OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

GOOD CATCH CALIFORNIA
Your Fish Advisor

Health Advisory and Guidelines for Eating Fish from the Sacramento River and Northern Delta (Butte, Colusa, Glenn, Shasta, Sacramento, Solano, Sutter, Tehama, and Yolo Counties)

Updated May 2020

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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
CFCP	Coastal Fish Contamination Program
CVAA	Cold Vapor Atomic Absorption
DDT(s)	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
DHA	docosahexaenoic acid
DMA	Direct Mercury Analyzer
EPA	eicosapentaenoic acid
FDA	Food and Drug Administration
FMP	Fish Mercury Project
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
RMP	Regional Monitoring Program
RWB2	Regional Water Board 2 (San Francisco Bay)
RWB5	Regional Water Board 5 (Central Valley)
Se	selenium
SFEI	San Francisco Estuary Institute
SRWP	Sacramento River Watershed Program
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load

TSMP	Toxic Substances Monitoring Program
UCD	University of California, Davis
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 updated guidelines for eating fish from the Sacramento River and Northern Delta, which runs through Butte, Colusa, Glenn, Shasta, Sacramento, Solano, Sutter, Tehama, and Yolo counties. 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. This final version supercedes all prior advisories for this area.

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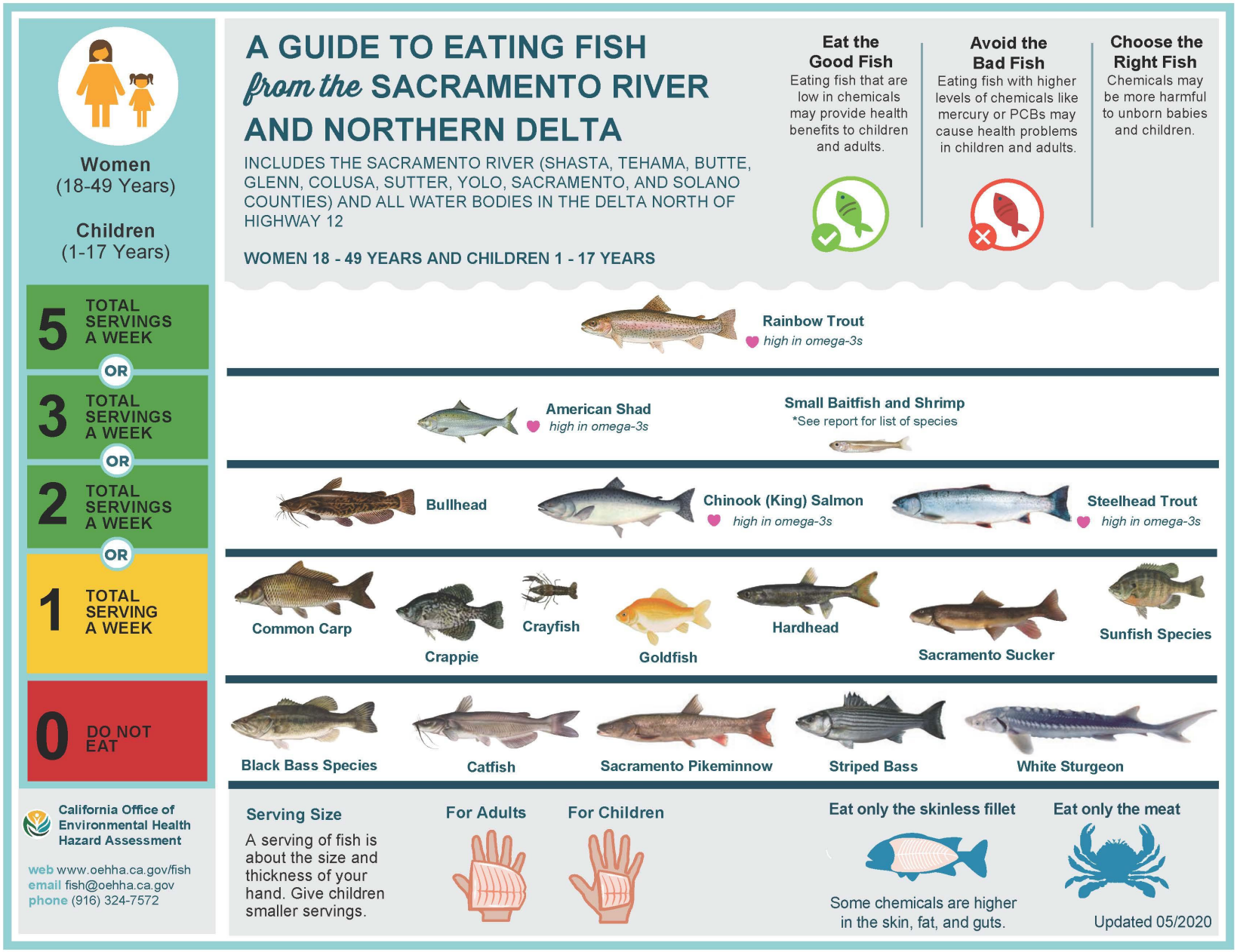
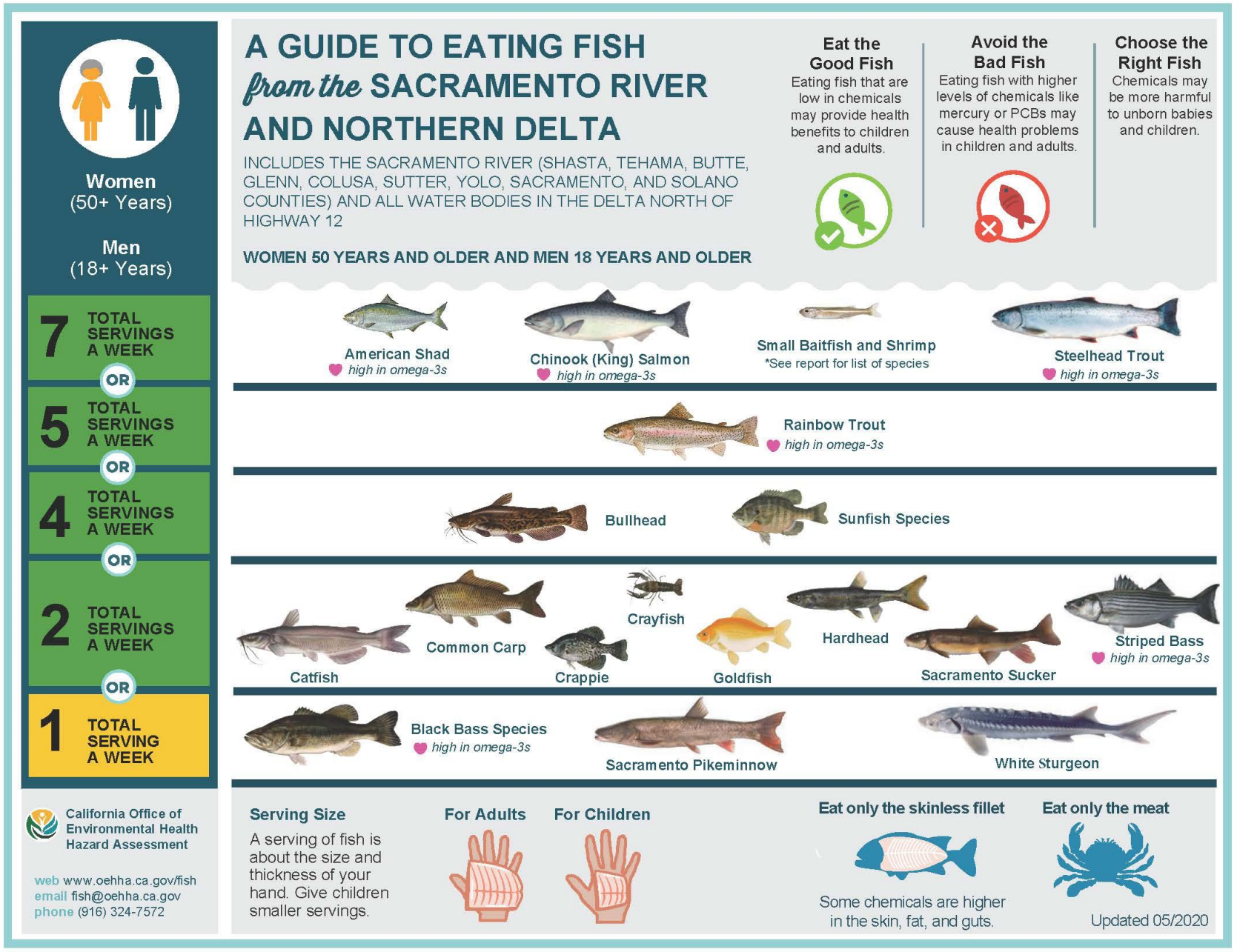

