OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from Anderson Lake (Santa Clara County)

August 2017

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

LIST OF CONTRIBUTORS

Office of Environmental Health Hazard Assessment

Authors

Wesley Smith, Ph.D.
Huyen Tran Pham, M.P.H.

Primary Reviewers

Susan A. Klasing, Ph.D., Section Chief
Shannon R. Murphy, Ph.D.
Lori Chumney, M.S.

Final Reviewers

David Ting, Ph.D., Branch Chief
David Siegel, Ph.D., Assistant to the Deputy Director
Allan Hirsch, Chief Deputy Director

Director

Lauren Zeise, Ph.D.

ACKNOWLEDGMENTS

Developing fish consumption advisories depends on sampling and analysis of fish. The Office of Environmental Health Hazard Assessment (OEHHA) acknowledges the contribution of information from the following entities: the State Water Resources Control Board (SWRCB), the California Department of Fish and Wildlife and its analytical resources, the Moss Landing Marine Laboratories and the Water Pollution Control Laboratory. Data were obtained from the California Environmental Data Exchange Network (http://www.ceden.us/AdvancedQueryTool). The map was created using ArcMap (10.3) from Environmental Systems Resource Institute (ESRI, Redlands, California).

For further information, contact:

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

1515 Clay Street, 16th Floor
Oakland, California 94612
Telephone: (510) 622-3170
Email address: fish@oehha.ca.gov

1001 I Street, P.O. Box 4010
Sacramento, CA 95812-4010
Telephone: (916) 324-7572

LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
EPA	eicosapentaenoic acid
FDA	Food and Drug Administration
Hg	mercury
MDL	method detection limit
MLML	Moss Landing Marine Laboratories
mm	millimeters
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
RWB2	Regional Water Board 2
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
TSMP	Toxic Substances Monitoring Program
USDA	United States Department of Agriculture

USDHHS	United States Department of Health and Human Services
US EPA	United States Environmental Protection Agency

PREFACE

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

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

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

This report presents guidelines for eating fish from Anderson Lake in Santa Clara County. The report provides background information and a technical description of how the guidelines were developed. The resulting advice is summarized in the illustrations after the Table of Contents and List of Figures and Tables.

TABLE OF CONTENTS

A GUIDE TO EATING FISH FROM ANDERSON LAKE 6

INTRODUCTION 7

Location 7

Approach Used 8

CHEMICALS OF POTENTIAL CONCERN 8

DATA SOURCES 10

Surface Water Ambient Monitoring Program (SWAMP): Contaminants in Fish From California Lakes and Reservoirs Project, 2007-2008 10

Regional Water Quality Control Board, San Francisco Bay (RWB2) Fish Contamination Study, 2004-2005 10

