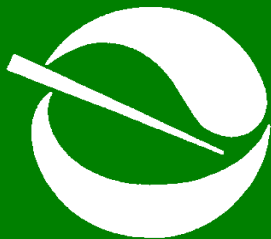


**HEALTH ADVISORY AND  
GUIDELINES  
FOR EATING FISH FROM  
THERMALITO FOREBAY AND  
THERMALITO AFTERBAY  
(Butte County)**

**September 2014**



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

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## LIST OF ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife (formerly California Department of Fish and Game)
DDTs	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyl-dichloroethylene (DDE)
DWR	Department of Water Resources
DWR I	Phase I of FERC project conducted by DWR
DWR II	Phase II of FERC project conducted by DWR
FERC	Federal Energy Regulatory Commission
MDL	method detection limit
mm	millimeter
OEHHA	Office of Environmental Health Hazard Assessment
PCBs	polychlorinated biphenyls (as congeners)
ppb	parts per billion
RL	reporting limit
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
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 Thermalito Forebay and Thermalito Afterbay in Butte County, California. It provides background information and a description of how the guidelines were developed. The resulting advice is summarized in the two illustrations after the Table of Contents.

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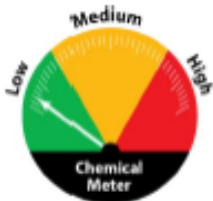
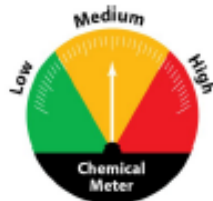
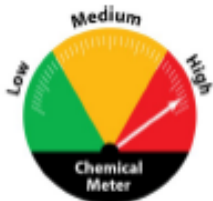

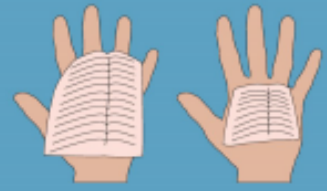
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## A Healthy Guide to Eating Fish from Thermalito Forebay and Thermalito Afterbay


### Women 18-45 years and children 1-17 years

 <p><b>Bluegill</b></p> <p><b>Redear sunfish</b></p> <p><b>Crayfish</b></p>	 <p><b>Largemouth or smallmouth bass</b> ♥</p> <p>♥ = High in Omega-3s</p>	 <p><b>Carp</b></p> <p><b>Pikeminnow</b></p>
<p>Sunfish—2 servings a week OR Crayfish—7 servings a week</p>	<p>1 serving a week</p>	<p>Do not eat</p>
<p><b>Eat only the skinless fillet.</b> PCBs are in the fat and skin of the fish.</p>  <ul style="list-style-type: none"> <li>• Remove and throw away the skin before cooking.</li> <li>• Cook thoroughly and allow the juices to drain away.</li> </ul>	<p><b>What is a serving?</b></p>  <p style="text-align: center;">For Adults    For Children</p> <p>The recommended serving is the size and thickness of your hand. Give children smaller servings.</p> <p><b>Why eat fish?</b> 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.</p> <p><b>What is the concern?</b> Some fish have high levels of mercury and PCBs. PCBs can cause cancer. Mercury can harm the brain, especially in unborn babies and children.</p>	
<p>California Office of Environmental Health Hazard Assessment • <a href="http://www.oehha.ca.gov/fish.html">www.oehha.ca.gov/fish.html</a> • (916) 327-7319 or (510) 622-3170</p>		





## A Healthy Guide to Eating Fish from Thermalito Forebay and Thermalito Afterbay

**Women over 45 years and men can safely eat more fish**

 Bluegill   Redear sunfish   Crayfish	 Largemouth or smallmouth bass    Pikeminnow  <div style="background-color: red; color: white; text-align: center; padding: 5px;"><b>Do not eat</b></div>  Carp
--	--