A GUIDE TO EATING FISH
from the SACRAMENTO RIVER
AND NORTHERN DELTA
INCLUDES THE SACRAMENTO RIVER (SHASTA, TEHAMA, BUTTE, GLENN, COLUSA, SUTTER, YOLO, SACRAMENTO, AND SOLANO COUNTIES) AND ALL WATER BODIES IN THE DELTA NORTH OF HIGHWAY 12
WOMEN 18 - 49 YEARS AND CHILDREN 1 - 17 YEARS
Eat the Good Fish
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.
Women (18-49 Years)
Children (1-17 Years)
5 TOTAL SERVINGS A WEEK
OR
3 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
0 DO NOT EAT
Rainbow Trout
high in omega-3s
American Shad
high in omega-3s
Small Baitfish and Shrimp
*See report for list of species
Bullhead
Chinook (King) Salmon
high in omega-3s
Steelhead Trout
high in omega-3s
Common Carp
Crappie
Crayfish
Goldfish
Hardhead
Sacramento Sucker
Sunfish Species
Black Bass Species
Catfish
Sacramento Pikeminnow
Striped Bass
White Sturgeon
California Office of Environmental Health Hazard Assessment
web www.oehha.ca.gov/fish
email fish@oehha.ca.gov
phone (916) 324-7572
Serving Size
A serving of fish is about the size and thickness of your hand. Give children smaller servings.
For Adults
For Children
Eat only the skinless fillet
Some chemicals are higher in the skin, fat, and guts.
Eat only the meat
Updated 05/2020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WOMEN 50 YEARS AND OLDER AND MEN 18 YEARS AND OLDER
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.
Women (50+ Years)
Men (18+ Years)
7 TOTAL SERVINGS A WEEK
OR
5 TOTAL SERVINGS A WEEK
OR
4 TOTAL SERVINGS A WEEK
OR
2 TOTAL SERVINGS A WEEK
OR
1 TOTAL SERVING A WEEK
American Shad
high in omega-3s
Chinook (King) Salmon
high in omega-3s
Small Baitfish and Shrimp
*See report for list of species
Steelhead Trout
high in omega-3s
Rainbow Trout
high in omega-3s
Bullhead
Sunfish Species
Catfish
Common Carp
Crayfish
Crappie
Goldfish
Hardhead
Sacramento Sucker
Striped Bass
high in omega-3s
Black Bass Species
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Updated 05/2020

INTRODUCTION

This report presents an update and supersedes the previous advice for eating fish from the Sacramento River and Northern Delta, located in Butte, Colusa, Glenn, Shasta, Sacramento, Solano, Sutter, Tehama, and Yolo counties. Figures 1 and 2 show the area of the advisory and sampling locations. Additional sampling sites were used for anadromous species included in this advisory (see discussion on page 16 below).

LOCATION

The Sacramento River is the largest river in California, at over 300 miles in length. Its source waters are the Upper Sacramento, McCloud and Pit rivers, which join in Lake Shasta. The Sacramento River runs south from Lake Shasta, past the cities of Redding and Red Bluff, where it is joined by several small and moderately sized tributaries. Much of the water is diverted near Red Bluff into irrigation canals for agriculture in the southern Sacramento Valley. In Verona, the river receives its largest tributary, the Feather River. The river then passes through the city of Sacramento, where it joins with its second largest tributary, the American River. In West Sacramento, the Sacramento Deep Water Ship Channel diverges from the main river and rejoins it near the town of Rio Vista. The river joins with the San Joaquin River at Suisun Bay near Pittsburg, where its waters flow through the Carquinez Strait into , San Francisco Bay and the Pacific Ocean.[1]

This advisory applies to the Sacramento River just below Shasta Lake to the confluence with the San Joaquin River in Pittsburg, as well as the waters of the Northern Delta (north of Highway 12), including the Sacramento Deep Water Ship Channel. It also includes small water bodies, creeks and sloughs associated with the Sacramento River and Northern Delta, including:

Battle Creek
Big Chico Creek
Bounde Creek
Butte Creek
Bypass Slough
Cache Slough
Central Drain
Clear Creek
Colusa Drain
Cross Canal
Dead Horse Slough
Delta Cross Canal
Delta Meadows Slough
Georgiana Slough
Glenn-Colusa Canal
Green's Lake
Liberty Island
Lindsey Slough
Little Hastings Tract
Little Holland Tract
Logan Creek
Lost Slough
Miner Slough
Pine Creek
Prospect Slough
Rattlesnake Creek
Reclamation Slough
Sacramento Slough
Snodgrass Slough
Steamboat Slough
Sutter Bypass
Toe Drain
Willow Creek

[1] Information regarding the Sacramento River was obtained from the Sacramento River Watershed Program. Available online at: http://www.sacriver.org/aboutwatershed/roadmap/sacramento-river-basin.

