular to catch in the Upper Feather River area. The mercury concentrations of individual samples of brook trout and brown trout were within the concentration range of the rainbow trout (Table 2). The mean mercury concentration of the combined trout species was 65 ppb. OEHHA recommends three servings per week for the sensitive population and seven servings per week for women over 45 years and men.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK

The recommended maximum number of servings per week for each fish species with sufficient data is presented in the following table.

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THE UPPER FEATHER RIVER

Fish Species	Women 18–45 Years and Children 1 to 17 Years	Women over 45 Years and Men
Pikeminnow	0	1
Black Bass	1	2
Trout (Brook, Brown and Rainbow)	3	7

REFERENCES

American Heart Association (2014). Fish and omega-3 fatty acids.
<http://www.americanheart.org/presenter.jhtml?identifier=4632>

CDFW (2014-2015). Freshwater Sport Fishing Regulations. Fish and Game Commission, Department of Fish and Wildlife, Natural Resources Agency, Sacramento, CA.
<http://www.dfg.ca.gov/regulations>

Davis, J.A., J.R.M. Ross, S.N. Bezalel, J.A. Hunt, G. Ichikawa, A. Bonnema, W.A. Heim, D. Crane, S. Swensen, and C. Lamerdin (2013). Contaminants in fish from California rivers and streams, 2011. A report of the Surface Water Ambient Monitoring Program (SWAMP). California State Water Resources Control Board, Sacramento, CA.
http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/rivers_study/rs_rpt_only.pdf

DWR (2004). Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain. Study Plan W2, Phase 1 Draft Report. Oroville Facilities Relicensing FERC Project No. 2100. Department of Water Resources, the Resources Agency, Sacramento, CA.

DWR (2006). Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain. Study Plan W2, Phase 2 Report. Oroville Facilities Relicensing FERC Project No. 2100. Department of Water Resources, the Resources Agency, Sacramento, CA.

DWR (2013). Final California 2010 Integrated Report (303(d) List/305(b) Report).
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01177.shtml#14546

FDA (Food and Drug Administration)/US EPA (2014). Fish: What Pregnant Women and Parents Should Know. Draft Updated Advice by FDA and EPA/June 2014.
<http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/Metals/UCM400358.pdf>

Institute of Medicine (2007). Seafood choices, balancing benefits and risks. Committee on Nutrient Relationships in Seafood: Selections to Balance Benefits and Risks Food and Nutrition Board. The National Academies Press, Washington, D.C.

Kris-Etherton, P.M., W.S. Harris, and L.J. Appel (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* 106:2747-2757.

OEHHA (2005). General protocol for sport fish sampling and analysis. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.
<http://oehha.ca.gov/fish/pdf/fishsampling121406.pdf>

OEHHA (2008). Development of fish contaminant goals and Advisory Tissue Levels for common contaminants in California sport fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA. <http://www.oehha.ca.gov/fish/gtislsv/pdf/FCGsATLs27June2008.pdf>

OEHHA (2013). Health Advisory and Consumption Guidelines for Eating Fish from Lake Oroville (Butte County). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA. http://www.oehha.ca.gov/fish/special_reports/pdf/071613LakeOrovilleReport.pdf

OEHHA (2014a). Health Advisory and Consumption Guidelines for Eating Fish from Thermalito Forebay and Thermalito Afterbay (Butte County). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.

OEHHA (2014b). Health Advisory and Consumption Guidelines for Eating Fish from the Lower Feather River Including the Diversion Pool (Butte, Sutter, and Yuba Counties). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.

Oken E., J.S. Radesky, R.O. Wright, D. Bellinger, C.J. Amarasiriwardena, K.P. Kleinman, H. Hu, J.W. Rich-Edwards, and M.W. Gillman (2008). Maternal fish intake during pregnancy, blood mercury levels, and infant cognition at age 3 years in a U.S. cohort. *Am. J. Epidemiol.* 167(10):1171-1181.

Oken E., R.O. Wright, K.P. Kleinman, D. Bellinger, C.J. Amarasiriwardena, H. Hu, J.W. Rich-Edwards, and M.W. Gillman (2005). Maternal fish consumption, hair mercury, and infant cognition in a U.S. cohort. *Environ. Health Perspect.* 113(10):1376-1380.

PG&E (2002). Upper North Fork Feather River Project FERC No. 2105. Application for New License. Volume 6 of 8, Appendices. Pacific Gas and Electric Company.

