OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from the Laguna de Santa Rosa (Sonoma County)

June 2018

Fish, Ecotoxicology, and Water Section
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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites 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
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
RWB1	Regional Water Board 1 (North Coast)
Se	selenium
SMWP	State Mussel Watch Program
SWAMP	Surface Water Ambient Monitoring Program
TMDL	Total Maximum Daily Load
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 the Laguna de Santa Rosa in Sonoma 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.

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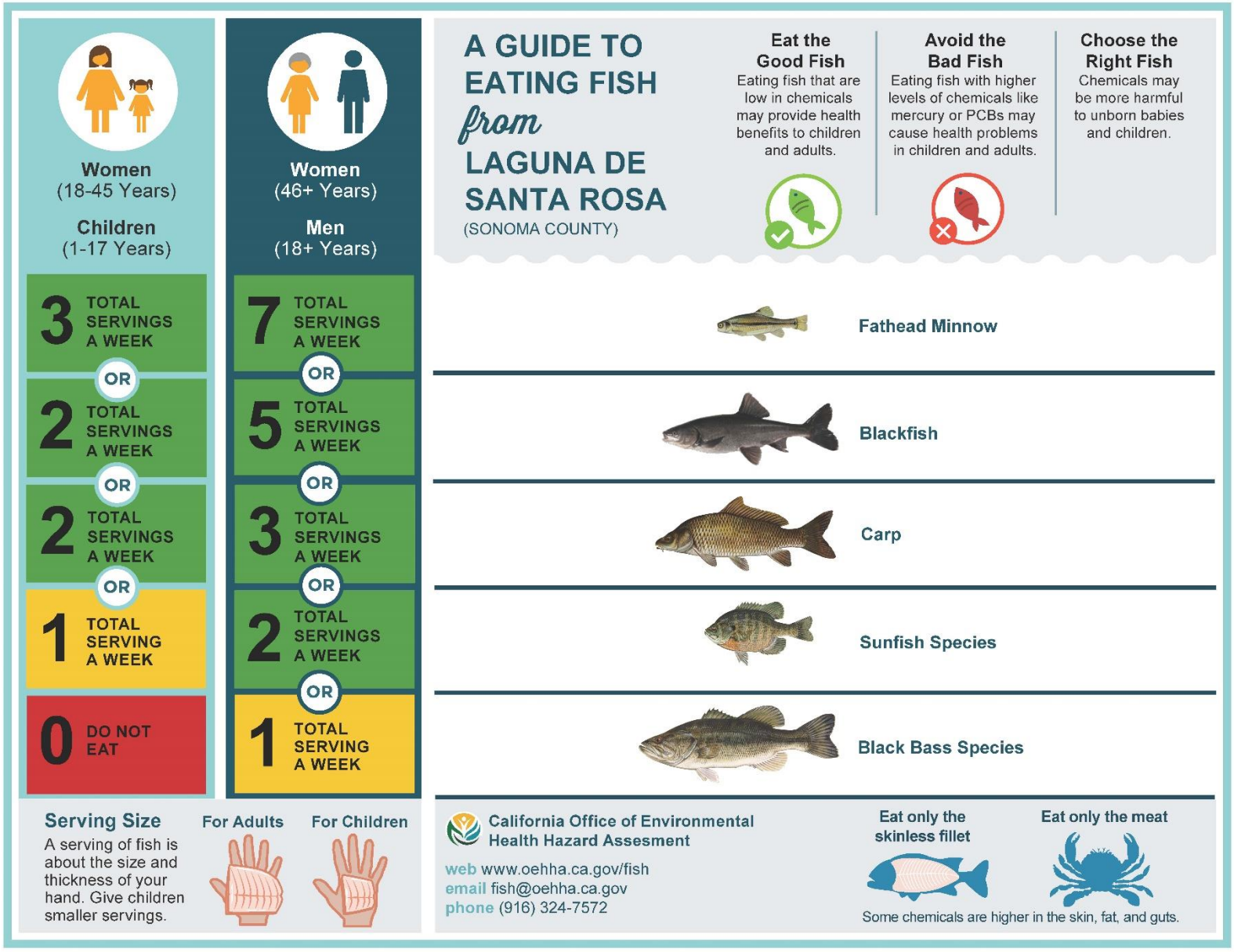

Women
(18-45 Years)
Children
(1-17 Years)
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
Women
(46+ Years)
Men
(18+ Years)
7 TOTAL SERVINGS A WEEK
OR
5 TOTAL SERVINGS A WEEK
OR
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
A GUIDE TO EATING FISH from LAGUNA DE SANTA ROSA
(SONOMA 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.
Fathead Minnow
Blackfish
Carp
Sunfish Species
Black Bass Species
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 Assesment
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.