This advisory does not include any other lakes or reservoirs in the Sacramento River watershed. Site-specific advice has previously been developed for major tributaries that flow into the Sacramento River, including the Lower American River and the Lower Feather River, as well as for the Central and South Delta (south of Highway 12).

FIGURE 1. SAMPLE LOCATIONS IN THE SACRAMENTO RIVER NORTH OF THE DELTA

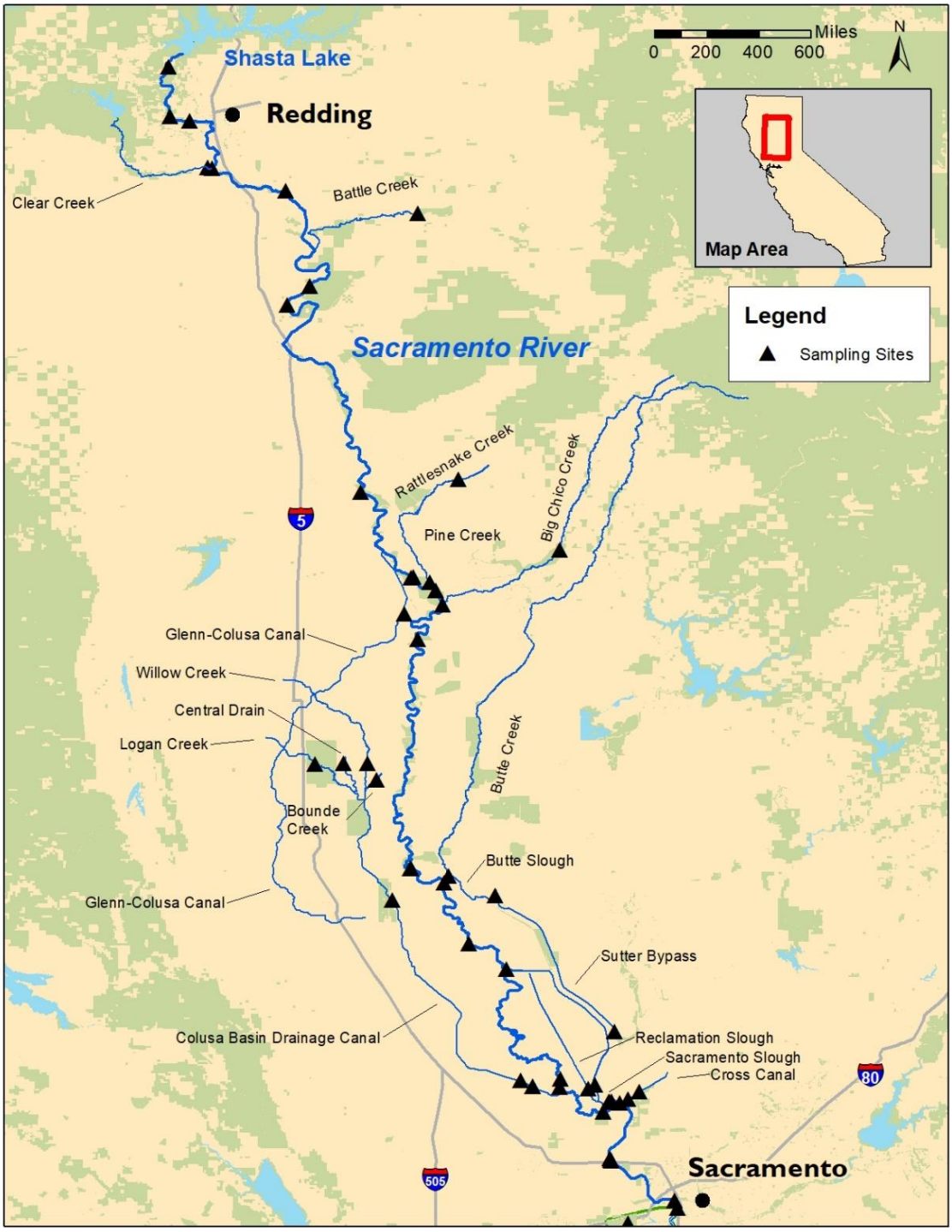

FIGURE 2. SAMPLE LOCATIONS IN THE NORTHERN DELTA (NORTH OF HIGHWAY 12)

APPROACH USED

The Office of Environmental Health Hazard Assessment (OEHHA) used the results from ten monitoring studies described in this report to develop the Sacramento River and Northern Delta 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 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 the Sacramento River and Northern Delta and used in advisory development were analyzed for mercury (as a measure of methylmercury). Some species were additionally analyzed for PBDEs, PCBs, selenium, and/or the legacy pesticides chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane), dieldrin, DDTs (DDT and its metabolites dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]), 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 the Sacramento River and Northern Delta are based on the chemicals detected in the fish collected for the ten 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.

CALFED BAY-DELTA PROGRAM (CALFED)

The CALFED Bay-Delta Program was a state and federal interagency group, established in 1994, to develop strategies and provide funding for projects that improve water quality, increase water supply, and support ecosystem restoration and levee improvement in the San Francisco Bay-Delta. CALFED sampled a wide variety of species throughout the Delta in 1999 and 2000 to evaluate potential human health concerns from mercury in sport fish, establish baseline mercury levels to assist with long-term trend monitoring, examine spatial patterns in mercury contamination, and to evaluate how age/size and trophic level influence mercury concentrations (Davis and Greenfield, 2004).

COASTAL FISH CONTAMINATION PROGRAM (CFCP)

The CFCP (1998-2003) was a statewide monitoring program managed by the State Water Resources Control Board (SWRCB) to assess human health risks from eating sport fish and shellfish caught from nearshore (marine and estuarine) waters in California (Gassel, 2005). The program was halted after five years due to budget constraints.

CONTAMINANTS IN FISH FROM CALIFORNIA LAKES AND RESERVOIRS, 2007-2008 (SWAMP)

The Surface Water Ambient Monitoring Program (SWAMP) operated by the SWRCB in cooperation with the Central Valley Regional Water Board (RWB5), monitors water quality in California's surface waters. The program collected fish from the Sacramento River and Northern Delta as part of a SWAMP statewide sampling effort to survey contaminants in sport fish found in California lakes and reservoirs (SWRCB, 2010).

CONTAMINANTS IN FISH FROM CALIFORNIA RIVERS AND STREAMS, 2011 (SWAMP)

In 2011, SWAMP performed a statewide survey of California rivers and streams to evaluate contaminants in commonly consumed sport fish. The study had two primary goals: to determine the geographic extent of contamination in fish in relation to

assessment thresholds and to identify locations for future sampling to assist with the development of fish consumption advisories (SWRCB, 2013).

