HEALTH ADVISORY AND GUIDELINES FOR EATING FISH FROM SAN DIEGO BAY (SAN DIEGO COUNTY)

October 2013

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

LIST OF CONTRIBUTORS

Authors

Margy Gassel, Ph.D.
Robert K. Brodberg, Ph.D.
Komal Bangia, MPH

Primary Reviewers

Lori Lim, Ph.D.
Susan Klasing, Ph.D.

Final Reviewers

Anna Fan, Ph.D.
Lauren Zeise, Ph.D.
Allan Hirsch

Director

George V. Alexeeff, Ph.D.

ACKNOWLEDGMENTS

Sampling and analysis of fish for contaminants are critical in the development of fish consumption advisories. The Office of Environmental Health Hazard Assessment (OEHHA) acknowledges the contribution of data from the following entities: California Department of Fish and Wildlife, Moss Landing Marine Laboratories and Water Pollution Control Laboratory, and the State Water Resources Control Board.

For further information, contact:

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

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

1001 I Street, P.O. Box 4010
Sacramento, CA 95812-4010
Telephone: (916) 327-7319

LIST OF ABBREVIATIONS AND ACRONYMS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife, formerly the California Department of Fish and Game
CFCP	Coastal Fish Contamination Program
DDTs	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyl dichloroethane (DDD) and dichlorodiphenyl dichloroethylene (DDE)
MDL	method detection limit
mm	millimeters
OEHHA	Office of Environmental Health Hazard Assessment
PCBs	polychlorinated biphenyls
ppb	parts per billion
RWB-9	San Diego Regional Water Quality Control Board- (Region 9)
SWAMP	Surface Water Ambient Monitoring Program
U.S. EPA	U.S. 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 task 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 "Public Health Advisories."

This report presents guidelines for eating fish from San Diego Bay, California. The report provides background information and a description of how the guidelines were developed. The resulting advice is summarized in the two illustrations after the Table of Contents.

Note: the minimum and average concentrations of PCBs for shiner perch (whole) in Table 4 were corrected in this version of the report (9/5/2014).

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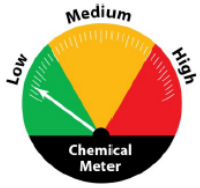
Women 18-45 years and children 1-17 years

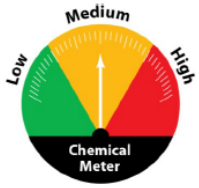


Diamond turbot

Spotted turbot

Black perch
Pile surfperch
Rainbow seaperch

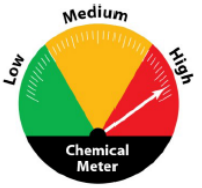
California lizardfish



Pacific chub mackerel

Round stingray

Shovelnose guitarfish



Barred sand bass

Spotted sand bass

Shiner perch

Topsmelt

Yellowfin croaker

Leopard shark

Gray smoothhound shark

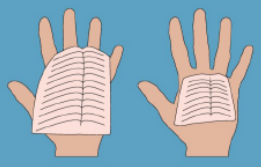
2 servings a week	OR	1 serving a week	Do not eat

Eat only the skinless fillet.

PCBs are in the fat and skin of the fish.

- Remove and throw away the skin before cooking.
- Cook thoroughly and allow the juices to drain away.

What is a serving?



For Adults For Children

The recommended serving is the size and thickness of your hand. Give children smaller servings.

Why eat fish?

Eating fish is good for your health. Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

What is the concern?

Some fish have high levels of mercury or PCBs. Mercury can harm the brain, especially in unborn babies and children. PCBs can cause cancer.

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A Healthy Guide to Eating Fish from San Diego Bay

Women over 45 years and men can safely eat more fish

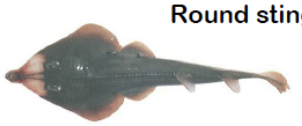
Diamond turbot

Spotted turbot

Black perch
Pile surfperch
Rainbow seaperch

California lizardfish

Round stingray



Shovelnose guitarfish

Spotted sand bass

Barred sand bass

Yellowfin croaker

Pacific chub mackerel

Leopard shark

Gray smoothhound shark

Shiner perch

Topsmelt

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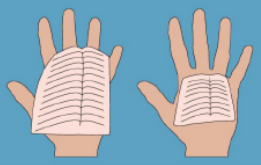