PG&E (2003). Poe Hydroelectric Project FERC No. 2107. Application for New License. Application for new license, study plan for conducting fish tissue contaminants bioaccumulation screening. References 829 and 830 in http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/r5_ref_index.shtml

Sacramento River Watershed Program (2010). The Sacramento River Basin. A Roadmap to Watershed Management, October, 2010. <http://www.sacriver.org/aboutwatershed/roadmap>

Saiki, M.K., D.G. Slotton, T.W. May, S.M. Ayers, and C.N. Alpers (2004). Summary of total mercury concentrations in filets of selected sport fishes collected from 2000-2003

from Lake Natoma, Sacramento County, California: U.S. Geological Survey Data Series 103, 21 p.

Slotton, D.G., S.M. Ayers, J.E. Reuter, and C.R. Goldman (1997). Gold Mining Impacts on Food Chain Mercury in Northwestern Sierra Nevada Streams (1997 Revision). University of California Water Resources Center, University of California.
<http://eschloarship.org/uc/item/58h617dr>

USDA (U.S. Department of Agriculture)/USDHHS (U.S. Department of Human Health Services) (2010). Dietary Guidelines for Americans, 2010. 7th Edition, Washington, DC: U.S. Government Printing Office, December 2010.
<http://www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf>

US EPA (1989). Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final. EPA/5401-89/002, December 1989. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.
Online at: <http://www.epa.gov/oswer/riskassessment/ragse/index.htm>

US EPA (2000a). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Vol.1. Fish Sampling and Analysis. 3rd Ed. EPA 823-B00-007.

US EPA (2000b). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Vol.2. Risk Assessment and fish consumption limits. 3rd Ed. EPA 823-B00-008.

Weaver, K.L., P. Ivester, J.A. Chilton, M.D. Wilson, P. Pandey, and F.H. Chilton (2008). The content of favorable and unfavorable polyunsaturated fatty acids found in commonly eaten fish. J. American Dietetic Association 108:1178-1185.

Wiener, J.G.; R.A. Bodaly; S.S. Brown; M. Lucotte; M.C. Newman; D.B. Porcella; R.J. Reash; and E.B. Swain (2007). Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. Chapter 4 in Ecosystem Responses to Mercury Contamination: Indicators of Change (R.C. Harris, D. P. Krabbenhoft, R.P. Mason, M.W. Murray, R.J. Reash, and T. Saltman, editors). SETAC Press, Pensacola, Florida.

APPENDIX I. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs) guide the development of advice for people eating sport fish. ATLs are chemical levels 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 dose⁶ 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 the Upper Feather River are followed, exposure to chemicals in fish from areas comprising the Upper Feather River would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

TABLE 5. ADVISORY TISSUE LEVELS FOR METHYLMERCURY AND PCBs

Number of servings per week ^a	Advisory Tissue Levels (ATLs, in ppb)		
	Methylmercury		PCBs
	Women 18 to 45 years and children 1 to 17 years	Women over 45 years and men	
0	>440	>1,310	>120
1	>150-440	>440-1,310	>42-120
2	>70-150	>220-440	>21-42
3	>55-70	>160-220	>16-21
4	>44-55	>130-160	>13-16
5	>36-44	>109-130	>10-13
6	>31-36	>94-109	>9-10
7	≤ 31	≤ 94	≤ 9

^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. When residue data are compared to this table they should also first be rounded to the second significant digit.

⁶ 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.

APPENDIX II. DETECTION LIMITS

The method detection limits (MDLs) and reporting limits (RLs) in parts per billion (ppb) are listed in Table 6. The MDL is the lowest concentration of a chemical that can be distinguished (as greater than zero) in a sample. The RL is the lowest concentration of a chemical that can be accurately quantified in a sample.

TABLE 6. METHOD DETECTION LIMITS AND REPORTING LIMITS

Chemicals	DWR RL (ppb)	PG&E MDL (ppb)	SWAMP MDL (ppb)	UCD MDL (ppb)
Mercury	10	10	12	10
PCBs	0.6	0.1	0.2-0.3	NA
Chlordanes	NA	NA	0.19-0.47	NA
DDTs	NA	NA	0.1-0.47	NA
Dieldrin	NA	NA	0.42-0.47	NA

NA=samples not analyzed for this chemical