Toxic Substances Monitoring Program (TSMP) 10

FISH SAMPLED FROM ANDERSON LAKE 10

CHEMICAL CONCENTRATIONS 12

Mercury 12

PCBs, PBDEs, and Pesticides 13

Selenium 14

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM ANDERSON LAKE 14

CONSUMPTION ADVICE FOR FISH FROM ANDERSON LAKE 16

Black Bass Species (Largemouth Bass) 17

Channel Catfish 17

Common Carp 17

Crappie (Black Crappie) 17

Sunfish Species (Bluegill) 18

RECOMMENDED MAXIMUM NUMBER OF SERVINGS 18

REFERENCES 19

APPENDIX I. Advisory Tissue Levels 22

LIST OF FIGURES AND TABLES

Figure 1. Location of Anderson Lake 7

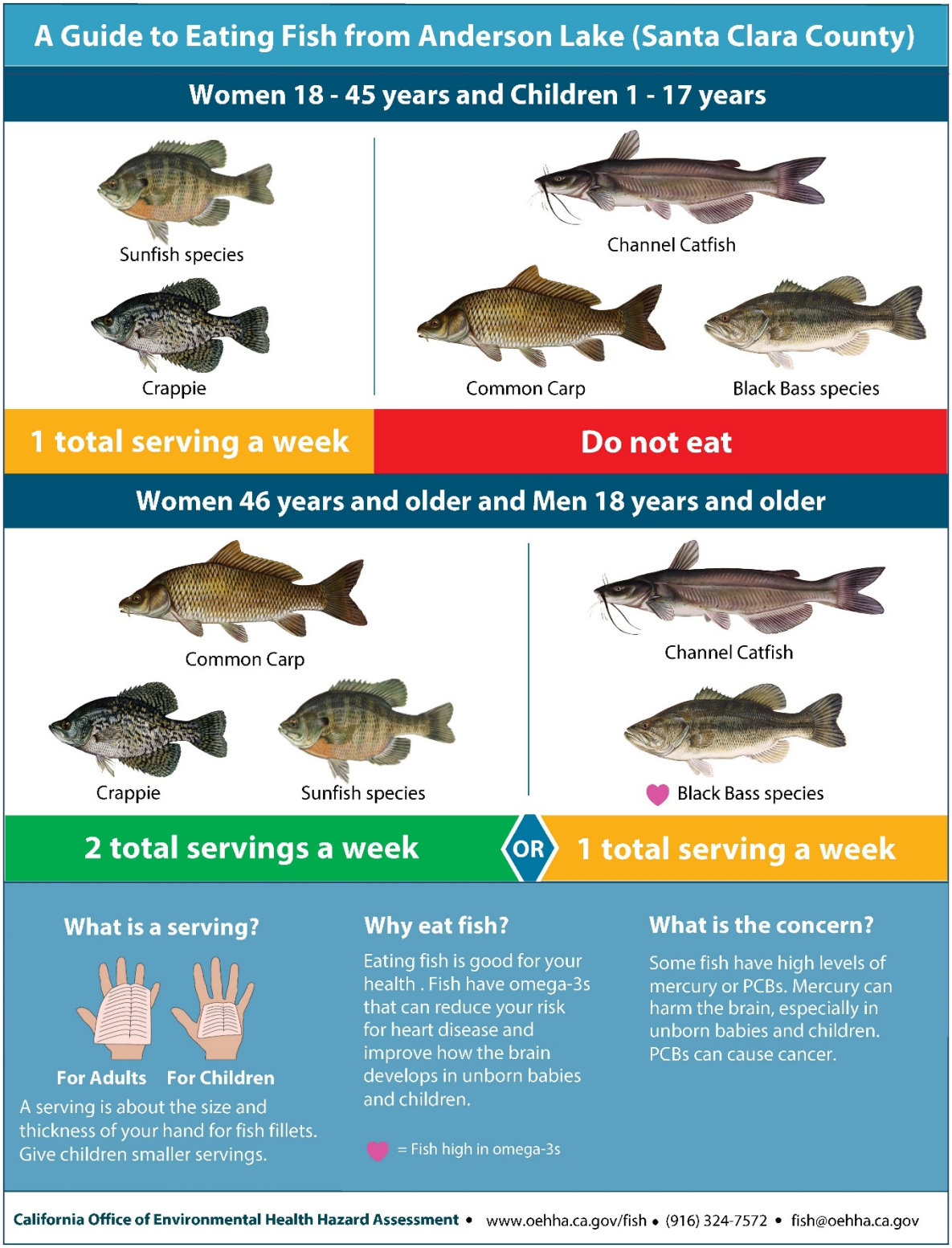
Table 1. Fish Samples Evaluated for the Anderson Lake Advisory 11

Table 2. Mercury Concentrations in Fish from Anderson Lake 13

Table 3. PCB Concentrations in Fish from Anderson Lake 14

Table 4. Recommended Maximum Number of Servings per Week for Fish from Anderson Lake 18

Advisory Tissue Levels for Selected Analytes 22


A Guide to Eating Fish from Anderson Lake (Santa Clara County)
Women 18 - 45 years and Children 1 - 17 years
Sunfish species
Crappie
Channel Catfish
Common Carp
Black Bass species
1 total serving a week
Do not eat
Women 46 years and older and Men 18 years and older
Common Carp
Crappie
Sunfish species
Channel Catfish
Black Bass species
2 total servings a week
OR
1 total serving a week
What is a serving?
For Adults
For Children
A serving is about 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 or PCBs. Mercury can harm the brain, especially in unborn babies and children. PCBs can cause cancer.
California Office of Environmental Health Hazard Assessment • www.oehha.ca.gov/fish • (916) 324-7572 • fish@oehha.ca.gov

INTRODUCTION

This report presents an update for eating fish from Anderson Lake (also referred to as Anderson Reservoir) (Figure 1) in Santa Clara County, located northeast of Morgan Hill. The previous update was developed in 2009 and included advice for black bass species, carp, and crappie. Adequate data are available to update the previous advisory to include Bluegill. Advice for Channel Catfish was also developed due to health concerns, although the sampling data do not meet OEHHA quality objectives, as discussed in the advisory.