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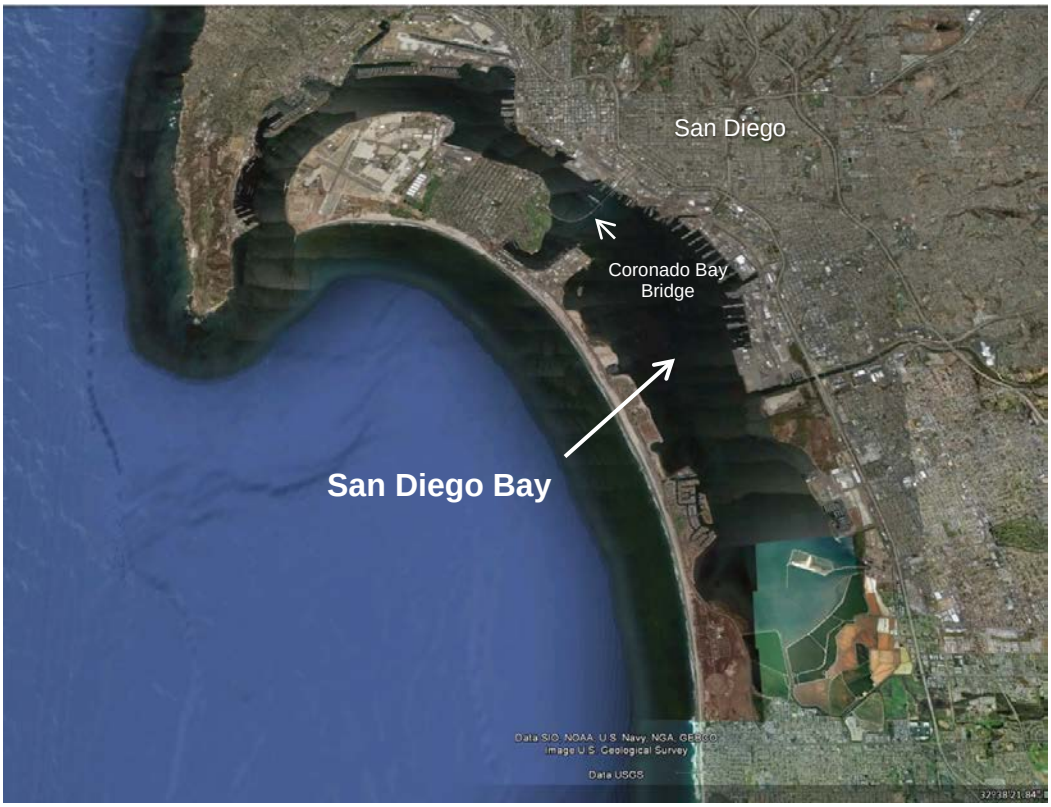
INTRODUCTION

This report presents guidelines for eating fish from San Diego Bay, California. The report provides background information and a description of how the guidelines were developed.

San Diego Bay (Figure 1) is a natural harbor with 34 miles of waterfront and is one of California's five major ports. San Diego Bay is popular for fishing, both from shore and by boat. Many fish species are supported by the variety of habitats in the bay, and many piers and boat launches provide access for fishers. Numerous urban and industrial discharges have contributed to pollution of the bay. Manufacturing, particularly in the areas of shipbuilding and repair, and military and defense activities are the city of San Diego's first and second largest industries, respectively. The port also has two marine cargo facilities, and cruise ship operations are growing, with more than 180 cruise ships docking per year.[1]

FIGURE 1. MAP SHOWING SAN DIEGO BAY



[1] http://www.city-data.com/us-cities/The-West/San-Diego-Economy.html

The California Regional Water Quality Control Board–San Diego Region (RWB-9) is working to address contaminated sediments in San Diego Bay. The RWB-9 identified the following sources of toxic pollutants: urban and storm water runoff, industrial and construction site runoff, shipyards, shipbuilding industries, naval stations, transportation, oil spills, bilge and ballast water, leaching from creosote pilings, deposits from air, and resuspension of sediments (RWB-9, 2008).

Studies finding elevated levels of chemical contaminants in San Diego Bay fish tissues (see below) prompted the Office of Environmental Health Hazard Assessment (OEHHA) to develop this advisory for eating fish from San Diego Bay. The basic OEHHA process to develop fish consumption advice involves these steps:

1) Select the chemical data and fish species to be evaluated;
2) Calculate average (mean) chemical concentrations and other descriptive statistics as appropriate for the selected fish species;
3) Compare the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of concern.

OEHHA developed ATLs (Appendix I,) which are acceptable levels of specific contaminants in fish tissue based on the toxicity of each chemical for a range of consumption rates. Development of the ATLs also included consideration of health benefits linked to eating fish (Klasing and Brodberg, 2008).

CHEMICALS OF POTENTIAL CONCERN

Chemical analysis of fish from San Diego Bay included mercury (as a measure of methylmercury), polychlorinated biphenyls (PCBs), and the pesticides DDTs (dichlorodiphenyltrichloroethane and its metabolites), chlordanes, and dieldrin.