 = High in Omega-3s

7 servings a week
↔ OR ↔
2 servings a week
↔ OR ↔
1 serving a week

<p><b>Eat only the skinless fillet.</b> PCBs are in the fat and skin of the fish.</p>  <ul style="list-style-type: none"> <li>Remove and throw away the skin before cooking.</li> <li>Cook thoroughly and allow the juices to drain away.</li> </ul>	<p><b>What is a serving?</b></p> <div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;">For Adults    For Children</p> <p>The recommended serving is the size and thickness of your hand. Give children smaller servings.</p>	<p> <b>Why eat fish?</b></p> <p>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.</p> <p><b>What is the concern?</b></p> <p>Some fish have high levels of mercury and PCBs. PCBs can cause cancer. Mercury can harm the brain, especially in unborn babies and children.</p>
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California Office of Environmental Health Hazard Assessment • [www.oehha.ca.gov/fish.html](http://www.oehha.ca.gov/fish.html) • (916) 327-7319 or (510) 622-3170



## INTRODUCTION

This report presents guidelines for eating fish from Thermalito Forebay and Thermalito Afterbay, collectively referred to as Thermalito Forebay and Afterbay, in Butte County (Figure 1). This report provides 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), Lower Feather River (OEHHA, 2014a), and the Upper Feather River (OEHHA, 2014b).

There are several water bodies, ponds, and wetland areas open to recreational fishing downstream from the Oroville Dam in Butte County (Figure 2). They include the Diversion Pool, Oroville Wildlife Area (Thermalito Forebay and Afterbay, and ponds in the adjacent land), and the Lower Feather River (Department of Water Resources, DWR, 2006). The Thermalito Diversion Dam creates the Diversion Pool to collect and divert water from Lake Oroville to Thermalito Forebay and the Lower Feather River. Thermalito Forebay is an off-stream regulating reservoir for the Thermalito Pumping-Generation plant. It discharges water into Thermalito Afterbay, a 42,000-foot-long earth-fill dam. Thermalito Forebay and Afterbay help to regulate the dam's power system, provide storage for pump-back operations, offer recreational opportunities, and provide water to irrigation districts. The area adjacent to Thermalito Afterbay contains 12 miles of the Lower Feather River and several ponds created by dredging operations. When there is a high water release from Lake Oroville, the water from the Lower Feather River spills out to the ponds.

FIGURE 1. LOCATION OF THERMALITO FOREBAY AND AFTERBAY IN BUTTE COUNTY, CALIFORNIA

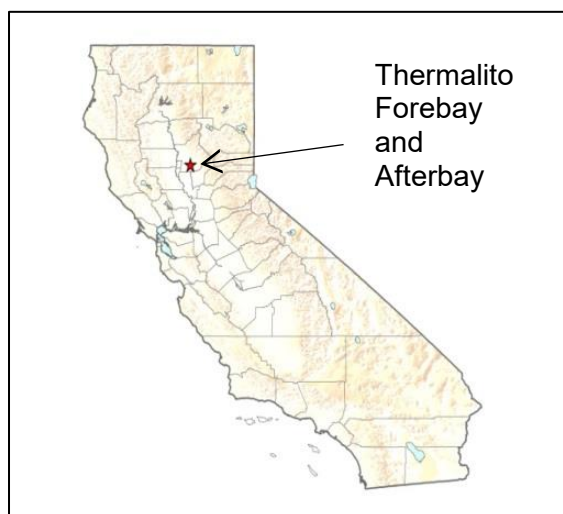


FIGURE 2. WATER BODIES IN THE THERMALITO- LAKE OROVILLE AREA



Image copied from Google™ earth. The approximate boundary of the Oroville Wildlife Area is indicated by the yellow lines.