LOCATION

Anderson Lake, operated by the Santa Clara County Water District, is approximately 7 miles long and has a capacity of 89,073 acre-feet. The 953 surface-acre lake is formed by Anderson Dam, built in 1950 on Coyote Creek. [1,2] The fishing season is year-round at Anderson Lake.

FIGURE 1. LOCATION OF ANDERSON LAKE

[1] https://www.sccgov.org/sites/parks/parkfinder/pages/andersonlake.aspx
[2] http://www.valleywater.org/Services/AndersonDamAndReservoir.aspx

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from three monitoring studies described in this report to develop the Anderson Lake Advisory. OEHHA uses the following general process in developing consumption advice for sport fish:

1) Evaluation of all fish contaminant data available from a water body and selection of appropriate data that meet data quality criteria and sampling plan guidelines.
2) Determination of fish species for which adequate data are available to issue fish consumption advice.
3) Calculation of an appropriate measure of central tendency (often a weighted arithmetic mean[3]) and other descriptive statistics of the contaminant data, as appropriate, for a chemical of potential concern for the selected fish species.
4) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of potential concern.
5) Development of final advice based on a thorough review of the data and best professional judgment relating to the benefits and risks of consuming a particular fish species.

The ATLs (discussed further in a subsequent section of this report) are chemical levels in fish tissue that are considered acceptable, based on chemical toxicity, for a range of consumption rates. Development of the ATLs also included consideration of health benefits associated with including fish in the diet (OEHHA, 2008). The ATLs should not be interpreted as static “bright lines”, but one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of 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 (Hg), followed by polychlorinated biphenyls (PCBs) and, in a few cases, selenium (Se) or some legacy pesticides (pesticides that are no longer used but remain in the environment).

Mercury is a natural element found in some rock and soil. Human activities, such as burning coal and the historic 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

---

[3] Means are an arithmetic average of individual values and/or a weighted average of composites. A weighted average of composites is calculated by multiplying the chemical concentration in each composite by the number of fish in that composite for each species. Products are then summed and divided by the total number of fish in all composites for that species, combined.

known as methylmercury – which can pass into and build up in fish. High levels of methylmercury can harm the brain, especially in fetuses and children.

PCBs are industrial chemicals previously used in electrical transformers, plastics, and lubricating oils, often as flame retardants or electrical insulators. Their use was banned in the 1970s, but they persist in the environment because they do not break down easily and can accumulate in fish. Depending on the exposure level, PCBs may cause cancer or other health effects, including neurotoxicity, in humans.

Selenium is a naturally occurring metalloid and at low doses is an essential nutrient for many important human health processes, including thyroid regulation and vitamin C metabolism. Higher doses cause selenium toxicity, which can include symptoms ranging from hair loss and gastrointestinal distress to dizziness and tremors.

Chlordanes, dichlorodiphenyltrichloroethane (DDT), dieldrin, and toxaphene are pesticides that were banned from use in 1973 (DDT), the late 1980s (chlordanes and dieldrin) and 1990 (toxaphene), but are still found in some fish in certain water bodies in California. Depending on the exposure level, these chemicals may cause cancer or adverse effects on the nervous system.

Polybrominated diphenyl ethers (PBDEs) are a class of flame retardants historically used in a variety of consumer products including furniture, textiles, automotive parts, and electronics. The use of PBDEs in new products was largely phased out by 2013 but, due to their wide usage and persistence in the environment, they are still being detected in fish tissues. PBDEs may affect hormone levels or learning and behavior in children.

Detailed discussion of the toxicity of these chemicals and references are presented in “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene” (OEHHA, 2008) and “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)” (OEHHA, 2011).

All fish species collected from Anderson Lake and used in advisory development were analyzed for mercury (as a measure of methylmercury) and the legacy pesticides (chlordanes, dieldrin, DDTs [DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]), with the exception of Largemouth Bass (mercury only). Black Crappie and Common Carp were also analyzed for toxaphene. Additionally, Bluegill, Channel Catfish, and Common Carp were analyzed for PCBs, and Common Carp were further analyzed for PBDEs and selenium. Among the chemicals analyzed in fish tissue samples from Anderson Lake, mercury and PCB levels were sufficiently high to impact consumption advice. For this reason, levels of other contaminants are not shown in this report.