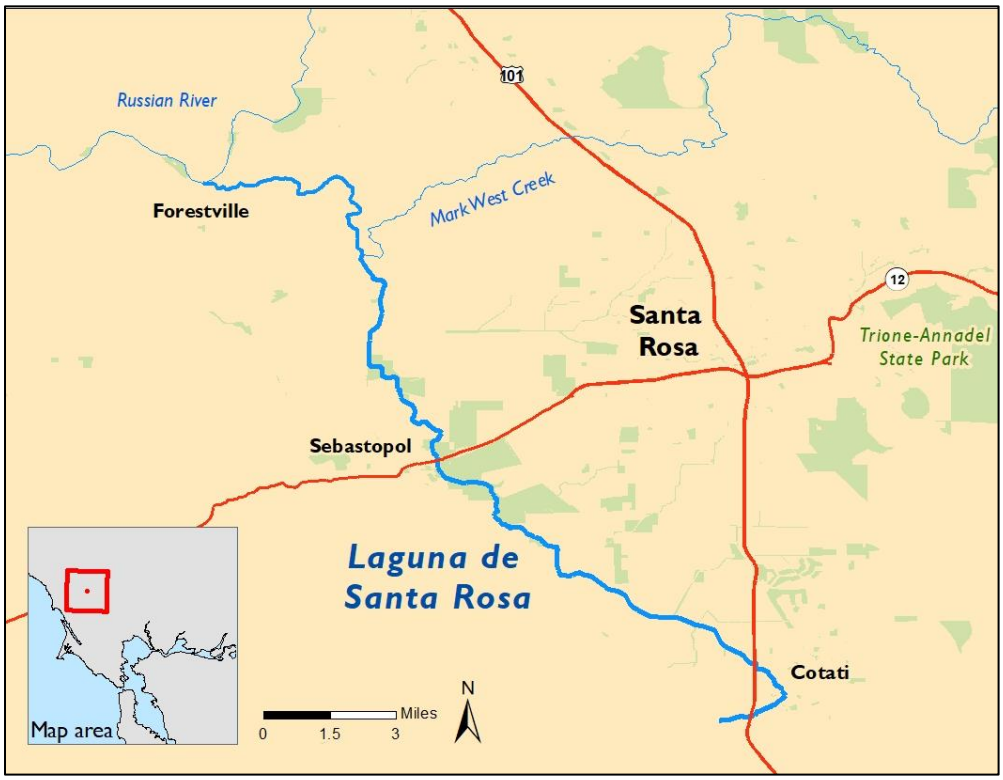
INTRODUCTION

This report presents a guideline for eating fish from the Laguna de Santa Rosa (Figure 1) in Sonoma County.

LOCATION

The Laguna de Santa Rosa is located west of the city of Santa Rosa, in Sonoma County. It is the largest freshwater wetlands complex in the northern coastal region of Calfornia and is known for its high biological diversity. At 22 miles in length, the Laguna is the largest tributary to the Russian River, and flows north from Cotati to the confluence at Forestville. It encompasses over 30,000 acres and drains a 254 square mile watershed. The Laguna serves as a natural holding basin for floodwaters from the Russian River and is critical to Sonoma County's water quality.[1]

FIGURE 1. LOCATION OF THE LAGUNA DE SANTA ROSA



[1] Information regarding the Laguna de Santa Rosa was obtained from Sonoma County and the Laguna de Santa Rosa Foundation. Online at: https://www.sonomacounty.com/articles/explore-laguna-de-santa-rosa-wetlands and http://www.lagunafoundation.org/about_ecology.html.

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from three monitoring studies described in this report to develop the Laguna de Santa Rosa 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[2]) 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) 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 water bodies in California. Depending on the exposure level, these chemicals may cause cancer or adverse effects on the nervous system.

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).

All fish species collected from the Laguna de Santa Rosa and used in advisory development were analyzed for mercury (as a measure of methylmercury) and selenium. Bluegill, Common Carp, Green Sunfish, Redear Sunfish, and Sacramento Blackfish were also analyzed for the legacy pesticides, including: chlordanes, dieldrin, DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]) and toxaphene. Additionally, Common Carp was analyzed for PCBs.

DATA SOURCES

The guidelines for eating fish from the Laguna de Santa Rosa 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.

