



Health Advisory and Guidelines for Eating Fish from Bishop Creek (Inyo County)

May 2020



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

Contributors

Lori Chumney, M.S.
Huyen Tran Pham, M.P.H.

Primary Reviewers

Susan A. Klasing, Ph.D., Section Chief
Wesley Smith, Ph.D.
Shannon R. Murphy, Ph.D.

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 acknowledges the contribution of information from the following entities: the State Water Resources Control Board, 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://ceden.waterboards.ca.gov/AdvancedQueryTool) (<http://ceden.waterboards.ca.gov/AdvancedQueryTool>). The map was created using ArcMap (10.5) 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

1001 I Street, P.O. Box 4010
Sacramento, CA 95812-4010
Telephone: (916) 324-7572
Email address: fish@oehha.ca.gov

1515 Clay Street, 16th Floor
Oakland, California 94612
Telephone: (510) 622-3170

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
RWB6	Regional Water Board 6 (Lahontan)
Se	selenium
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TSMF	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 Bishop Creek in Inyo County. The report provides background information and a technical description of how the guidelines were developed. The resulting advice is summarized in the illustration after the Table of Contents and List of Figures and Tables.

TABLE OF CONTENTS

A GUIDE TO EATING FISH FROM BISHOP CREEK	5
INTRODUCTION	6
<i>Location</i>	6
<i>Approach Used</i>	7
CHEMICALS OF POTENTIAL CONCERN.....	7
DATA SOURCES.....	9
<i>Regional Water Quality Control Board (RWB6)</i>	9
<i>Contaminants in Fish from California Rivers and Streams (SWAMP)</i>	9
<i>Toxic Substances Monitoring Program (TSMP)</i>	9
FISH SAMPLED FROM BISHOP CREEK.....	10
CHEMICAL CONCENTRATIONS	10
<i>Mercury</i>	11
<i>PCBs and Pesticides</i>	11
<i>Selenium</i>	11
DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM BISHOP CREEK	12
CONSUMPTION ADVICE FOR FISH FROM BISHOP CREEK.....	14
<i>Brown Trout</i>	15
<i>Rainbow Trout</i>	15
RECOMMENDED MAXIMUM NUMBER OF SERVINGS.....	16
REFERENCES	17
APPENDIX I. Advisory Tissue Levels.....	19

LIST OF FIGURES AND TABLES

Figure 1. Location of Bishop Creek	6
Table 1. Fish Samples Evaluated for the Bishop Creek Advisory	10
Table 2. Mercury Concentrations in Fish from Bishop Creek	12
Table 3. PCB Concentrations in Fish from Bishop Creek.....	12
Table 4. Recommended Maximum Number of Servings per Week for Fish from Bishop Creek.....	16
Advisory Tissue Levels for Selected Analytes.....	19



Women
(18-49 Years)

Children
(1-17 Years)

2 TOTAL SERVINGS A WEEK

OR

7 TOTAL SERVINGS A WEEK



Women
(50+ Years)

Men
(18+ Years)

4 TOTAL SERVINGS A WEEK

OR

7 TOTAL SERVINGS A WEEK

A GUIDE TO EATING FISH

from BISHOP CREEK

(INYO COUNTY)

Eat the Good Fish

Eating fish that are low in chemicals may provide health benefits to children and adults.



Avoid the Bad Fish

Eating fish with higher levels of chemicals like mercury or PCBs may cause health problems in children and adults.



Choose the Right Fish

Chemicals may be more harmful to unborn babies and children.



Brown Trout

♥ high in omega-3s



Rainbow Trout

♥ high in omega-3s

Serving Size

A serving of fish is about the size and thickness of your hand. Give children smaller servings.

For Adults



For Children



California Office of Environmental Health Hazard Assessment

web www.oehha.ca.gov/fish

email fish@oehha.ca.gov

phone (916) 324-7572

Eat only the skinless fillet



Eat only the meat



Some chemicals are higher in the skin, fat, and guts.