DATA SOURCES

The guidelines for eating fish from Anderson Lake are based on the chemicals detected in the fish collected for the three monitoring studies described below. These studies met OEHHA's data quality criteria, including adequate documentation of sample collection, fish preparation method (e.g., skinning or filleting), chemical analyses, quality assurance, and sufficiently low detection limits. "Sample," as used in this report, refers to an individual fish or a composite of multiple fish for which contaminant data was reported. "Sampling" or "sampled" refers to the act of collecting fish for chemical analysis.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP): CONTAMINANTS IN FISH FROM CALIFORNIA LAKES AND RESERVOIRS PROJECT, 2007-2008

SWAMP, operated by the the State Water Resources Control Board (SWRCB) in cooperation with Regional Water Quality Control Board staff, monitors water quality in California's surface waters. The program collected Common Carp and Largemouth Bass from Anderson Lake in 2007 to analyze mercury in both species, and chlordanes, DDTs, dieldrin, selenium, PCBs, and PBDEs in Common Carp, as part of a SWAMP statewide sampling effort to survey contaminants in sport fish found in California lakes and reservoirs (SWRCB, 2010).

REGIONAL WATER QUALITY CONTROL BOARD, SAN FRANCISCO BAY (RWB2) FISH CONTAMINATION STUDY, 2004-2005

The RWB2 collected Bluegill and Channel Catfish in 2004 and 2005 to analyze for levels of chlordanes, DDTs, dieldrin, PCBs, and mercury (RWQCB, 2013).

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP, (1976-2003) was a state water quality-monitoring program managed by the SWRCB (SWRCB, 2007 and 2013). Its objective was to provide statewide information on the occurrence of toxic substances by monitoring water bodies with known or suspected water quality impairment. Staff from the California Department of Fish and Wildlife (CDFW), then known as the Department of Fish and Game, collected Largemouth Bass in 1982 and 2001 to analyze for mercury. In 2001, Black Crappie and Common Carp were analyzed for chlordanes, DDTs, dieldrin, mercury, and toxaphene.

FISH SAMPLED FROM ANDERSON LAKE

The fish sampling data used in this advisory were retrieved from the California Environmental Data Exchange Network (CEDEN), the State's repository for environmental data. Samples were excluded when the fish were not legal size to take or did not meet OEHHA's criteria for minimum "edible" size based on species size at maturity and professional judgment (as described in OEHHA, 2005). A summary of all fish species included in this advisory is shown in Table 1, including the name of the

species, number of samples, total number of fish, project name, year sampled, and contaminants analyzed.

TABLE 1. FISH SAMPLES EVALUATED FOR THE ANDERSON LAKE ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project Name	Year Sampled	Contaminants Analyzed
Black Crappie	*Pomoxis nigromaculatus*	2	8	TSMP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, Toxaphene
Bluegill	*Lepomis macrochirus*	2	20	RWB2	2005	Hg
		1	10	RWB2	2005	Chlordanes, DDTs, Dieldrin, PCBs
Channel Catfish	*Ictalurus punctatus*	1	3	RWB2	2004-2005	Chlordanes, DDTs, Dieldrin, PCBs
		3	3	RWB2	2004-2005	Hg
Common Carp	*Carassius auratus*	3	12	TSMP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, Toxaphene
		2	10	SWAMP	2007	Hg
		1	5	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs, Se
Largemouth Bass	*Micropterus salmoides*	1	2	TSMP[a]	1982	Hg
		3	12	TSMP[a]	2001	Hg
		7	7	SWAMP	2007	Hg

[a]Study report did not specify whether skin was removed from fillets prior to tissue analysis.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, PBDEs, PCBs (48-55 congeners[4]), and toxaphene. All fish samples were prepared as skinless fillets, except for the TSMP study where the fillet preparation method for Black Crappie, Common Carp, and Largemouth Bass was not recorded. Samples were analyzed as individual fish or composites.

Composites were prepared from equal amounts of tissue from several similarly sized individual fish of a species. For composite samples, the total length of the smallest fish in a composite sample must be at least 75% of the length of the largest fish in the sample (US EPA, 2000a). This information is not available for samples collected in the TSMP program; however, OEHHA assumes that the data is in compliance with the 75% rule. Composite samples from Anderson Lake met this requirement, except for Channel Catfish. One composite sample of three Channel Catfish was analyzed for PCBs. The length of the smallest fish in the composite was only 48% of the length of the largest fish in the composite. These data are shown in Table 3 but did not affect advice for this species.