The sport fish available include black bass (largemouth, smallmouth), channel catfish, carp, Coho salmon, crappie, sunfish (also known as panfish, bluegill, and green sunfish), and trout (brown and rainbow).<sup>1,2,3</sup> The legal size limit for black bass is 12 inches; only fish with a total length of 12 inches (305 millimeters, mm) or longer can be kept (CDFW, 2014-2015). A regulatory change in 2012 allows Coho Salmon of any size to be kept when they are taken from Thermalito Forebay and Afterbay, the Diversion Pool, and the Feather River from the Diversion Pool Dam to the Fish Barrier Dam (Fish and Game Commission, 2011). The Coho salmon in these water bodies are non-indigenous salmon, raised in the Lake Oroville hatchery beginning in 2002, that have escaped to these water bodies. The change in regulation would decrease the population that may interbreed with native Coho salmon in the Feather River or in other streams and rivers with runs of native Coho salmon. Beginning in 2011, sterile non-indigenous Coho salmon were planted in Lake Oroville. Native Coho salmon from all

<sup>1</sup> <http://www.dfg.ca.gov/lands/wa/region2/oroville.html>

<sup>2</sup> <http://www.water.ca.gov/recreation/locations/oroville/fishing.cfm>

<sup>3</sup> Scoot McReynolds, personal communications, September 2013.

other water bodies in the state must be immediately released to the waters where they were caught.

In addition, steelhead trout<sup>4</sup> are available to catch in the Forebay and Afterbay because staff with the California Department of Fish and Wildlife (CDFW) stocks them in the Afterbay to improve recreational fishing opportunities.<sup>5</sup> CDFW stocked 5,000 yearlings in 2012 and 10,000 yearlings in 2013. CDFW reported rapid growth of these trout. After one year in the freshwater, they had grown to 2 to 4 pounds. These steelhead trout can enter the Feather River via the Afterbay Outlet to the river.

Monitoring projects from DWR and a statewide lakes survey from the Surface Water Ambient Monitoring Program (SWAMP) of the State Water Resources Control Board (SWRCB) reported finding high mercury and polychlorinated biphenyl congeners (PCBs<sup>6</sup>) concentrations in some fish sampled from the Thermalito Forebay and Afterbay (DWR, 2004 and 2006; Davis et al., 2010). The results of these projects were used to support the inclusion of Thermalito Forebay (SWRCB, 2010a) and Thermalito Afterbay (SWRCB, 2010b) in the Clean Water Act 303(d) list of impaired water bodies (due to PCBs in Thermalito Forebay and mercury and PCBs in Thermalito Afterbay). The presence of mercury was attributed to gold mining at areas nearby and upstream of Thermalito Afterbay. The sources of PCBs include their previous use in the electric power plants in the Feather River watershed and two contamination events in the 1980s.

The results from the DWR and SWAMP monitoring projects provided sufficient sampling of representative fish species for the Office of Environmental Health Hazard Assessment (OEHHA) to develop this advisory for Thermalito Forebay and Afterbay. 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).

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<sup>4</sup> Steelhead trout is an anadromous form of rainbow trout. However, in the Thermalito Afterbay they are landlocked because they are growing to adult size in fresh water and are unable to migrate to the ocean and return. Some steelhead trout may escape to the Feather River through the Afterbay outlet and potentially go to saltwater, but they cannot return to the Afterbay.

<sup>5</sup> <http://cdfgnews.wordpress.com/2013/02/21/cdfw-stocks-10000-steelhead-in-thermalito-afterbay-near-oroville/>

<sup>6</sup> Congeners are related compounds with similar chemical forms. There are 209 possible PCB congeners.

## CHEMICALS OF POTENTIAL CONCERN

Fish samples from the Thermalito Forebay and Afterbay have been analyzed for mercury (as a measure of methylmercury) and PCBs as noted above. In addition, they were analyzed for 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 the fish people eat, changes in the brain may occur, 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 accumulate in fish. Depending on the exposure level, PCBs can cause cancer and other health 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 the exposure levels, 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 Thermalito Forebay and Afterbay were based on chemical analysis of fish samples by the DWR and SWAMP monitoring projects, as described below. These studies had adequate documentation of sample collection, fish preparation, chemical analyses, quality assurance, and had detection limits below levels of health concern. Table 1 shows the common and scientific names of fish species, the projects under which the samples used for this report were collected, and the years of sampling.