DELTA REGIONAL MONITORING PROGRAM (RMP)

The Delta RMP sampled sport fish in 2016 and 2017 to provide critical information to aid in the implementation of the Total Maximum Daily Load (TMDL) for methylmercury for the Sacramento-San Joaquin Delta Estuary. Two sport fish species, Largemouth and Spotted Bass, were targeted due to the linkage of methylmercury concentrations in black bass species and water, thereby providing an indicator of waterbody impairment. These efforts were used to contribute spatial and temporal fish data to inform the TMDL conceptual model (Davis et al., 2018).

FISH MERCURY PROJECT (FMP)

The FMP was a three-year (2005 to 2007) sampling program funded by CALFED (SFEI, 2009). Monitoring of sport fish from Central Valley water bodies was planned and conducted by staff at the California Department of Fish and Wildlife (CDFW), OEHHA, the California Department of Public Health, the University of California, Davis, and the San Francisco Estuary Institute (SFEI). More than 4,000 fish, including 31 sport fish species, from 146 popular fishing locations in the Delta watershed were collected to help characterize spatial and temporal trends in mercury in fishery resources.

REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY, EXPOSURE AND EFFECTS PILOT STUDY, (EEPS)

The San Francisco Bay Regional Monitoring Program developed the EEPS to address questions on beneficial use management developed by San Francisco Bay Regional Water Quality Control Board (RWB2) staff. The EEPS evaluated the effects and exposure of contaminants at different spatial scales throughout the bay. The goal of this study was to monitor mercury concentrations in sediment and small fish to locate hotspots of methylmercury bioavailability (Greenfield et al. 2013), (SFEI, 2010).

SACRAMENTO RIVER WATERSHED PROGRAM (SRWP)

The SRWP was founded in 1996 and certified as a California not-for-profit corporation in 2002. Its mission is to sustain, restore, and enhance current and potential resources in the Sacramento River watershed including the Sacramento, San Joaquin, Feather, and American rivers. The SRWP operates through collaborative partnerships and conducts coordinated research and monitoring activities to assess water quality and other indicators of watershed health. The SRWP conducted fish tissue sampling from 1998 - 2005 and analyzed for mercury, PCBs, and persistent pesticides (SRWP, 2006).

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. CDFW staff collected fish from the Sacramento River and Northern Delta, as part of the program.

University of California, Davis (UCD)

UCD conducted a CALFED-funded, survey-level study between 1998 and 2001 to assess the production and bioaccumulation of methylmercury in relation to wetland restoration efforts in the Sacramento-San Joaquin Delta. The study provided an initial understanding of ambient mercury trends in the Delta and how wetland restoration sites may impact trends (Slotton et al. 2002).

FISH SAMPLED FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

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.

Anadromous (Migratory) Species

Anadromous species are fish that migrate from the ocean to rivers to spawn, and include American Shad, Chinook Salmon, Steelhead Trout, Striped Bass, and White Sturgeon. OEHHA issued an Advisory for Fish that Migrate (anadromous species) in 2012 for these species (OEHHA, 2012). The Advisory for Fish that Migrate is based on data collected from the Pacific Ocean along the San Francisco coast, San Francisco Bay, the Delta, or rivers that flow into the San Francisco Bay/Estuary including the Sacramento, San Joaquin, American, Feather, Cosumnes, and Mokelumne rivers. The Advisory for Fish that Migrate applies to these species whenever they are found in rivers, bays, and coastal open waters, including the Sacramento River and Northern Delta. Only a very small number of anadromous fish were collected from the Sacramento River and Northern Delta since the development of the anadromous advisory. These samples will be included in a future update of the anadromous advisory, but are not included in this advisory. The updated Sacramento River and Northern Delta advisory thus provides the same advice for anadromous species, using the same data, as did the Advisory for Fish that Migrate. Fish contaminant data

evaluated for the updated Sacramento River and Northern Delta Advisory are shown in Table 1.

TABLE 1. FISH SAMPLES EVALUATED FOR THE SACRAMENTO RIVER AND NORTHERN DELTA ADVISORY

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
American Shad*	*Alosa sapidissima*	50	50	FMP	2006	Hg
		1	5	TSMP[a]	2003	Hg
Bigscale Logperch	*Percina macrolepida*	37	152	UCD[c]	1998 - 1999	Hg
Bluegill	*Lepomis macrochirus*	48	48	FMP	2005 - 2007	Hg
		1	5	SRWP	1999	Hg
Bullhead	*Ameiurus spp.*	5	33	TSMP[a]	1980, 1988	Hg
		2	20	TSMP[a]	1988	Se
Channel Catfish	*Ictalurus punctatus*	1	2	CALFED	2000	Hg
		58	58	FMP	2005 - 2007	Hg
		4	16	SRWP	2005	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		1	4	SRWP	2005	PBDEs
		11	48	TSMP[a]	1980 - 1982, 1987 - 1988, 1993	Hg
		5	24	TSMP[a]	1987 - 1988, 1993	Se
Chinook Salmon*	*Oncorhynchus tshawytscha*	2	8	CFCP	2000	Hg
		34	34	FMP	2005	Hg
		5	15	RMP	2003, 2006	Hg, PCBs
		1	3	TSMP[a]	2002	Hg
Common Carp	*Cyprinus carpio*	6	26	CALFED[b]	2000	Hg
		88	88	FMP	2005 - 2007	Hg
		2	10	SRWP	1998	PBDEs
		6	28	SRWP	1998 - 2002	Hg

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
		4	20	SRWP	1998, 2000, 2001	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		3	13	SRWP	2005	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		1	5	SWAMP	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		12	49	TSMP[a]	1981, 1985 - 1989	Hg
		8	34	TSMP[a]	1986 - 1989	Se
Crangon Shrimp	*Crangon spp.*	10	72	UCD[c]	1999	Hg
Crappie	*Pomoxis spp.*	2	10	CALFED[b]	2000	Hg
		32	32	FMP	2005 - 2007	Hg
		2	10	SRWP	2000 - 2001	Hg
Golden Shiner	*Notemigonus crysoleucas*	1	11	UCD[c]	1999	Hg
Goldfish	*Carassius auratus*	4	4	FMP	2006	Hg
Hardhead	*Mylopharodon conocephalus*	15	15	FMP	2005 - 2006	Hg
		1	5	TSMP[a]	1981	Hg
Inland Silverside	*Menidia beryllina*	199	989	UCD[c]	1998 - 2000	Hg
Largemouth Bass	*Micropterus salmoides*	7	7	CALFED[b]	2000	Hg
		123	123	FMP	2005 - 2007	Hg
		7	7	RMP	2016	Hg
		5	25	SRWP	1998	PBDEs
		48	104	SRWP	1998 - 2000, 2002 - 2003	Hg
		13	67	SRWP	1998 - 2000	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		7	7	SWAMP	2007	Hg
		7	26	TSMP[a]	1987 - 1988, 1990, 1998, 2001 - 2002	Hg
		5	15	TSMP[a]	1987 - 1988, 1998, 2002	Se
		1	5	TSMP[a]	2001	Chlordanes, DDTs, Dieldrin, Toxaphene