For this advisory, OEHHA used the weighted (by the number of individual fish) arithmetic mean (average) of the chemical concentrations (in wet weight) for each fish species to estimate average human exposure.

MERCURY

Samples were analyzed for total mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA) at the CDFW Moss Landing Marine Laboratories (MLML). The DMA method utilizes thermal decomposition and atomic absorption. OEHHA assumed all mercury detected was methylmercury, which is the most common form found in fish and is also the more toxic form (Bloom, 1992). Table 2 shows the averages and ranges for total length[5], as well as mercury concentrations in each fish species. The DMA method detection limit (MDL)[6] and the reporting limit (RL)[7] for total mercury were reported at 9 or 12, and 12 or 26 parts per billion (ppb), respectively. Although mercury was detected at commonly found concentrations in the TSMP study, the MDL and RL for mercury were not reported.

---

[4] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.
[5] 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.
[6] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[7] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM ANDERSON LAKE

Species from Anderson Lake	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Black Crappie	2	8	215	190 – 239	315	254 – 375
Bluegill	2	20	136	120 – 148	279	256 – 301
Channel Catfish	3	3	540	360 – 746	1019	577 – 1350
Common Carp	5	22	479	407 – 540	422	316 – 516
Largemouth Bass	11	21	377	307 – 515	1114	680 – 1610

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

PCBS, PBDES, AND PESTICIDES

Some composite samples were analyzed for PCBs, PBDEs, and the legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene). Pesticides, PBDEs and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, PCBs, and PBDEs, each of the concentrations presented was the sum of the detected parent compound, congeners, or metabolites, where applicable. Since the MDLs or RLs were relatively low (≤ 5 ppb), individual congeners or metabolites with concentrations reported as non-detects were assumed to be zero. This is a standard method of handling non-detect values for PCBs and other chemicals with multiple congeners or metabolites in a given sample when detection levels are adequate (US EPA, 2000a). Table 3 shows the averages and ranges for total length[8], as well as PCB concentrations in each fish species. Concentrations of chlordanes, dieldrin, DDTs, PBDEs, and toxaphene were not sufficiently high to alter consumption advice and are not shown.

[8] 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.

TABLE 3. PCB CONCENTRATIONS IN FISH FROM ANDERSON LAKE

Species from Anderson Lake	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCBs (ppb)	
					Mean*	Range**
Bluegill	1	10	154	150 – 168	2	n/a
Channel Catfish	1	3	540	360 – 746	8	n/a
Common Carp	1	5	503	470 – 524	10	n/a

*Means are an arithmetic average of individual values and/or a weighted average of composites.
**Range of individuals and/or range of the composites.
n/a – not applicable

SELENIUM

Selenium was analyzed in a single composite of five Common Carp with reported MDL and RL values at 100 and 300 ppb, respectively. The selenium concentration was not sufficiently high to alter consumption advice and is not shown.

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM ANDERSON LAKE

The OEHHA fish advisory process considers the health benefits of fish consumption as well as the risk from exposure to the chemical contaminants found in fish. Benefits are included in the advisory process because there is considerable evidence and scientific consensus that fish should be part of a healthy, well-balanced diet. Fish contain many nutrients that are important for general health and, in particular, help promote optimal growth and development of babies and young children, and may reduce the incidence of heart disease in adults (FDA/US EPA, 2017; American Heart Association, 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 seafood[9] "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

[9] "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).

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 and 2008). Accordingly, because of the high mercury content of certain fish species, the FDA and US EPA recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children avoid consuming shark, swordfish, tilefish (Gulf of Mexico), bigeye tuna, marlin, orange roughy, and king mackerel (FDA/US EPA, 2017).

In order to address the potential health concerns associated with exposure to contaminants in sport fish, OEHHA has established ATLs for chemicals that are known to accumulate in the edible tissues of fish. ATLs consider both the toxicity of the chemical and potential benefits of eating fish. OEHHA uses the ATLs to determine the maximum number of servings per week that consumers can eat, 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, are lower than those 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) and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated Diphenyl Ethers (PBDEs)" (OEHHA, 2011). A list of the ATLs used in this report is presented in Appendix I.

For each fish species in this advisory, OEHHA compared the mean mercury and PCB concentrations detected in the fillet to the corresponding ATLs to establish the maximum number of servings per week that could be consumed (see Appendix I).