TABLE 1. FISH SAMPLES FROM THERMALITO FOREBAY AND AFTERBAY

Common Name	Scientific Name		Project	Year Sampled
	Family	Genus		
Bass, Largemouth	Centrarchidae	<i>Micropterus</i>	DWR I	2002
Bass, Smallmouth			DWR II	2003
			SWAMP	2007
Sunfish (Bluegill, redeer sunfish)	Centrarchidae	<i>Lepomis</i>	DWR II	2003
Carp	Cyprinidae	<i>Cyprinus</i>	DWR I DWR II SWAMP	2002 2003 2007
Pikeminnow	Cyprinidae	<i>Ptychocheilus</i>	DWR I	2002
Crayfish	NA	NA	DWR I	2002

Abbreviations: DWR=Department of Water Resources, NA=not provided in DWR report, SWAMP=Surface Water Ambient Monitoring Program

## FEDERAL ENERGY REGULATORY COMMISSION (FERC) RELICENSING PROJECT No. 2100

DWR collected biota and sediment samples to evaluate chemical contamination of Lake Oroville and water bodies in the vicinity (Lower Feather River and the Oroville Wildlife Area) for the Oroville FERC Relicensing Project No. 2100 (DWR, 2004 and 2006).

Phase I of the project (referred to as DWR I) evaluated contaminants in biota and sediments in 2002 (DWR, 2004). Fish collected from the Thermalito Forebay and Afterbay included largemouth bass, carp, and pikeminnow. In 2003, Phase II (referred to as DWR II) evaluated sources of the contamination and extent of downstream effects (DWR, 2006). The fish collected were largemouth bass and small sunfish (bluegill and redear sunfish).

## SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

A statewide survey of inland water bodies was conducted by the State Water Resources Control Board under its SWAMP program, which sampled fish from 272 of California's more than 9,000 lakes and reservoirs from 2007 to 2008 (Davis et al., 2010). Of the surveyed lakes, 222 were targeted for sampling as popular fishing lakes and an additional 50 (including Thermalito Afterbay) were selected using a random sampling draw to provide a statistical statewide assessment. In this survey, smallmouth bass and carp were collected from Thermalito Afterbay in 2007.<sup>7</sup>

<sup>7</sup> California Environmental Data Exchange Network, <http://www.ceden.us/AdvancedQueryTool>

## CHEMICAL CONCENTRATIONS

### CHEMICAL ANALYSIS

Fish samples were prepared as skinless fillets for analysis of mercury, PCBs, and pesticides. Crayfish were analyzed as whole body. 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 combusted and analyzed by inductively coupled plasma-mass spectrometry in the DWR projects, and by atomic absorption spectrometry in the SWAMP lakes survey. Samples from all species, except for sunfish, were analyzed by gas chromatography for PCBs, DDTs, dieldrin, and chlordanes. The specific chemicals were: PCB congeners (47 to 54 congeners); total DDTs including o,p' and p,p' DDT, o,p' and p,p' dichlorodipenyldichloroethane (DDD), and o,p' and p,p' dichlorodiphenyl-dichloroethylene (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]).<sup>8</sup> Fish sampled from Thermalito Forebay and Afterbay were measured as total length or fork length (in millimeters [mm]).<sup>9</sup> Fork length was converted to total length, as the standard measurement, using conversion factors OEHHA estimated from limited available length data for select species and by considering the degree of fork in the tail, which associates these two length measurements.

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. The one exception was a sample (9 fish) of bluegill where the ratio was 0.68. This sample was included in the evaluation so that there would be a sufficient number of fish to develop the advice for sunfish, a common sport fish for these water bodies. The mercury concentration of this

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<sup>8</sup> 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.

<sup>9</sup> Total length refers to the length from the tip of the snout to the tip of the longer lobe of the caudal fin. Fork length refers to the length from the tip of the snout to the end of the middle caudal fin rays.

sample (90 ppb) was within the range of mercury concentrations (30 to 90 ppb) in other sunfish samples (three individual samples and one composite of three fish).