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
Mississippi Silverside	*Menidia audens*	4	20	EEPS[c]	2010	Hg
Mosquitofish	*Gambusia affinis*	13	84	UCD[c]	1998 - 1999	Hg
Northern Crayfish	*Orconectes spp.*	1	1	UCD[d]	1999	Hg
Rainbow Trout	*Oncorhynchus mykiss*	43	43	FMP	2005 - 2006	Hg
		1	5	SRWP	1998	PBDEs
		6	30	SRWP	1998, 2000 - 2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs
		4	20	SRWP	1998, 2000 - 2001	Toxaphene
		3	15	SRWP	2005	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		1	5	SWAMP	2011	Hg, Se
		15	88	TSMP[a]	1980 - 2002	Hg
		11	66	TSMP[a]	1984 - 2002	Se
Red Shiner	*Notropis lutrensis*	7	32	UCD[c]	1998 - 1999	Hg
Red Swamp Crayfish	*Procambarus spp.*	12	12	UCD[d]	1998 - 1999	Hg
Redear Sunfish	*Lepomis microlophus*	92	92	FMP	2005 - 2007	Hg
		2	15	TSMP[a]	1988 - 1989	Hg
		1	9	TSMP[a]	1989	Se
Sacramento Pikeminnow	*Ptychocheilus grandis*	12	12	CALFED[b]	2000	Hg
		81	81	FMP	2005 - 2007	Hg
		3	15	SRWP	1998	PBDEs
		9	44	SRWP	1998, 2000 -2001	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		8	39	SRWP	1998 - 2001	Hg
		2	11	TSMP[a]	1987, 2002	Hg, Se

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
Sacramento Sucker	*Catostomus occidentalis*	2	10	CALFED[b]	2000	Hg
		121	121	FMP	2005 - 2007	Hg
		2	10	SRWP	1998, 2002	PBDEs
		10	50	SRWP	1998 - 2000, 2002 - 2003	Hg
		7	35	SRWP	1998 - 2000, 2002	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		9	45	SRWP	2005	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		3	15	SRWP	2005	PBDEs
		1	5	SWAMP	2007	Chlordanes, DDTs, Dieldrin, PBDEs, PCBs, Se
		2	10	SWAMP	2007	Hg
		2	10	SWAMP	2011	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Se
		7	32	TSMP[a]	1981 - 2002	Hg
		5	29	TSMP[a]	1987 - 1988, 2002	Se
Shimofuri Goby	*Tridentiger bifasciatus*	22	73	UCD[c]	1998 - 1999	Hg
Signal Crayfish	*Pacifastacus spp.*	6	36	TSMP[d]	1991	Hg, Se
		116	116	UCD[d]	1998 - 1999	Hg
Smallmouth Bass	*Micropterus dolomieu*	3	3	FMP	2005	Hg
		1	5	SRWP	2001	Chlordanes, DDTs, Dieldrin, Hg, PCBs, Toxaphene
		7	7	SWAMP	2011	Hg
		1	5	SWAMP	2011	Se
		1	5	TSMP[a]	2001	Chlordanes, DDTs, Dieldrin, Hg, Toxaphene
Spotted Bass	*Micropterus punctulatus*	22	22	FMP	2005 - 2007	Hg
		6	6	RMP	2016	Hg

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
Steelhead Trout*	*Oncorhynchus mykiss gairdneri*	25	25	FMP	2005 - 2006	Hg
Striped Bass*	*Morone saxatilis*	123	123	FMP	2005 - 2007	Hg
		17	17	FMP	2006 - 2007	Chlordanes, DDTs, Diedrin, PCBs
		113	122	RMP	1997, 2000, 2003, 2006, 2009	Hg
		23	68	RMP	2000, 2003, 2009	Chlordanes, DDTs, PCBs
		21	62	RMP	2000, 2003, 2009	Dieldrin
		6	18	RMP	2009	PBDEs, Se
		31	31	SRWP	1999 - 2000, 2002	Hg
		2	2	TSMP[a]	1997	Chlordanes, DDTs, Dieldrin, Hg
Threadfin Shad	*Dorosoma petenense*	38	228	UCD[c]	1998 - 1999	Hg
White Catfish	*Ameiurus catus*	16	16	CALFED	2000	Hg
		48	48	FMP	2005 - 2007	Hg
		56	108	SRWP	1997 - 2000	Hg
		2	10	SRWP	1998	PBDEs
		12	67	SRWP	1998 - 2000	Chlordanes, DDTs, Dieldrin, PCBs
		9	52	SRWP	1998 - 2000	Toxaphene
		1	5	SRWP	2005	Chlordanes, DDTs, Dieldrin, PCBs, Toxaphene
		29	105	TSMP[a]	1978 - 1986, 1991 - 1993, 1998	Hg
		4	27	TSMP[a]	1986, 1993, 1998	Se

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Project	Year Collected	Contaminants Analyzed[e]
White Sturgeon*	*Acipenser transmontanus*	8	8	FMP	2006 - 2007	Hg
		21	28	RMP	1997, 2000, 2003, 2006	Hg
		15	40	RMP	2000, 2003, 2006, 2009	Chlordanes, DDTs, PCBs
		53	53	RMP	1997, 2000, 2003, 2006, 2009	Se
		4	12	RMP	2009	PBDEs
Yellowfin Goby	*Acanthogobius flavimanus*	2	33	TSMP[a]	1989 - 1990	Hg, Se
		2	12	UCD[c]	1999	Hg

*Data for these species were excerpted from the Advisory for Fish that Migrate. Data were recalculated for White Sturgeon because of a change in legal size limits since that publication.
[a]Study report did not specify whether skin was removed from fillets prior to tissue analysis.
[b]Samples were analyzed as skin-on fillets.
[c]Samples were analyzed as whole organisms, including head, skin, internal organs, muscle, and bones.
[d]Samples were analyzed using the tail meat.
[e]Organic 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, unless part of an ongoing monitoring study (e.g. Sacramento River Watershed Program).

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 (36-54 congeners[3]), and toxaphene. Among the chemicals analyzed in fish tissue samples from the Sacramento River and Northern Delta, only mercury, PBDE, and PCB levels were sufficiently high to impact consumption advice.

All fish samples were prepared as skinless fillets, except for the EEPS and UCD studies where smaller fish were analyzed as whole organisms, and the CALFED study where some species were analyzed as skin-on fillets. The fillet preparation method was not recorded for the TSMP study. Crayfish were analyzed using tail muscle. Samples were analyzed as individual fish or composites.