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of servings per week. Because some chemicals, such as mercury and PCBs, are known to have similar adverse effects, additivity of toxicity is assumed in such cases and may be assessed using multiple chemical exposure methodology (US EPA, 1989 and 2000b). If two or more chemicals with similar adverse effects are present in fish tissue at levels above the corresponding ATL values for daily

consumption, multiple chemical exposure methodology is employed. This may result in advising the sensitive population to consume fewer meals per week than would be the case for the presence of one chemical alone, in a similar concentration. The potential effect of multiple chemical exposures (mercury and PCBs) was assessed in Bluegill, Channel Catfish, and Common Carp, and affected advice for Common Carp. Advice for other species in this advisory was based solely on mercury or, in one case, mercury and PCB concentrations.

OEHHA recommends that individuals strive to meet the US Dietary Guidelines seafood consumption recommendations, while also adhering to federal and OEHHA recommendations to limit the consumption of fish with higher contaminant levels. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish species. People should eat no more than the recommended number of servings for each fish species or species group. OEHHA's advice on consuming a particular fish species can be extended to other closely related fish species[10] 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 (including commercial) 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, or eat one fish from that category and one from a category that recommends more than two-servings-per-week (if available), for a total of two servings in that week. Then they should not eat any other fish from any source (including commercial) until the following week.

CONSUMPTION ADVICE FOR FISH FROM ANDERSON LAKE

OEHHA's advisory protocol requires at least nine fish of a species to be collected from a water body before an advisory can be developed for the primary contaminant of concern. This is to ensure the sample dataset is representative of the fish species population in the water body. In some cases, an exception is made for species that are commonly caught and consumed from a given water body but where available data may be limited. The advice for Channel Catfish, which is based on three individuals, was included due to the high mercury levels found in catfish and other species in Anderson Lake. For Anderson Lake, the sample size criterion was met for the following species: Black Crappie, Bluegill, Common Carp, and Largemouth Bass. There were not sufficient data to evaluate other species that may be found in this water body.

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

Black Bass Species (Largemouth Bass)

Based on the mean mercury concentration of 1114 ppb, OEHHA recommends no consumption of black bass species 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). PCBs were not analyzed in Largemouth Bass.

OEHHA has evaluated mercury concentrations in black bass species in many water bodies in California and has found a similar range of mercury concentrations when two or more of these species were caught from the same water body. Therefore, OEHHA extends the consumption advice for Largemouth Bass to other black bass species, including Redeye, Smallmouth, and Spotted Bass.

Channel Catfish

Mercury and PCBs were only evaluated in three Channel Catfish, which had mean mercury and PCB concentrations of 1019 and 8 ppb, respectively. Although contaminant data from three fish is generally considered insufficient to provide consumption advice, the range of mercury concentrations in these Channel Catfish was consistent with mercury concentrations found in Largemouth Bass in this water body. Mercury has been shown to accumulate in Channel Catfish in some water bodies to similar or higher concentrations than in Largemouth Bass (e.g,. Shasta Lake, Lake Natoma). For this reason, OEHHA determined that providing health protective consumption advice was appropriate in this case. OEHHA recommends no consumption of Channel Catfish 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), based on mercury. PCBs did not impact the advice.

Common Carp

The mean mercury and PCB concentrations in Common Carp from Anderson Lake were 422 and 10 ppb, respectively. OEHHA recommends no consumption of Common Carp for the sensitive population (women 18 to 45 years and children 1 to 17 years), based on mercury and PCBs, and a maximum of two serving a week for the general population (women 46 years and older, and men 18 years and older), based on mercury.

Crappie (Black Crappie)

The mean mercury concentration in Black Crappie from Anderson Lake was 315 ppb. 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 two servings a week for the general population (women 46 years and older, and men 18 years and older), based on mercury. PCBs were not analyzed in Black Crappie.

Contaminant concentrations in crappie species are generally similar within the same water body. Therefore, advice for Black Crappie can be extended to White Crappie.

Sunfish Species (Bluegill)

The mean mercury and PCBs concentrations in sunfish species from Anderson Lake were 279 and 2 ppb, respectively. 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 two servings a week the general population (women 46 years and older, and men 18 years and older), based on mercury. PCBs did not impact the advice.

OEHHA has evaluated mercury concentrations in sunfish species in many water bodies in California and has found a similar range of mercury concentrations when two or more of these species were caught from the same water body. Therefore, OEHHA extends the consumption advice for sunfish species (Bluegill) to other sunfish species, including Green Sunfish, Pumpkinseed, and Redear Sunfish.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from Anderson Lake are shown in Table 4.