## 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 (Wiener et al., 2007). Table 2 shows the weighted mean total fish lengths and mean mercury concentrations for each fish species collected from Thermalito Forebay and Afterbay.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM THERMALITO FOREBAY AND AFTERBAY

Fish Species	Number of Samples	Total Number of Fish <sup>a</sup>	Mean Total Length <sup>b</sup> (mm)	Mercury (ppb)	
				Mean <sup>c</sup>	Range
Black Bass	31	37	395	291	87-688
Carp	11	33	599	185	100-243
Crayfish	2	20	No Data	26	25-26
Pikeminnow	1	7	771	543	NA
Sunfish	5	15	163	75	30-90

<sup>a</sup> 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.

<sup>b</sup> Mean total fish length is weighted according to the number of fish in each composite sample.

<sup>c</sup> Mean concentration is weighted according to the number of fish in each composite sample.

NA=Not applicable because 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,  $\leq 2$  parts per billion (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 and Table 4 show the weighted mean total lengths and mean chemical concentrations for PCBs, and the measured pesticides, respectively.

TABLE 3. PCB CONCENTRATIONS IN FISH FROM THERMALITO FOREBAY AND AFTERBAY

Fish Species	Number of Samples	Total Number of Fish <sup>a</sup>	Mean Total Length <sup>b</sup> (mm)	PCBs (ppb)	
				Mean <sup>c</sup>	Range
Black Bass	4	22	386	5	2-7
Carp	7	33	599	99	23-281
Crayfish	2	20	No Data	7	6-7
Pikeminnow	1	7	771	187	NA
Sunfish	0	0	NA	NA	NA

<sup>a</sup> 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.

<sup>b</sup> Mean total fish length is weighted according to the number of fish in each composite sample.

<sup>c</sup> Mean concentration is weighted according to the number of fish in each composite sample.

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

TABLE 4. PESTICIDE CONCENTRATIONS IN FISH FROM THERMALITO FOREBAY AND AFTERBAY

Fish Species	Number of Samples	Total Number of Fish <sup>a</sup>	Mean Chlordanes <sup>b</sup> (ppb)	Mean DDTs <sup>b</sup> (ppb)	Mean Dieldrin <sup>b</sup> (ppb)
Black Bass	2	8	4	143	<1
Carp	4	23	4	69	<1
Crayfish	2	20	<1	4	<1
Pikeminnow	1	7	13	105	2
Sunfish	0	0	NA	NA	NA

<sup>a</sup> 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.

<sup>b</sup> Mean concentration is weighted according to the number of fish in each composite sample. When the detected concentration is lower than the MDL, the highest MDL is shown in this table.

NA=not applicable because no sample was analyzed.



## DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM THERMALITO FOREBAY AND AFTERBAY

### 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 seafood<sup>10</sup> 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 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

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<sup>10</sup> “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).

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 advisory<sup>11</sup>, 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 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.

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<sup>11</sup> A species group includes related species. Fish species within the same genus are most closely related, and Family is the next level of relationship.

## CONSUMPTION ADVICE FOR FISH FROM THERMALITO FOREBAY AND AFTERBAY

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 5, 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

The black bass samples consisted of largemouth and smallmouth bass. The mean concentrations were 291 ppb mercury and 5 ppb PCBs. The advice is based on mercury. OEHHA recommends one serving per week for the sensitive population and two servings per week for women over 45 years and men.

### CARP

In carp, the mean concentrations were 185 ppb for mercury and 99 ppb for PCBs. The PCB concentration was high in three samples (94 ppb to 281 ppb) of large carp (total fish lengths of 583, 601, and 694 mm). The sample (total fish length of 694 mm) with the highest PCBs (281 ppb) was collected from Thermalito Forebay; this was the only sample collected at this site. This sample also has the highest levels of pesticides, compared to other carp samples. As presented below, a sample of pikeminnow collected from the Forebay also contained high levels of PCBs.