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

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. For the CFCP, FMP, RMP, and SWAMP (2007-2008, 2011) studies, analyses were performed at the CDFW Moss Landing Marine Laboratories (MLML) using a direct mercury analyzer (DMA). The DMA method utilizes thermal decomposition and atomic absorption. The DMA method detection limit (MDL)[4] and the reporting limit (RL)[5] for total mercury were reported at 4-19 and 12-36 parts per billion (ppb), respectively.

For the CALFED, EEPS, SRWP, and UCD studies, analyses were performed using cold vapor atomic absorption (CVAA) spectrometry, which determines the concentration of mercury by measuring the amount of radiation it absorbs. The CVAA MDL and the RL for total mercury were reported at 10 and 20 parts per billion (ppb), respectively.

Although mercury was detected at commonly found concentrations in the CALFED, EEPS, TSMP, and UCD studies, the MDL and RL for mercury were not reported. The TSMP study also did not report the mercury analysis method. 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[6], as well as mercury concentrations in each species.

PBDES, PCBS, AND PESTICIDES

Some composite samples were analyzed for PBDEs, PCBs, and the legacy pesticides (chlordanes, DDTs, dieldrin, and toxaphene). PBDEs, PCBs, and pesticides 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 for most samples), 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). Tables 3 and 4 show the averages and ranges

[4] The MDL is the lowest quantity of a chemical that can be distinguished (as greater than zero) in a sample.
[5] The RL is the lowest quantity of a chemical that can be accurately quantified in a sample.
[6] 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. For crayfish species, the total carapace length was measured.

for total length[7], as well as PBDE and PCB concentrations, respectively, in each fish species.

SELENIUM

Some composite samples collected from the Sacramento River and Northern Delta were analyzed for selenium, as composite samples, using inductively coupled plasma-mass spectrometry (ICP-MS). 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 30, 100, 150, and 300 or 400 ppb, respectively. The TSMP did not provide method of analysis, MDL, or RL.

Concentrations of chlordanes, dieldrin, DDTs, selenium, and toxaphene were lower than the corresponding ATL threshold values for daily consumption (OEHHA, 2008 and 2011). 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 THE SACRAMENTO RIVER AND NORTHERN DELTA

Species from the Sacramento River and Northern Delta	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
American Shad***	51	55	428	286 - 571	61	29 - 337
Black Bass Species	239	322	367	305 - 614	639	207 - 1530
Largemouth Bass	199	274	369	307 - 614	630	207 - 1530
Smallmouth Bass	12	20	368	312 - 479	852	469 - 1408
Spotted Bass	28	28	343	305 - 421	580	357 - 991
Bullhead	5	33	250	221 - 389	135	70 - 580
Catfish	219	385	319	204 - 726	393	112 - 1265
Channel Catfish	70	108	394	204 - 726	269	112 - 1265
White Catfish	149	277	290	207 - 587	441	134 - 1140

[7] 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.

Species from the Sacramento River and Northern Delta	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Carp and Goldfish	117	200	483	265 - 770	248	50 - 938
Common Carp	113	196	486	267 - 770	247	50 - 938
Goldfish	4	4	324	265 - 375	263	87 - 488
Chinook Salmon***	42	60	815	599 - 1040	82	36 - 150
Crappie	36	52	242	170 - 395	299	78 - 686
Crayfish	135	165	46	33 - 65	203	44 - 662
Signal Crayfish	122	152	46	33 - 65	212	50 - 662
Red Swamp Crayfish	12	12	46	37 - 56	101	44 - 339
Northern Crayfish	1	1	43	n/a	97	n/a
Hardhead	16	20	395	314 - 491	281	94 - 810
Rainbow Trout	65	166	338	209 - 399	38	0 - 111
Sacramento Pikeminnow	103	143	361	254 - 638	450	70 - 2039
Sacramento Sucker	144	233	413	214 - 574	182	0 - 562
Small Baitfish and Shrimp	334	1692	58	26 - 160	54	6 - 242
Bigscale Logperch	37	152	65	54 - 110	70	24 - 242
Crangon Shrimp	10	72	nr	nr	8	6 - 10
Golden Shiner	1	11	74	n/a	21	n/a
Inland Silverside	199	986	60	34 - 88	60	21 - 186
Mississippi Silverside	4	20	61	46 - 74	46	41 - 50
Mosquitofish	13	84	32	26 - 51	58	37 - 139
Red Shiner	7	32	42	34 - 56	56	31 - 81
Shimofuri Goby	22	73	54	44 - 72	31	13 - 107
Threadfin Shad	38	228	59	40 - 105	43	19 - 171
Yellowfin Goby	4	45	143	100 - 160	45	33 - 60
Steelhead Trout***	25	25	620	420 - 930	81	38 - 165

Species from the Sacramento River and Northern Delta	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	Mercury (ppb)	
					Mean*	Range**
Striped Bass***	269	278	598	448 - 1149	443	132 - 3500
Sunfish Species	143	160	172	115 - 206	151	38 - 492
Bluegill	49	53	146	115 - 206	173	67 - 419
Redear Sunfish	94	107	184	130 - 266	141	38 - 492
White Sturgeon***	29	36	1382	1170 - 1650	321	149 - 914

*Means are an arithmetic average of individual values, and/or a weighted average of composites. Samples from the University of California, Davis (UCD) were reported as a median.
**Range of individuals and/or range of the composites.
*** Data for these species were excerpted from the Advisory for Fish that Migrate. Data were recalculated for White Sturgeon because of a change in legal size limits since that publication.
nr = not reported
n/a = not applicable due to a single sample

TABLE 3. PBDE CONCENTRATIONS IN FISH FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

Species from the Sacramento River and Northern Delta	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PBDEs (ppb)	
					Mean*	Range**
Catfish	3	14	325	250 - 509	49	39 - 58
Channel Catfish	1	4	470	433 - 509	39	n/a
White Catfish	2	10	268	250 - 286	53	47 - 58
Common Carp	2	10	392	386 - 398	6	6 - 7
Largemouth Bass	5	25	353	334 - 381	29	5 - 119
Rainbow Trout	1	5	399	n/a	26	n/a
Sacramento Pikeminnow	3	15	273	254 - 286	9	7 - 10
Sacramento Sucker	6	30	440	322 - 550	125	1 - 593
Striped Bass***	6	18	609	480 - 790	5	1 - 9
White Sturgeon***	4	12	1322	1170 - 1560	3	2 - 5

*Means are an arithmetic average of individual values and/or a weighted average of composites.
**Range of individuals and/or range of the composites.
***Data for these species were exerpted from the Advisory for Fish that Migrate.
n/a = not applicable due to a single sample

TABLE 4. PCB CONCENTRATIONS IN FISH FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