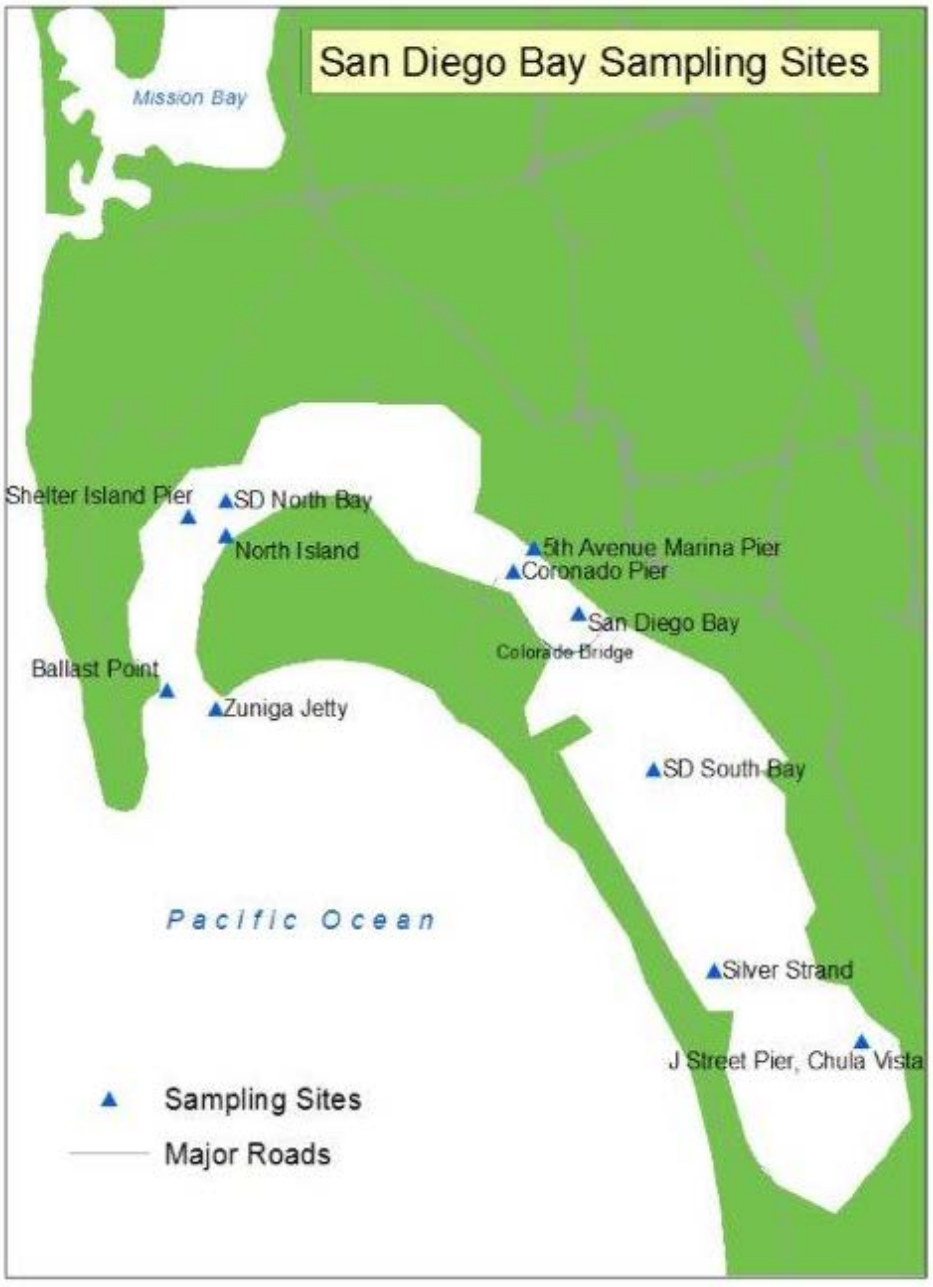
High levels of methylmercury can cause subtle changes in the brain, especially in fetuses and children as they grow. PCBs are man-made chemicals previously used in electrical transformers, lubricating oils, and plastics. PCBs can cause cancer and other health effects in humans. Chlordanes, DDTs, and dieldrin are pesticides that were banned from use many years ago but have been found in some fish in certain water bodies in California. These chemicals may cause cancer or adverse effects to the nervous system. Detailed discussion of the toxicity of these chemicals is presented in Klasing and Brodberg (2008).

DATA SOURCES

The guidelines for eating fish from San Diego Bay were based on chemical analysis of fish sampled by the two programs described below. These studies had adequate documentation of sample collection, fish preparation, chemical analyses, and quality assurance, and detection limits were below levels of health concern. Fish were

collected from various locations in San Diego Bay. The sampling sites are shown in Figure 2.

FIGURE 2. MAP OF SAMPLING SITES IN SAN DIEGO BAY



COASTAL FISH CONTAMINATION PROGRAM (CFCP)

The Coastal Fish Contamination Program was a statewide monitoring program of chemical contamination in sport fish and shellfish in nearshore (marine and estuarine) waters in California (Gassel et al., 2002). The CFCP was designed to provide data for assessing human health risks from fish consumption. The program began as a result of legislation (Assembly Bill 2872) passed in 2000 and continued for five years until it was halted due to budget constraints. Fish from San Diego Bay were collected in years 1999 through 2002.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

The State Water Resources Control Board operates the Surface Water Ambient Monitoring Program (SWAMP). This program monitors the water quality of California's surface waters. In 2009 and 2010, the program performed a statewide coastal fish survey. Fish from San Diego Bay were sampled in 2009.