Table 4. Recommended Maximum Number of Servings per Week for Fish from Anderson Lake

Fish Species	Women 18–45 years and Children 1–17 years	Women 46 years and older and Men 18 years and older
Black Bass species	0	1
Channel Catfish	0	1
Common Carp	0	2
Crappie	1	2
Sunfish species	1	2

REFERENCES

American Heart Association. 2014. Fish and Omega-3 Fatty Acids. Online at: http://www.americanheart.org/presenter.jhtml?identifier=4632.

Bloom, N.S. 1992. On the chemical form of mercury in edible fish and marine invertebrate tissue. Can. J. Fish. Aquat. Sci. 49(5):1010-1017.

FDA/USEPA. 2017. Eating Fish: What pregnant women and parents should know. Advice by FDA and US EPA/January, 2017. Online at: http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/Metals/UCM537120.pdf.

Institute of Medicine. 2007. Seafood choices, balancing benefits and risks. Committee on Nutrient Relationships in Seafood: Selections to Balance Benefits and Risks. Institute of Medicine, 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. Circ. 106:2747-2757.

OEHHA. 2005. General Protocol for Sport Fish Sampling and Analysis. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://oehha.ca.gov/media/downloads/fish/document/fishsamplingprotocol2005.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, California. Online at: http://oehha.ca.gov/media/downloads/fish/report/atlmhgandothers2008c.pdf.

OEHHA. 2011. Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Polybrominated diphenyl ethers (PBDEs). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, California. Online at: http://oehha.ca.gov/media/downloads/fish/report/pbdes052311.pdf.

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.

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.

RWQCB. 2013. Fact Sheet: Region 2. Regional Water Quality Control Board, San Francisco Bay, Region 2, California Environmental Protection Agency. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/factsheets/rb2_cw101.pdf.

SWRCB. 2007. Bioaccumulation of Pollutants in California Waters: A Review of Historic Data and Assessment of Impacts on Fishing and Aquatic Life. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/bop/cw117_swrcb_report.pdf.

SWRCB. 2010. Contaminants in Fish from California Lakes and Reservoirs, 2007-2008: Summary Report on a Two-Year Screening Survey. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/lakes_study/lake_survey_yr2_no_app.pdf.

SWRCB. 2013. State Mussel Watch (SMW) Program/Toxic Substances Monitoring (TSM) Program. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California. Online at: http://www.waterboards.ca.gov/water_issues/programs/swamp/mussel_watch.shtml.

USDA/USDHHS. 2015. 2015-2020 Dietary Guidelines for Americans. 8th Edition. U.S. Government Printing Office, Washington, D.C. December. Online at: http://health.gov/dietaryguidelines/2015/guidelines/.

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: https://rais.ornl.gov/documents/HHEMA.pdf.

US EPA. 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1. Fish Sampling and Analysis. 3rd Ed. EPA 823-B00-007. Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

US EPA. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 2. Risk Assessment and Fish Consumption Limits, 3rd Edition. EPA 823-B-00-007. Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

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 Assoc. 108:1178-1185.

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 dose[11] 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 Anderson Lake are followed, exposure to chemicals in fish from Anderson Lake would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

ADVISORY TISSUE LEVELS FOR SELECTED ANALYTES

Contaminant	Consumption Frequency Categories (8-ounce servings/week)[a] and ATLs (in ppb)							
	7	6	5	4	3	2	1	0
Chlordanes	≤ 80	>80-90	>90-110	>110-140	>140-190	>190-280	>280-560	>560
DDTs	≤ 220	>220-260	>260-310	>310-390	>390-520	>520-1,000	>1,000-2,100	>2,100
Dieldrin	≤ 7	>7-8	>8-9	>9-11	>11-15	>15-23	>23-46	>46
MeHg (Women 18-45 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	>10-13	>13-16	>16-21	>21-42	>42-120	>120
Selenium	≤ 1000	>1,000-1200	>1,200-1,400	>1,400-1,800	>1,800-2,500	>2,500-4,900	>4,900-15,000	>15,000
Toxaphene	≤ 87	>87-100	>100-120	>120-150	>150-200	>200-300	>300-610	>610

[a] Serving sizes (prior to cooking, wet weight) are based on an average 160-pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts.

[11] 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.