Species from the Sacramento River and Northern Delta	Number of Samples	Total Number of Fish	Mean* Total Length (mm)	Range of Total Lengths** (mm)	PCBs (ppb)	
					Mean*	Range**
Black Bass Species	14	72	361	333 - 381	14	3 - 112
Largemouth Bass	13	67	362	333 - 381	14	3 - 112
Smallmouth Bass	1	5	338	n/a	6	n/a
Catfish	17	88	315	249 - 646	27	1 - 103
Channel Catfish	4	16	502	359 - 646	46	12 - 103
White Catfish	13	72	274	249 - 395	22	1 - 53
Chinook Salmon***	5	15	857	690 - 1040	5	1 - 8
Common Carp	8	38	427	340 - 607	8	1 - 27
Rainbow Trout	9	45	355	313 - 399	12	6 - 24
Sacramento Pikeminnow	9	44	274	252 - 298	10	5 - 25
Sacramento Sucker	19	95	421	290 - 569	14	1 - 63
Striped Bass***	40	85	565	450 - 820	40	2 - 156
White Sturgeon***	15	40	1346	1170 - 1650	79	5 - 383

*Means are an arithmetic average of individual values and/or a weighted average of composites.
**Range of individuals and/or range of the composites.
***Data for these species were excerpted from the Advisory for Fish that Migrate. Data were recalculated for White Sturgeon because of a change in legal size limits since that publication.
n/a = not applicable due to a single sample

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

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 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 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) and "Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California

[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).

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, PBDE, 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) in resident species was assessed in catfish species, Rainbow Trout, and Sacramento Sucker, and affected advice for catfish species. The effect of multiple chemical exposures in anadromous species also reduced consumption advice for White Sturgeon. Advice for other species in this advisory was based solely on mercury, PBDE, 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 species[9] 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.

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

CONSUMPTION ADVICE FOR FISH FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

In most cases, 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 Sacramento River and Northern Delta, the sample size criterion was increased to 20 individuals because of the large geographic area encompassed by the advisory. This criterion was met for the primary contaminant of concern for this region (mercury) for the species listed in Table 1. Organic chemical analyses (e.g., PCBs, legacy pesticides, and PBDEs) are often performed on a smaller subset of samples because of cost considerations. These data may be used for advisory development nonetheless. There were not sufficient data to evaluate other species that may be found in this water body.

ANADROMOUS SPECIES

The updated Sacramento River and Northern Delta Advisory includes safe eating guidelines for anadromous species, which are fish that migrate from the ocean to rivers to spawn. Further detail on the analyses of these species can be found in the Advisory for Fish that Migrate (OEHHA, 2012).

AMERICAN SHAD

The mean mercury concentration in American Shad was 61 ppb. OEHHA recommends a maximum of three servings a week of American Shad for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of seven servings a week for the general population (women 50 years and older, and men 18 years and older).

CHINOOK SALMON

The mean mercury and PCBs concentrations in Chinook Salmon were 82 and 5 ppb, respectively. Based on the concentration of mercury, OEHHA recommends a maximum of two servings per week of Chinook Salmon for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of seven servings a week for the general population (women 50 years and older, and men 18 years and older). PCBs did not impact advice.

STEELHEAD TROUT

The mean mercury concentration in Steelhead Trout was 81 ppb. OEHHA recommends a maximum of two servings a week for the sensitive population (women 18 to 49 years

and children 1 to 17 years), and a maximum of seven servings a week for the general population (women 50 years and older, and men 18 years and older).

Striped Bass

The mean mercury, PBDE, and PCB concentrations in Striped Bass were 443, 5, and 40 ppb, respectively. Based on the concentration of mercury, OEHHA recommends no consumption of Striped Bass for the sensitive population (women 18 to 49 years and children 1 to 17 years). Based on the Advisory for Fish that Migrate, advice for the consumption of Striped Bass for the general population (women 50 years and older, and men 18 years and older) is a maximum of two servings per week. Due to minor changes in analysis methodology since the 2012 publication of the Advisory for Fish that Migrate, the mercury concentration of 443 ppb would now prompt a recommendation of one serving a week for the general population. However, OEHHA elected to retain advice at 2 meals per week for the following reasons:

1- To remain consistent with the Advisory for Fish that Migrate,
2- The mean mercury value of 443 ppb is just above 440 ppb, which is the delineation between one and two servings per week for the general population in OEHHA's advisories, and
3- An updated OEHHA analysis for Striped Bass collected in anadromous waters, which includes more recent mercury and PCB data and excludes all data collected prior to 2000, supports advice of two meals per week for the general population based on mercury or PCBs.

PBDEs did not impact advice for Striped Bass.

White Sturgeon

The mean mercury, PBDE, and PCB concentrations in White Sturgeon were 321, 3, and 79 ppb, respectively. Mercury and PCB concentrations changed slightly from those published in the 2012 Advisory for Fish that Migrate due to a recalculation of the data that reflects the change in legal size limits for this species. This update did not change the advice. OEHHA recommends no consumption of White Sturgeon for the sensitive population (women 18 to 49 years and children 1 to 17 years), based on a multiple chemical exposure analysis of mercury and PCBs, and a maximum of one serving a week for the general population (women 50 years and older, and men 18 years and older), based on PCBs. PBDEs did not impact advice.

Resident Species

The updated Sacramento River and Northern Delta Advisory also includes safe eating guidelines for resident species, which are fish that do not migrate to the ocean.

Black Bass Species (Largemouth Bass, Smallmouth Bass, and Spotted Bass)

The mean mercury and PCB concentrations in black bass species from the Sacramento River and Northern Delta were 639 ppb and 14 ppb, respectively. Mercury and PCB concentrations for individual black bass species were as follows: Largemouth Bass (Hg: 630 ppb, PCB: 14 ppb), Smallmouth Bass (Hg: 852 ppb, PCB: 6 ppb), and Spotted Bass (Hg: 580, PCB: not analyzed). The mean PBDE concentration in Largemouth Bass was 29 ppb; PBDEs were not analyzed in other black bass species. Based on the concentration of mercury in these black bass species, OEHHA recommends no consumption for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of one serving a week for the general population (women 50 years and older, and men 18 years and older). PBDEs and PCBs did not impact advice.

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, Smallmouth, and Spotted Bass to other black bass species, including Redeye.

Bullhead Species

The mean mercury concentration in bullhead from the Sacramento River and Northern Delta was 135 ppb. OEHHA recommends a maximum of two servings a week of bullhead species for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of four servings a week for the general population (women 50 years and older, and men 18 years and older).

Catfish Species (Channel Catfish and White Catfish)

The mean mercury, PBDE, and PCB concentrations in catfish species from the Sacramento River and Northern Delta were 393 ppb, 49 ppb, and 27 ppb, respectively. Chemical concentrations for individual species were as follows: Channel Catfish (Hg: 269 ppb, PBDE: 39 ppb, PCB: 46 ppb), and White Catfish (Hg: 441 ppb, PBDE: 53 ppb, PCB: 22 ppb). OEHHA recommends no consumption of catfish species for the sensitive population (women 18 to 49 years and children 1 to 17 years) based on a multiple chemical exposure analysis of mercury and PCBs, and a maximum of two servings a week for the general population (women 50 years and older, and men 18 years and older), based on mercury or PCBs. PBDEs did not impact advice.