Tables 1 and 2 below show the type and numbers of fish sampled from San Diego Bay, the year sampled, and the program that collected the samples. OEHHA uses only fish samples that meet either legal size requirements, when specified by the California Department of Fish and Wildlife (CDFW), or OEHHA's criteria for minimum "edible" size based on species size at maturity, catch data from the Recreational Fisheries Information Network (http://www.recfin.org/), and professional judgment (Gassel and Brodberg, 2005).

In 2013, CDFW changed the legal size requirement for sea bass including barred sand bass, spotted sand bass, and kelp bass. The minimum legal size, previously 12 inches (equivalent to 305 millimeters or mm), is now 14 inches (equivalent to 356 mm). As a result, the numbers of samples of legal-sized fish for these three species were greatly reduced. Table 1 shows the samples collected of the three bass species. The table includes a column for the data OEHHA evaluated previously, when the minimum legal size was 12 inches, and a column for bass meeting the new minimum legal size of 14 inches. After applying the new legal size for bass, sample size for spotted sand bass no longer met OEHHA's minimum requirement of at least nine fish per species, and there were no samples of kelp bass 14 inches or larger. Prior to this change, as seen in Table 1, there were adequate if not robust sample sizes for these species. Therefore, as discussed further in the section, "Development of Guidelines for Eating Fish from San Diego Bay," OEHHA considered both data sets for the bass species.

TABLE 1. BASS SPECIES COLLECTED FROM SAN DIEGO BAY

Program	Year	Fish Species Common Name (Scientific Name)	Number of Fish Collected[a]	
			≥ 12 inches	≥ 14 inches
CFCP	1999	Barred Sand Bass (*Paralabrax nebulifer)*	5	0
		Spotted Sand Bass (*Paralabrax maculatofasciatus)*	24	0
	2000	Spotted Sand Bass	5	0
	2001	Spotted Sand Bass	92	5
		Kelp Bass (*Paralabrax clathratus)*	8	0
	2002	Barred Sand Bass	25	5
		Kelp Bass	18	0
		Spotted Sand Bass	6	0
CFCP Total			**183**	**10**
SWAMP	2009	Barred Sand Bass	23	21
		Spotted Sand Bass	46	3
SWAMP Total			**69**	**24**
Total Number of Fish			**252**	**34**

[a] The number of fish shown for barred sand bass, spotted sand bass, and kelp bass indicate, first, the number 12 inches or larger and, second, the number 14 inches and larger. Total numbers are also shown both ways.

Table 2 shows the other fish species sampled from San Diego Bay. All fish in Table 2 met either CDFW's legal size requirements or OEHHA's criterion for "edible" size.

TABLE 2. NON-BASS FISH SPECIES COLLECTED FROM SAN DIEGO BAY

Program	Year	Fish Species Common Name	Scientific Name	Number of Fish Collected
CFCP	1999	Black Perch	*Embiotoca jacksoni*	5
		Diamond Turbot	*Hypsopsetta guttulata*	10
	2000	Shiner Perch	*Cymatogaster aggregata*	10
	2001	Black Perch	*Embiotoca jacksoni*	33
		Chub Mackerel	*Scomber japonicas*	5
		Diamond Turbot	*Hypsopsetta guttulata*	15
		Pile Surfperch	*Rhacochilus vacca*	12
		Rainbow Surfperch	*Hypsurus caryi*	5
		Round Stingray	*Urolophus halleri*	80
		Shiner Perch	*Cymatogaster aggregata*	9
		Spotted Turbot	*Pleuronichthys ritteri*	21
		Yellowfin Croaker	*Umbrina roncador*	5
		Black Perch	*Embiotoca jacksoni*	14
		California Halibut	*Paralichthys californicus*	3
		California Lizardfish	*Synodus lucioceps*	16
		Chub Mackerel	*Scomber japonicas*	24
		Gray Smoothhound Shark	*Mustelus californicus*	23
		Leopard shark	*Triakis semifasciata*	3
		Opaleye	*Girella nigricans*	5
		Shiner Perch	*Cymatogaster aggregata*	20
		Shovelnose guitarfish	*Rhinobatos productus*	12
		Spotted Turbot	*Pleuronichthys ritteri*	5
		Topsmelt	*Atherinops affinis*	66
		Yellowfin Croaker	*Umbrina roncador*	3
CFCP Total				**404**
SWAMP	2009	Chub Mackerel	*Scomber japonicas*	20
		Gray Smoothhound Shark	*Mustelus californicus*	6
		Shiner Perch	*Cymatogaster aggregata*	73
		Yellowfin Croaker	*Umbrina roncador*	15
SWAMP Total				**114**
Total Number of Fish				**518**

CHEMICAL CONCENTRATIONS

Fish samples were analyzed either as individual fish or composite samples. Composite samples are prepared from equal amounts of tissues from several individual fish of the same species. Analysis of composite samples is done for cost savings. The results represent average concentrations for the group of fish in the sample. For composite samples, U.S. EPA (2000) advised that the total length of the smallest fish in each composite sample be at least 75 percent of the length of the largest fish in the composite. This condition was met in most composite samples. The exceptions were two samples of spotted turbot (71% and 74%).