For the sensitive population, the consumption frequency would be one serving per week based on either mean mercury or PCB concentrations. However, multiple chemical exposure assessment showed that the consumption advice needed to be reduced. Thus, OEHHA recommends the sensitive population not eat carp. For women over 45 years and men, the advice is one serving per week, determined by PCB concentration.

### CRAYFISH

Even though size data were not available, OEHHA decided to provide advice because crayfish are consumed and there was sufficient tissue chemical data. Mean mercury (26 ppb) and PCB (7 ppb) concentrations in crayfish were low enough that they can be eaten daily by all consumers.

### PIKEMINNOW

There was only one sample (7 fish) of pikeminnow, which was collected from Thermalito Forebay. The chemical concentrations were high: 543 ppb mercury and 187 ppb PCBs. While this sample did not reach the minimum criterion of 9 fish, the high PCB level exceeded the threshold for any consumption. Thus, OEHHA recommends that pikeminnow should not be consumed. High mercury concentrations have also been found in pikeminnow collected from other water bodies including the Lower Feather River, Yuba River, Sacramento River, and the American River. OEHHA has recommended no consumption of pikeminnow from these water bodies.

## SUNFISH

The mercury data for bluegill and redear sunfish samples were combined. They are of the same family and genus, and the samples had similar total length and mercury concentrations. The mean mercury concentration was 75 ppb. There was no data for PCBs and pesticides. OEHHA recommends two servings per week for the sensitive population and seven servings per week for women over 45 years and men.

## OTHER SPECIES

There were no data for Coho salmon, catfish, crappie, and trout (steelhead, brook, or rainbow) which could be caught at Thermalito Forebay and Afterbay. In the absence of data and no related species in the dataset, OEHHA could not develop advice for these species. Future sampling studies should include these species, as well as investigation into the high PCB concentrations in fish (carp and pikeminnow) from the Forebay.

## RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK

The following table (Table 5) presents the consumption advice developed for fish species found in Thermalito Forebay and Afterbay.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THERMALITO FOREBAY AND AFTERBAY

<b>Fish Species</b>	<b>Women 18–45 Years and Children 1 to 17 Years</b>	<b>Women over 45 Years and Men</b>
Pikeminnow	0	0
Carp	0	1
Black Bass	1	2
Sunfish (Bluegill, redear sunfish)	2	7
Crayfish	7	7

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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 show 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 dose<sup>12</sup> 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 Thermalito Forebay and Afterbay are followed, exposure to chemicals in fish from these water bodies would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

TABLE 6. ADVISORY TISSUE LEVELS FOR METHYLMERCURY AND PCBs

Number of servings per week <sup>a</sup>	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

<sup>a</sup>/ Serving sizes (prior to cooking, wet weight) are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts. When residue data are compared to this table they should also first be rounded to the second significant digit.

<sup>12</sup> The reference dose is an estimate of the maximum daily exposure to a chemical likely to be without significant risk of harmful health effects during a lifetime.



## APPENDIX II. DETECTION LIMITS

Table 7 shows that the detection limits for the projects used in this report. The method detection limit (MDL) is the lowest concentration of a chemical that can be distinguished (as greater than zero) in a sample. The reporting limit (RL) is the lowest concentration of a chemical that can be accurately quantified in a sample.

TABLE 7. METHOD DETECTION LIMITS AND REPORTING LIMITS

<b>Chemical</b>	<b>DWR Study RL</b>	<b>SWAMP Lakes Study MDL</b>
Mercury	10 ppb	10 ppb
PCBs	0.6 ppb	0.09 to 0.24 ppb
Chlordanes	1 ppb	0.19 to 0.46 ppb
DDTs	2 ppb	0.09 to 0.47 ppb
Dieldrin	1 ppb	0.42 ppb

Abbreviation: ppb=parts per billion.