REGIONAL WATER QUALITY CONTROL BOARD 1, RUSSIAN RIVER FISH 2015 (RWB1)

The RWB1 collected fish from the Laguna de Santa Rosa as part of a larger study of the Russian River Watershed for the Total Maximium Daily Load (TMDL) program [3]. Staff collected Common Carp and Largemouth Bass in 2016 from the Laguna de Santa Rosa to analyze levels of mercury. Common Carp were also analyzed for chlordanes, DDTs, dieldrin, and PCBs.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP): CONTAMINANTS IN FISH FROM CALIFORNIA RIVERS AND STREAMS, 2011

The SWAMP, operated by the 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). The survey collected Common Carp and Largemouth Bass from the Laguna de Santa Rosa in 2011 and were analyzed for mercury and selenium. Common Carp were additionally analyzed for chlordanes, DDTs, dieldrin, and PCBs.

TOXIC SUBSTANCES MONITORING PROGRAM (TSMP)

The TSMP (1978-2003) 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 California Department of Fish and Game, collected Bluegill, Common Carp, Fathead Minnow, Green Sunfish, Redear Sunfish, and Sacramento Blackfish from the Laguna de Santa Rosa from 1987-2000, as part of the program. All samples were analyzed for chlordanes, DDTs, dieldrin, mercury, selenium, and toxaphene.

FISH SAMPLED FROM THE LAGUNA DE SANTA ROSA

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

[3] Further information on the Russian River Watershed TMDL Program can be found at: https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/russian_river/#mtmdl

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

TABLE 1. FISH SAMPLES EVALUATED FOR THE LAGUNA DE SANTA ROSA ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[c]
Bluegill	*Lepomis macrochirus*	1	20	TSMP[a]	1989	Hg, Se
		1	8	TSMP[a]	1990	Hg
		1	6	TSMP[a]	1994	Hg, Se
		1	18	TSMP[a]	1996	Hg, Se
		1	3	TSMP[a]	1997	Hg, Se
		1	1	TSMP[a]	2000	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Common Carp	*Cyprinus carpio*	1	5	RWB1	2016	Chlordanes, DDTs, Dieldrin, Hg, PCBs
		1	5	SWAMP	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		3	16	TSMP[a]	1998	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
		1	3	TSMP[a]	2000	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Fathead Minnow	*Pimephales promelas*	1	16	TSMP[b]	1994	Hg, Se
Green Sunfish	*Lepomis cyanellus*	1	1	TSMP[a]	1996	Hg, Se
		1	10	TSMP[a]	1999	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Largemouth Bass	*Micropterus salmoides*	4	4	RWB1	2016	Hg
		7	7	SWAMP	2011	Hg
		1	5	SWAMP	2011	Se
Redear Sunfish	*Lepomis microlophus*	1	1	TSMP[a]	1998	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene
Sacramento Blackfish	*Orthodon microlepidotus*	4	24	TSMP[a]	1998	Chlordanes, DDTs, Dieldrin, Hg, Se, Toxaphene

[a]Study report did not specify whether skin was removed from fillets prior to tissue analysis.
[b] Samples were analyzed as whole organisms, including head, skin, internal organs, muscle, and bones.
[c]Data for organic compounds (chlordanes, DDTs, dieldrin, PCBs or toxaphene) generated prior to 1998 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 (54-55 congeners[4]), and toxaphene. Among the chemicals analyzed in fish tissue samples from the Laguna de Santa Rosa, only mercury and PCB levels were sufficiently high to impact consumption advice. For this reason, levels of other contaminants are not shown in this report. All fish samples were prepared as skinless fillets, except for the TSMP study where the fillet preparation method for Bluegill, Common Carp, Green Sunfish, Redear Sunfish, and Sacramento Blackfish 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. Ideally, for composite samples, the total length of the smallest fish in a composite sample is 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 complies with the 75% recommendation. All composite samples from the other two monitoring studies met this requirement.

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 from the RWB1 and SWAMP studies 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 4 or 12 and 12 or 36 parts per billion (ppb), respectively. Although mercury was detected at commonly found concentrations in the TSMP study, the analysis method as well as the MDL and RL for mercury were not reported.

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[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.

PCBs and Pesticides

Some composite samples were analyzed for PCBs and 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 where reported (≤ 5 ppb, RL not reported for TSMP), except for toxaphene (MDL= 20 and 100; RL not reported for the TSMP study), 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).

Selenium

The CDFW MLML analyzed species collected from the RWB1 and SWAMP studies for selenium, as composite samples. Samples collected prior to 1998 were analyzed using atomic absorption spectroscopy; samples collected in 1998 and after were analyzed using inductively coupled plasma-mass spectrometry (ICP-MS). Atomic absorption spectroscopy passes electromagnectic radiation through an atomic medium and compares the wavelength pattern of the sample to that of selenium to determine the concentration of total selenium 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 RL for total selenium were reported at 150 and 400 ppb, respectively. Although selenium was detected at commonly found concentrations in the TSMP study, the analysis method as well as the MDL and RL were not reported.