Most fish were analyzed as skinless fillets. Topsmelt and one composite sample each of spotted turbot and shiner perch were analyzed as whole fish (without head, tail, and guts) with skin on. Other samples of spotted turbot and shiner perch were analyzed as skinless fillets. For these two species, OEHHA compared the results for samples analyzed as skin-off fillets and skin-on whole bodies, as discussed in the next section of the report.

Based on OEHHA's evaluation of chemical levels in fish collected from San Diego Bay, mercury and PCBs were the chemicals of potential concern. The concentrations of the pesticides DDTs, chlordane, and dieldrin, shown in Appendix II, were below ATLs for daily consumption and will not be discussed further.

METHYLMERCURY

Samples were combusted and analyzed for total mercury by DMA (direct mercury analyzer) at the CDFW Moss Landing Marine Laboratories. Chemical concentrations were reported in wet weight. Total mercury detected was assumed to be 100% methylmercury because almost all mercury present in fish is methylmercury (Bloom, 1992).

OEHHA used the arithmetic mean (average) of the mercury concentrations for each fish species to represent average human exposure. The averages were weighted by the number of fish in the samples. Samples reported as non-detect were assumed to be zero. Method detection limits (MDL[3]), when reported, were equal to or less than 15 parts per billion (ppb), which is lower than the acceptable level for daily consumption. Table 3, on the next page, shows the mean (average) mercury concentrations, lengths, and numbers of samples for each fish species from San Diego Bay. The numbers of fish shown for barred sand bass and spotted sand bass are shown three ways: 1) 12 inches and larger, 2) 12 to 14 inches, and 3) 14 inches and larger.

[3] The MDL is the lowest concentration of a chemical that can be distinguished (as greater than zero) in a sample.

Table 3. Concentrations of Mercury in San Diego Bay Fish

Fish Species[a]		Number of Samples	Total Number of Fish[c]	Mean Total Length[d] (mm)	Minimum Mercury (ppb)	Maximum Mercury (ppb)	Mean Mercury[d] (ppb)
Barred Sand Bass	≥ 12”	16	48	358	42	233	119
	12-14”	7	27	337	103	161	112
	≥ 14”	9	21	385	84	233	127
Spotted Sand Bass	≥ 12”	46	163	326	114	396	239
	12-14”	42	155	324	114	396	237
	≥ 14”	4	8	367	180	320	270
Kelp Bass	≥ 12”	5	26	322	112	162	129
	≥ 14”	0	0	NA	NA	NA	NA
Black Perch		10	52	226	33	168	86
Pile Surfperch		3	12	297	54	185	114
Rainbow Surfperch		1	5	249	28	28	28
Shiner Perch	fillet	22	39	135	ND	99	47
	whole[b]	3	73	114	57	57	57
California Halibut		1	3	599	203	203	203
California Lizardfish		3	16	241	ND	23	14
Chub Mackerel		8	49	290	42	155	80
Diamond Turbot		5	25	206	ND	43	22
Spotted Turbot	fillet	5	21	212	23	63	44
	whole[b]	1	5	235	58	58	58
Gray Smoothhound Shark		20	24	707	221	1041	430
Leopard shark		3	3	1062	477	1925	1018
Round Stingray		16	80	293	159	430	273
Shovelnose guitarfish		3	12	824	214	267	248
Opaleye		1	5	185	37	37	37
Topsmelt[b]		3	66	134	28	40	33
Yellowfin Croaker		5	23	322	167	375	246

[a] The type of sample is fillet with the skin off unless otherwise specified
[b] Whole without head, tail, and guts; preparation is skin on
[c] The number of fish can be greater than the number of samples because composite samples contain more than one fish.
[d] Averages are weighted according to the number of fish in each sample
ND Non-detect
NA Not applicable
≥ 12” Greater than or equal to 12 inches
≥ 14” Greater than or equal to 14 inches

PCBs

Composite samples from each species were analyzed for PCBs by gas chromatography at the CDFW Water Pollution Control Laboratory. Results were reported in wet weight. Total concentrations were calculated as the sum of the PCB congeners[4]. Individual congeners with concentrations reported as "non-detect" were assumed to be zero because the MDLs were relatively low, under 2 ppb. This is a standard method of handling non-detect samples for PCBs and other chemicals with multiple congeners when detection limits are adequate (U.S. EPA, 2000). OEHHA calculated the weighted average of the sum of PCBs for each fish species. Table 4 shows the mean (average) concentrations of PCBs, lengths, and number of samples for each fish species from San Diego Bay. The numbers of fish shown for barred sand bass and spotted sand bass are shown three ways: 1) 12 inches and larger, 2) 12 to 14 inches, and 3) 14 inches and larger.