Common Carp and Goldfish

The mean mercury concentration in Common Carp and Goldfish from the Sacramento River and Northern Delta was 248 ppb. Mercury concentrations for individual species were as follows: Common Carp (247 ppb) and Goldfish (263 ppb). The mean PBDE and PCB concentrations in Common Carp were 6 ppb and 8 ppb, respectively. PBDEs

and PCBs were not analyzed for Goldfish. Based on the concentration of mercury in these two species, OEHHA recommends a maximum of one serving a week for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of two servings a week for the general population (women 50 years and older, and men 18 years and older). PBDEs and PCBs did not impact advice.

Common Carp and Goldfish were analyzed together using a weighted average. Although the small sample size of Goldfish (n=4) would normally disqualify a species for inclusion in an advisory, OEHHA made an exception because Common Carp and Goldfish are very closely related and frequently hybridize when they are co-located, making them difficult to distinguish (Halas et al. 2018). Further, the data suggest that mercury concentrations for Common Carp and Goldfish from the Sacramento River and Northern Delta are very similar.

Crappie

The mean mercury concentration in crappie from the Sacramento River and Northern Delta was 299 ppb. OEHHA recommends a maximum of one serving a week of crappie for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of two servings a week for the general population (women 50 years and older, and men 18 years and older).

Crayfish

The mean mercury concentration in crayfish species from the Sacramento River and Northern Delta was 203 ppb. Mercury concentrations for individual species were as follows: Signal Crayfish (212 ppb), Red Swamp Crayfish (101 ppb), and Northern Crayfish (97 ppb). OEHHA recommends a maximum of one serving per week of crayfish for the sensitive population (women 18 to 49 years and children 1 to 17 years). To improve risk communication through the reduction of different meal frequency categories for species from the Sacramento River and Northern Delta, OEHHA reduced the number of recommended servings a week of crayfish from three to two for the general population (women 50 years and older, and men 18 years and older).

Hardhead

The mean mercury concentration in Hardhead from the Sacramento River and Northern Delta was 281 ppb. OEHHA recommends a maximum of one serving a week of Hardhead for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of two servings a week for the general population (women 50 years and older, and men 18 years and older).

Rainbow Trout

The mean mercury, PBDE, and PCB concentrations in Rainbow Trout from the Sacramento River and Northern Delta were 38, 26, and 12 ppb, respectively. OEHHA

recommends a maximum of five servings a week of Rainbow Trout for the sensitive population (women 18 to 49 years and children 1 to 17 years) based on mercury or PCBs, and a maximum of five servings a week for the general population (women 50 years and older, and men 18 years and older), based on PCBs. PBDEs did not impact advice.

Sacramento Pikeminnow

The mean mercury, PBDE, and PCB concentrations in Sacramento Pikeminnow from the Sacramento River and Northern Delta were 450, 9, and 10 ppb, respectively. Based on mercury concentrations, OEHHA recommends no consumption of Sacramento Pikeminnow for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of one serving a week for the general population (women 50 years and older, and men 18 years and older). PBDEs and PCBs did not impact advice.

Sacramento Sucker

The mean mercury, PBDE, and PCB concentrations in Sacramento Sucker from the Sacramento River and Northern Delta were 182, 125, and 14 ppb, respectively. OEHHA recommends a maximum of one serving a week of Sacramento Sucker for the sensitive population (women 18 to 49 years and children 1 to 17 years) based on mercury, and a maximum of two servings a week for the general population (women 50 years and older, and men 18 years and older) based on PBDEs. PCBs did not impact advice.

Small Baitfish and Shrimp (Bigscale Logperch, Crangon Shrimp, Golden Shiner, Inland Silverside, Mississippi Silverside, Mosquitofish, Red Shiner, Shimofuri Goby, Threadfin Shad, Yellowfin Goby)

The mean mercury concentrations in small baitfish and shrimp from the Sacramento River and Northern Delta was 54 ppb. Mercury concentrations for individual species were as follows: Bigscale Logperch (70 ppb), Crangon Shrimp (8 ppb), Golden Shiner (21 ppb), Inland Silverside (60 ppb), Mississippi Silverside (46 ppb), Mosquitofish (58 ppb), Red Shiner (56 ppb), Shimofuri Goby (31 ppb), Threadfin Shad (43 ppb), and Yellowfin Goby (45 ppb). Based on the weighted average concentration of mercury in these small baitfish and shrimp species, OEHHA would typically recommend a maximum of four servings a week for the sensitive population (women 18 to 49 years and children 1 to 17 years). However, four of the ten species included in the “small baitfish and shrimp” group have mercury concentrations greater than 55 ppb and would prompt a recommendation of three servings per week for the sensitive population, if analyzed individually. Therefore, in order to provide advice that is the most health protective and for ease of risk communication, OEHHA elected to reduce the number of recommended servings of small baitfish and shrimp from four to three servings a week for the sensitive population. OEHHA recommends a maximum of seven servings a

week for the general population (women 50 years and older, and men 18 years and older).

SUNFISH SPECIES (BLUEGILL, REDEAR SUNFISH)

The mean mercury concentration in sunfish species from the Sacramento River and Northern Delta was 151 ppb. Mercury concentrations for individual sunfish species were as follows: Bluegill (173 ppb) and Redear Sunfish (141 ppb). OEHHA recommends a maximum of one serving a week of sunfish species for the sensitive population (women 18 to 49 years and children 1 to 17 years), and a maximum of four servings a week for the general population (women 50 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, Redear Sunfish) to other sunfish species, including Green Sunfish and Pumpkinseed.

RECOMMENDED MAXIMUM NUMBER OF SERVINGS

The recommended maximum numbers of servings per week for fish from the Sacramento River and Northern Delta are shown in Table 5.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM THE SACRAMENTO RIVER AND NORTHERN DELTA

Fish Species from the Sacramento River and Northern Delta	Women 18–49 years and Children 1-17 years	Women 50 years and older and Men 18 years and older
American Shad	3	7
Black Bass Species	0	1
Bullhead	2	4
Catfish	0	2
Chinook Salmon	2	7
Common Carp, Goldfish	1	2
Crappie	1	2
Crayfish	1	2
Hardhead	1	2
Rainbow Trout	5	5
Sacramento Pikeminnow	0	1
Sacramento Sucker	1	2
Small Baitfish and Shrimp	3	7
Steelhead Trout	2	7
Striped Bass	0	2
Sunfish Species	1	4
White Sturgeon	0	1

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APPENDIX I. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs) guide the development of advice for people eating sport fish. ATLs are 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 Sacramento River and Northern Delta are followed, exposure to chemicals in fish from the Sacramento River and Northern Delta 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
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 over a lifetime.