TABLE 2. MERCURY AND PCB CONCENTRATIONS IN FISH FROM THE LAGUNA DE SANTA ROSA

Species from Laguna de Santa Rosa	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Concentration in Fish (ppb)	
					Hg	
					Mean*	Range**
Largemouth Bass	11	11	371	308-469	609	318-1440
Common Carp	6	29	322	246-525	147	59-351
Fathead Minnow	1	16	68***	n/a	60	n/a
Sacramento Blackfish	4	24	326	319-334	122	113-132
Sunfish Species	9	68	120	106-233	320	107-650
Bluegill	6	56	118	106-233	316	107-650
Green Sunfish	2	11	129	124-176	354	320-357
Redear Sunfish	1	1	178	n/a	192	n/a
					PCBs	
Common Carp	2	10	448	388-525	17	0-34

*Means are an arithmetic average of individual values and/or a weighted average of composites.
**Range of individuals and/or range of the composites.
***Total length for Fathead Minnow (1.07) was derived from fork length using a conversion factor from Anseeuw et al. 2005.
n/a = not applicable due to a single sample

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM THE LAGUNA DE SANTA ROSA

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 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[8] "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 (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.

[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).

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). 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 tissue 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 small fish species, several individual fish may make up a single 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 Common Carp and did not affect advice for this species. Advice for all 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 species or species group. OEHHA's consumption advice for a particular fish species can be extended to other closely related fish species[9] known to accumulate similar levels of contaminants.

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

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 THE LAGUNA DE SANTA ROSA

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. For the Laguna de Santa Rosa, the sample size criterion was met for the following species: black bass species, Common Carp, Fathead Minnow, Sacramento Blackfish and sunfish species. There were not sufficient data to evaluate other species that may be found in this water body.

BLACK BASS SPECIES (LARGEMOUTH BASS)

The mean mercury concentration in Largemouth Bass from Laguna de Santa Rosa was 609 ppb. OEHHA recommends no consumption of Largemouth Bass 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).

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.

COMMON CARP

The mean mercury and PCB concentrations in Common Carp from the Laguna de Santa Rosa were 147 and 17 ppb, respectively. OEHHA recommends a maximum of two servings a week for the sensitive population (women 18 to 45 years and children 1 to 17 years) based on mercury, and a maximum of three servings a week for the general population (women 46 years and older, and men 18 years and older), based on PCBs.

Fathead Minnow

The mean mercury concentration in Fathead Minnow from the Laguna de Santa Rosa was 60 ppb. OEHHA recommends a maximum of three servings a week of Fathead Minnow for the sensitive population (women 18 to 45 years and children 1 to 17 years), and a maximum of 7 servings a week for the general population (women 46 years and older, and men 18 years and older).

Sacramento Blackfish

The mean mercury concentration in Sacramento Blackfish from the Laguna de Santa Rosa was 122 ppb. OEHHA recommends a maximum of two servings a week of Sacramento Blackfish for the sensitive population (women 18 to 45 years and children 1 to 17 years), and a maximum of five servings a week for the general population (women 46 years and older, and men 18 years and older).

Sunfish Species (Bluegill, Green Sunfish, Redear Sunfish)

The mean mercury concentration in sunfish species from the Laguna de Santa Rosa was 320 ppb. Mercury concentrations for individual sunfish species were as follows: Bluegill (316 ppb), Green Sunfish (354 ppb), and Redear Sunfish (192 ppb). OEHHA recommends a maximum of one serving a week of sunfish species 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).

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, Green Sunfish, Redear Sunfish) to other sunfish species, including Pumpkinseed.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from the Laguna de Santa Rosa are shown in Table 3.

TABLE 3. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THE LAGUNA DE SANTA ROSA

Fish Species from Laguna de Santa Rosa	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
Common Carp	2	3
Fathead Minnow	3	7
Sacramento Blackfish	2	5
Sunfish Species	1	2

REFERENCES

Anseeuw, D., T. Gaethofs, and G. Louette. 2005. First record and morphometry of the non-indigenous fathead minnow *Pimephales promelas* (Rafinesque, 1820) (Teleostei, Cyprinidae) in Flanders (Belgium). Belg. J. Zool. 135(1):87-90

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#.WI57BnlG2Uk.

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 USEPA/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.

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

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for one to seven eight-ounce servings per week. The most health-protective ATLs for each chemical, selected from either cancer or non-cancer based risk, are shown in the table below for zero to seven servings per week. When the guidelines for eating fish from the Laguna de Santa Rosa are followed, exposure to chemicals in fish from the Laguna de Santa Rosa 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.

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