[4] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, 54 were reported.

TABLE 4. CONCENTRATIONS OF PCBS IN SAN DIEGO BAY FISH

Fish Species[a]		Number of Samples	Total Number of Fish[c]	Mean Total Length[d] (mm)	Minimum PCB (ppb)	Maximum PCB (ppb)	Mean PCB[d] (ppb)
Barred Sand Bass	≥ 12”	6	30	346	31	225	73
	12-14”	4	20	334	40	225	94
	≥ 14”	2	10	371	31	34	33
Spotted Sand Bass	≥ 12”	23	113	327	12	146	62
	12-14”	22	108	325	12	146	61
	≥ 14”	1	5	369	75	75	75
Kelp Bass	≥ 12”	5	26	322	17	117	34
	≥ 14”	0	0	NA	NA	NA	NA
Black Perch		9	47	227	5	202	34
Pile Surfperch		3	12	297	3	6	3
Rainbow Surfperch		1	5	249	7	7	7
Shiner Perch	fillet	2	19	153	109	151	129
	whole[b]	3	73	114	68	190	128
California Halibut		1	3	599	29	29	29
California Lizardfish		3	16	241	23	46	31
Chub Mackerel		5	34	297	25	115	89
Diamond Turbot		4	20	204	6	70	26
Spotted Turbot	fillet	5	21	212	1	10	7
	whole[b]	1	5	235	35	35	35
Gray Smoothhound Shark		3	11	678	9	41	18
Leopard shark		1	1	916	6	6	6
Round Stingray		16	80	293	5	31	15
Shovelnose guitarfish		3	12	824	14	31	22
Opaleye		1	5	185	21	21	21
Topsmelt[b]		3	66	134	109	155	127
Yellowfin Croaker		3	13	323	84	96	89

[a] The type of sample is fillet with the skin off unless otherwise specified
[b] Whole without head, tail, and guts; preparation is skin on
[c] The number of fish can be greater than the number of samples because composite samples contain more than one fish.
[d] Averages are weighted according to number of fish in each sample
NA Not applicable
≥ 12” Greater than or equal to 12 inches
≥ 14” Greater than or equal to 14 inches

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM SAN DIEGO BAY

OEHHA used the average concentrations of mercury or PCBs as the basis for guidelines for eating fish from San Diego Bay and compared these concentrations to ATLs. For each species, the chemical resulting in the lowest recommended consumption frequency was considered the main chemical of concern. There are two sets of ATLs for exposure to methylmercury in fish because of age-related toxicity. The ATLs (summarized in Appendix I) for the sensitive population, women 18–45 years and children 1–17 years, are lower than for women over 45 years and men. This difference is meant to protect the brain and nervous system of the young during growth and development. Women ages 18–45 years are included in the sensitive population to protect the fetus because these women are of childbearing age. For the sensitive population, OEHHA also assessed the potential additive toxicity when both mercury and PCBs were detected in the fish tissues of the same species because both chemicals can affect the developing nervous system.

There is much evidence and scientific consensus that eating fish promotes significant health benefits. Reported health benefits include reduced rates of heart disease and stroke, decreased inflammation, and improved mental and visual functions (IOM, 2007). The potential beneficial effects are thought to stem largely from specific omega-3 fatty acids found in significant amounts in fish, namely

- docosahexaenoic acid or “DHA” and
- eicosapentaenoic acid or “EPA.”

Studies have shown that children of mothers who ate low-mercury fish during pregnancy scored better on cognitive tests compared to children of mothers who did not eat fish or ate high-mercury fish (Oken et al., 2005, 2008). OEHHA’s advisory process and development of ATLs considered the health benefits from fish consumption. Further discussion on the benefits and risks of fish consumption can be found in Klasing and Brodberg (2008).

For fish collected from San Diego Bay, sample sizes were sufficient to develop advice for barred sand bass, black perch, pile surfperch, shiner perch, California lizardfish, Pacific chub mackerel, diamond turbot, spotted turbot, gray smoothhound shark, round stingray, shovelnose guitarfish, topsmelt, and yellowfin croaker. As mentioned, no kelp bass meeting the new legal size of 14 inches or larger were collected. The numbers collected of spotted sand bass, California halibut, leopard shark, and rainbow surfperch did not meet OEHHA’s criterion for sample size of at least nine fish per species, as discussed further below.

BASS

Barred sand bass, spotted sand bass, and kelp bass are all in the same genus (*Paralabrax*). Despite being related species, an initial evaluation of each species showed the levels of mercury or PCBs to be different enough to support giving advice by species rather than as a group (species combined). After selecting bass samples that met the new minimum legal size of 14 inches, however, only barred sand bass had enough samples to meet OEHHA's criterion of at least nine fish. Eight spotted sand bass were analyzed for mercury, and five were analyzed for PCBs. There were no legal-sized kelp bass.