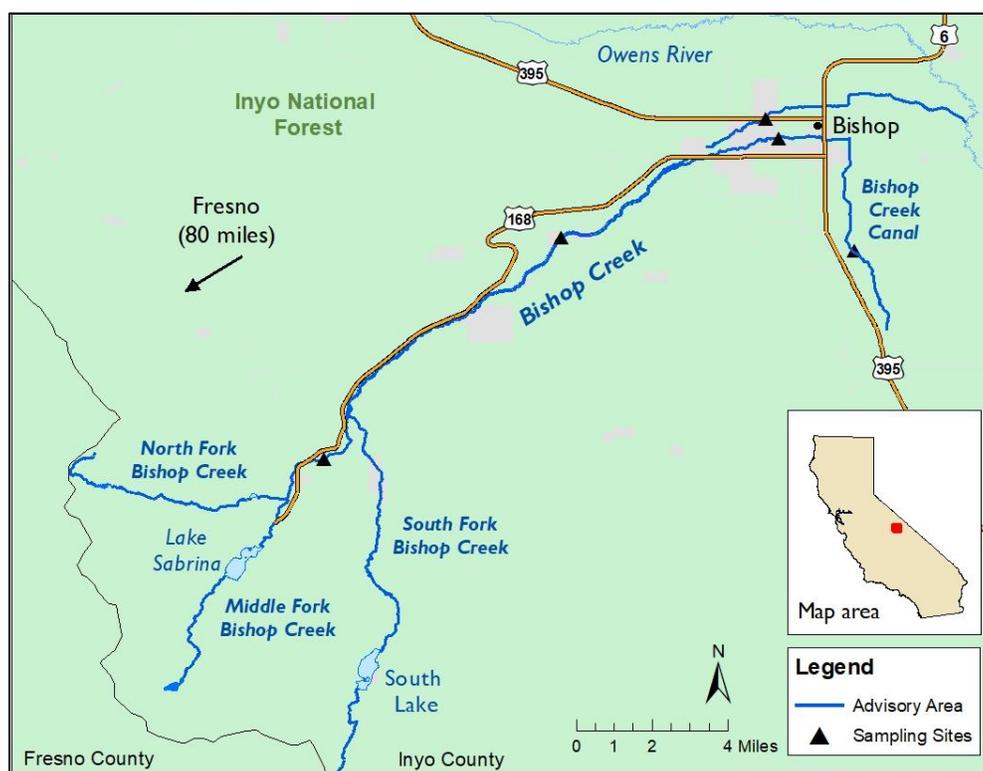
INTRODUCTION

This report presents guidelines for eating Brown Trout and Rainbow Trout from Bishop Creek, based on levels of mercury and PCBs found in these species.

LOCATION

Bishop Creek is located near the city of Bishop, in Inyo County, about 80 miles northeast of Fresno (Figure 1). Bishop Creek is a large stream that drains approximately 70 square miles and flows northeast from its headwaters near the crest of the Sierra Nevada for approximately 28 miles to its confluence with the Owens River. Bishop Creek has three forks: the North Fork, the Middle Fork, and the South Fork, which all originate near the Inyo-Fresno county border. Lake Sabrina, which impounds the Middle Fork Bishop Creek, and South Lake, which impounds the South Fork Bishop Creek, are the watershed's major storage reservoirs.¹ This advisory applies only to Bishop Creek, including its three forks, and does not apply to any other flowing waters within the watershed, nor the reservoirs that impound the creek.

FIGURE 1. LOCATION OF BISHOP CREEK



¹ Information on Bishop Creek obtained from the Southern California Edison Company. Available online at: https://www.sce.com/sites/default/files/inline-files/BishopCreek_PAD3_FacilitiesandOperations.pdf

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from three monitoring studies described in this report to develop the Bishop Creek 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 mean²) and other descriptive statistics of the contaminant data, as appropriate, for a chemical of potential concern for the selected fish species.
- 4) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of potential concern.
- 5) Development of final advice based on a thorough review of the data and best professional judgment relating to the benefits and risks of consuming a particular fish species.

The ATLs (discussed further in a subsequent section of this report) are chemical levels in fish tissue that are considered acceptable, based on chemical toxicity, for a range of consumption rates. Development of the ATLs also included consideration of health benefits associated with including fish in the diet (OEHHA, 2008). The ATLs should not be interpreted as static “bright lines,” but one component of a complex process of data evaluation and interpretation used by OEHHA in the assessment and communication of the benefits and risks of consuming sport fish.

CHEMICALS OF POTENTIAL CONCERN

Certain chemicals are 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), polybrominated diphenyl ethers (PBDEs), 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

² 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 California water bodies. 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 Bishop Creek and used in advisory development were analyzed for mercury (as a measure of methylmercury) and selenium. Brown Trout were analyzed for PCBs, and the legacy pesticides chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane), DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]), dieldrin, and toxaphene. Fish species that do not normally accumulate PCBs or other organic chemicals may not be analyzed for those contaminants in a particular monitoring study. Additionally, some studies do not analyze these chemicals and instead focus only on mercury.