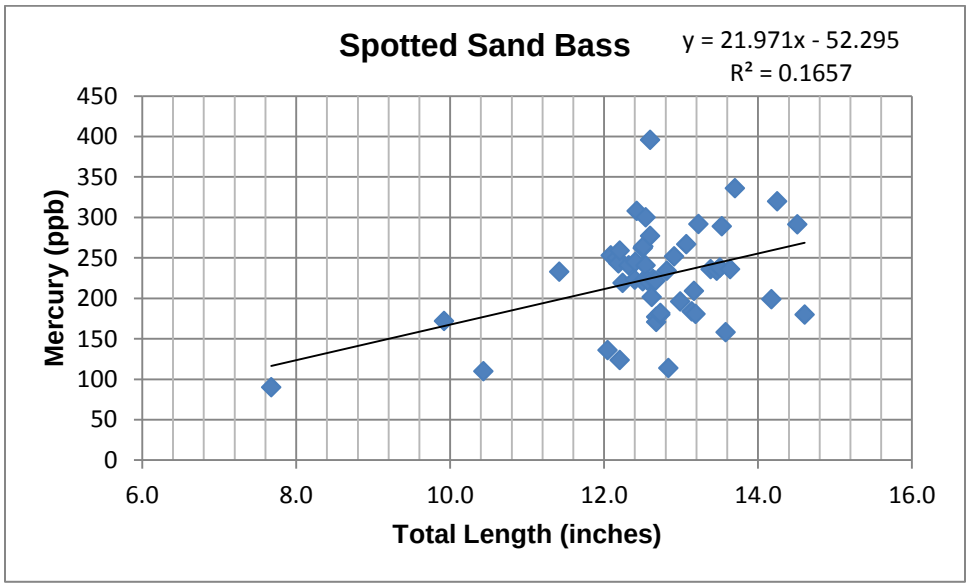
OEHHA used catch data from the Recreational Fisheries Information Network (RecFIN, http://www.recfin.org), a project of the Pacific States Marine Fisheries Commission, to assess the relative popularity of the species. The data from 2002 to 2012 showed that barred sand bass represented 55 percent of total catch of all three species in southern California; kelp bass comprised 42 percent, and spotted sand bass made up only three percent. Because the catch data were not specific to San Diego Bay, OEHHA looked at data for San Diego County and for "bays only" in southern California. These results showed that spotted sand bass were most frequently caught in San Diego County (83 percent of the spotted sand bass caught in southern California). Only 30 percent of barred sand bass and 34 percent of kelp bass were caught in San Diego County. The percentage caught in bays in southern California was 34 percent of spotted sand bass but only two percent of barred sand bass and one percent of kelp bass.

OEHHA concluded that spotted sand bass is an important species in San Diego Bay, and kelp bass are not as likely to be caught there. Therefore, because of the absence of data for legal-sized kelp bass, OEHHA did not develop advice for kelp bass.

SPOTTED SAND BASS

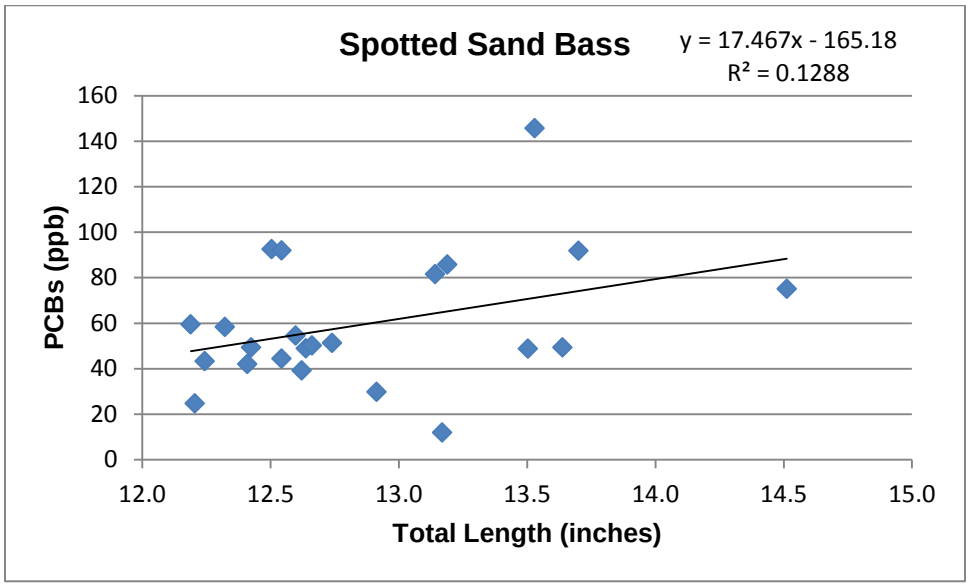
Using data for all sizes collected, OEHHA looked at the relationship between size (total length) and mercury concentrations in spotted sand bass. The results of this regression analysis are shown in Figure 3. The R^2 value (0.17, $p < 0.01$), although significant, indicates that length is not a strong predictor of mercury concentration because it explains only 17 percent of the variance in mercury concentrations. The graph shows that mercury concentrations in samples of spotted sand bass 14 inches and larger are similar to those in spotted sand bass between 12 and 14 inches. OEHHA considered the mean mercury concentration in spotted sand bass 12–14 inches (237 ppb) to be supportive for issuing advice based on the samples that were 14 inches and larger (mean mercury 270 ppb). Both of these mean concentrations correspond to the same advice.