DATA SOURCES

The guidelines for eating fish from Bishop Creek 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 methods (e.g., skinning or filleting), chemical analyses, quality assurance, and sufficiently low detection limits. "Sample," as used in this report, refers to an individual fish or a composite of multiple fish for which contaminant data were reported. "Sampling" or "sampled" refers to the act of collecting fish for chemical analysis.

REGIONAL WATER QUALITY CONTROL BOARD (RWB6)

The Lahontan Regional Water Quality Control Board (RWB6) coordinates ongoing sampling efforts to monitor contaminant levels, including mercury, in sport fish caught from lakes and reservoirs within the region. Brown Trout and Rainbow Trout were collected from Bishop Creek in 2017, and were analyzed for mercury.³

CONTAMINANTS IN FISH FROM CALIFORNIA RIVERS AND STREAMS (SWAMP)

The Surface Water Ambient Monitoring Program (SWAMP), operated by State Water Resources Control Board (SWRCB), monitors water quality in California's surface waters. In 2011, the program performed a statewide survey of California rivers and streams to evaluate contaminants in commonly consumed sport fish and to gain information about contamination in the greater aquatic food web (SWRCB, 2011). In 2011, the survey collected Brown Trout, which were analyzed for chlordanes, DDTs, dieldrin, mercury, PCBs, and selenium. Rainbow Trout were analyzed for mercury and selenium.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP operated from 1976 to 2003 as 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. The California Department of Fish and Wildlife (CDFW), then known as the California Department of Fish and Game, collected Brown Trout from Bishop Creek in 1991 and 2002, as part of the program. Brown Trout were analyzed for chlordanes, DDTs, dieldrin, mercury, selenium, and toxaphene.

³ Information on the Lahontan Regional Water Quality Control Board is available online at: <https://www.waterboards.ca.gov/rwqcb6/>.

FISH SAMPLED FROM BISHOP CREEK

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 evaluated for this advisory is shown in Table 1, including the name of the species, number of samples collected, total number of fish, project name, year sampled, and contaminants analyzed.

TABLE 1. FISH SAMPLES EVALUATED FOR THE BISHOP CREEK ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed
Brown Trout	<i>Salmo trutta</i>	3	18	TSMP ^{a,b}	1991, 2002	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		1	5	SWAMP	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		7	7	RWB6	2017	Hg
Rainbow Trout	<i>Oncorhynchus mykiss</i>	9	9	RWB6	2017	Hg
		1	5	SWAMP	2011	Hg, Se

^aStudy report did not specify whether skin was removed from fillets prior to tissue analysis.

^bOrganic data (chlordanes, DDTs, dieldrin, PCBs or toxaphene) generated prior to 2000 were excluded from the analysis because more recent data are considered more reliable due to improved analytical methods.

CHEMICAL CONCENTRATIONS

As shown in Table 1, samples were analyzed for one or more of the following: total mercury, selenium, chlordanes, DDTs, dieldrin, PCBs (54 congeners⁴), and toxaphene. Among the chemicals analyzed in fish tissue samples from Bishop Creek, only mercury and PCB levels were sufficiently high to impact consumption advice.

⁴ Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54-55 are generally reported.

All fish samples analyzed for the RWB6 and SWAMP studies were prepared as skinless fillets; the TSMP study did not report the fillet preparation method for Brown Trout. Samples were analyzed as individual fish or composites.

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

MERCURY

Samples were analyzed for total mercury, as either individual fish or composite samples, using a direct mercury analyzer (DMA) at the CDFW Moss Landing Marine Laboratories (MLML). 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 length⁵, as well as mercury concentrations in both fish species. The DMA method detection limit (MDL)⁶ and the reporting limit (RL)⁷ for total mercury were reported at 3 or 12 and 9 or 36 parts per billion (ppb), respectively, for the RWB6 and SWAMP studies. Although mercury was detected at commonly found concentrations in the TSMP study, the methodology, MDL, and RL were not reported.

PCBS AND PESTICIDES

Some composite samples were analyzed for PCBs and the legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene). Pesticides and PCBs were analyzed by gas chromatography at the CDFW Water Pollution Control Laboratory. For chlordanes, DDTs, and PCBs, 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 (≤ 10 ppb; except for the samples analyzed for toxaphene), 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, as well as the PCB concentration for Brown Trout.

SELENIUM

The CDFW MLML analyzed species collected from Bishop Creek for selenium, as composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS).

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.

The ICP-MS method utilizes desolvation, atomization and ionization with ion separation based on a mass-to-charge ratio to detect the total selenium concentration in a sample. The ICP-MS MDL and the RL for total selenium were reported at 150 and 400 ppb, respectively.

Concentrations of chlordanes, dieldrin, DDTs, selenium, and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008). These chemicals were therefore not considered further for developing consumption advice and are not shown in this report.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM BISHOP CREEK

Species from Bishop Creek	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Brown Trout	11	30	241	202-295	90	38-128
Rainbow Trout	10	14	280	222-322	18	12--22

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

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

TABLE 3. PCB CONCENTRATIONS IN FISH FROM BISHOP CREEK

Species from Bishop Creek	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCBs (ppb)	
					Mean*	Range**
Brown Trout	1	5	224	202-259	14	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 due to a single sample

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM BISHOP CREEK

The OEHHA fish advisory process considers the health benefits of fish consumption as well as the risk from exposure to the chemical contaminants found in fish. Benefits are included in the advisory process because there is considerable evidence and scientific consensus that fish should be part of a healthy, well-balanced diet. Fish contain many nutrients that are important for general health and, in particular, help promote optimal growth and development of babies and young children, and may reduce the incidence of heart disease in adults (FDA/US EPA, 2017; American Heart Association, 2016; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish are a significant source of the 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 US Dietary Guidelines recommend that 1) the general population “consume eight or more ounces per week (less for young children)” of a variety of seafood⁸ “for the total package of nutrients that seafood provides, including its EPA and DHA content” and 2) “women who are pregnant or breastfeeding should consume at least eight and up to twelve ounces of a variety of seafood per week from choices that are lower in methylmercury” (USDA/USDHHS, 2015). The particular fish that people eat is an important factor in determining the net beneficial effects of fish consumption. For example, studies have shown that children of mothers who ate low-mercury fish during pregnancy scored better on cognitive tests compared to children of mothers who did not eat fish or ate high-mercury fish (Oken et al., 2005 and 2008). Accordingly, because of the high mercury content of certain fish species, the US Food and Drug Administration (FDA) and the US Environmental Protection Agency recommend that women who are pregnant (or might become pregnant) or breastfeeding, and young children avoid consuming shark, swordfish, tilefish (Gulf of Mexico), bigeye tuna, marlin, orange roughy, and king mackerel (FDA/US EPA, 2017).

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 49 years of age) and children 1-17 years, are lower than those for women 50 years and older, and men 18 years and older. The lower ATL values for the sensitive population provide additional protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLs, are provided in “Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene” (OEHHA, 2008). A list of the ATLs used in this report is presented in Appendix I.

⁸ “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).

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). A serving size is considered to be 8 ounces, prior to cooking, or about the size and thickness of a hand for fish fillets. Children should be given smaller servings. For smaller fish species, several individuals may be required to yield a serving.

The consumption advice for a fish species is initially based on the chemical with the lowest allowable number of servings per week. Because some chemicals, such as mercury and PCBs, are known to have similar adverse effects, additivity of toxicity is assumed in such cases and may be assessed using multiple chemical exposure methodology (US EPA, 1989 and 2000b). If two or more chemicals with similar adverse effects are present in fish tissue 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 Brown Trout and did not affect advice. Advice for both species in this advisory was based solely on mercury or 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 consumption advice for a particular fish species can be extended to other closely related fish species⁹ 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 BISHOP CREEK

OEHHA's advisory protocol requires that a minimum of nine edible-size fish of a species that may be legally caught are collected and analyzed from small- and medium-sized lakes and reservoirs before an advisory can be developed. Additional samples beyond

⁹ Fish species within the same genus are most closely related, and family is the next level of relationship.

this number will increase confidence that the sample dataset is representative of the fish species population in the water body (OEHHA, 2005). The majority of fish consumption advisories in California are based on mercury, which is typically analyzed in individual fish, rather than as composites. Mercury analysis is relatively inexpensive and mercury concentrations in fish are more likely to be positively correlated with fish size than other contaminants. Thus, individual analysis allows for advice to be based on fish size, when appropriate. Other contaminants, such as PCBs, pesticides, and selenium, may also impact advice. These contaminants are often analyzed as a composite of a smaller subset of fish (usually at least five individuals) as a cost-saving mechanism, a common practice that is considered acceptable. In some cases, an exception is made regarding the minimum sample size. This is particularly true if the advice is based on a chemical other than mercury where sample size is often limited, and/or if doing so leads to more health-protective advice than would otherwise be provided.

For Bishop Creek, the sample size criterion was met for mercury for both species. However, for Brown Trout, one composite of five individuals was analyzed. Although this is fewer than the preferred number of samples, the data were included because they formed the basis for a recommended four servings per week based on PCBs, which is more health-protective than seven servings a week based on mercury that would have otherwise been the recommendation.

There were not sufficient data to evaluate other species that may be found in this water body.

BROWN TROUT

The mean mercury and PCB concentrations in Brown Trout from Bishop Creek were 90 and 14 ppb, respectively. OEHHA recommends a maximum of two servings a week of Brown Trout for the sensitive population (women 18 to 49 years and children 1 to 17 years) based on mercury, and a maximum of four servings a week for the general population (women 50 years and older, and men 18 years and older) based on PCBs.

RAINBOW TROUT

The mean mercury concentration in Rainbow Trout from Bishop Creek was 18 ppb. OEHHA recommends a maximum of seven servings a week of Rainbow Trout for both the sensitive population (women 18 to 49 years and children 1 to 17 years) and the general population (women 50 years and older, and men 18 years and older).

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

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

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM BISHOP CREEK

Fish Species from Bishop Creek	Women 18–49 years and Children 1-17 years	Women 50 years and older and Men 18 years and older
Brown Trout	2	4
Rainbow Trout	7	7

REFERENCES

- American Heart Association. 2016. Fish and Omega-3 Fatty Acids. Online at: http://www.heart.org/HEARTORG/HealthyLiving/HealthyEating/HealthyDietGoals/Fish-and-Omega-3-Fatty-Acids_UCM_303248_Article.jsp#.Wl57BnlG2Uk.
- 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/US EPA. 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.

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. 2011. Contaminants in Fish from California Rivers and Streams, 2011. Surface Water Ambient Monitoring Program. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California. Online at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/rivers_study/rs_rpt_only.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 Edition. 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 dose¹⁰ for chemicals not known to cause cancer, such as methylmercury, or
- For cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer endpoint is the maximum acceptable risk level recommended by the US EPA (2000b) for fish advisories.

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for one to seven eight-ounce servings per week. The most health-protective ATLs for each chemical, selected from either cancer or non-cancer based risk, are shown in the table below for zero to seven servings per week. When the guidelines for eating fish from Bishop Creek are followed, exposure to chemicals in fish from Bishop Creek would be at or below the average daily reference dose or the cancer risk probability of one in 10,000.

ADVISORY TISSUE LEVELS FOR SELECTED ANALYTES

Contaminant	Consumption Frequency Categories (8-ounce servings/week) ^a and ATLs (in ppb)							
	7	6	5	4	3	2	1	0
Chlordanes	≤ 80	>80-90	>90-110	>110-140	>140-190	>190-280	>280-560	>560
DDTs	≤ 220	>220-260	>260-310	>310-390	>390-520	>520-1,000	>1,000-2,100	>2,100
Dieldrin	≤ 7	>7-8	>8-9	>9-11	>11-15	>15-23	>23-46	>46
MeHg (Women 18-49 and children 1-17)	≤ 31	>31-36	>36-44	>44-55	>55-70	>70-150	>150-440	>440
MeHg (Women > 49 and men)	≤ 94	>94-109	>109-130	>130-160	>160-220	>220-440	>440-1,310	>1,310
PCBs	≤ 9	>9-10	>10-13	>13-16	>16-21	>21-42	>42-120	>120
Selenium	≤ 1000	>1,000-1200	>1,200-1,400	>1,400-1,800	>1,800-2,500	>2,500-4,900	>4,900-15,000	>15,000
Toxaphene	≤ 87	>87-100	>100-120	>120-150	>150-200	>200-300	>300-610	>610

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

¹⁰ The reference dose is an estimate of the maximum daily exposure to a chemical likely to be without significant risk of harmful health effects over a lifetime.