FIGURE 3. RELATIONSHIP BETWEEN LENGTH AND MERCURY CONCENTRATION IN SPOTTED SAND BASS



OEHHA performed a similar analysis for PCBs in spotted sand bass (Figure 4) with similar results. Length is not a strong predictor of PCB concentration ($R^2 = 0.13$, $p > 0.1$). Also, because there was only one sample of legal-sized spotted sand bass greater than or equal to 14 inches (one composite of five fish, mean total length 14.5 inches) analyzed for PCBs, OEHHA compared the results for spotted sand bass 12 to 14 inches to the 14.5-inch sample. The mean concentration of PCBs was 61 ppb for spotted sand bass 12 to 14 inches and 75 ppb for the 14.5-inch sample. Both values correspond to the same advice, 1 serving a week, which is less than that based on mercury. OEHHA considered the mean PCB concentration in spotted sand bass 12–14 inches to be supportive for issuing advice based on the 14.5-inch sample. The recommendation of one serving a week based on PCBs was applied to women over 45 years and men. For the sensitive population, OEHHA reduced the recommendation to no consumption based on the potential additive toxicity of mercury and PCBs to the nervous system.

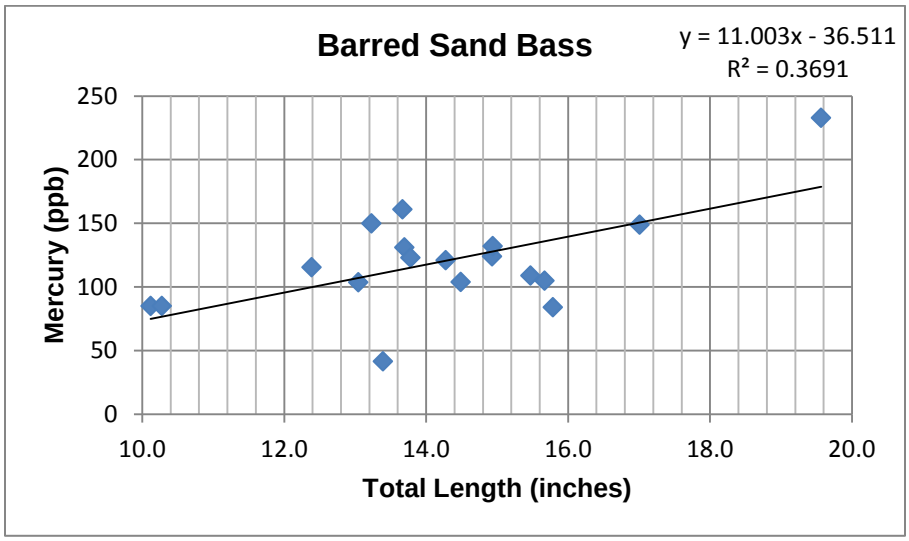
FIGURE 4. RELATIONSHIP BETWEEN LENGTH AND PCB CONCENTRATION IN SPOTTED SAND BASS



BARRED SAND BASS

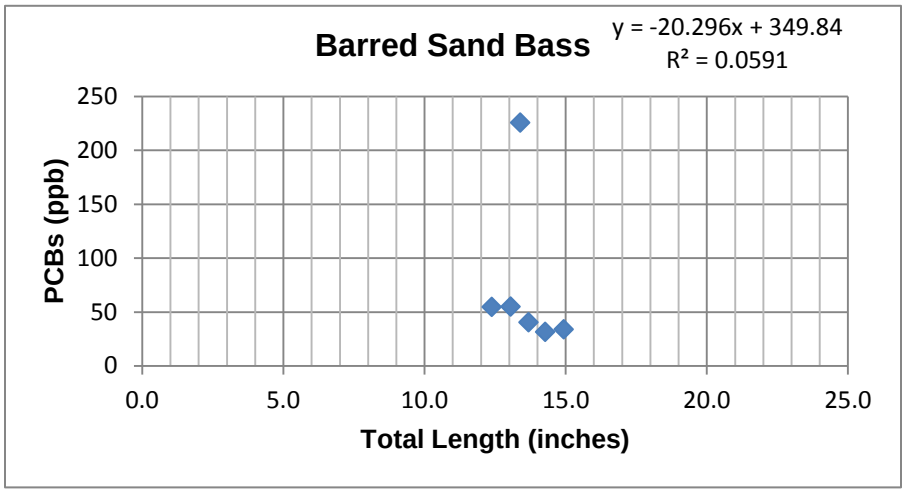
Twenty-one barred sand bass were analyzed for mercury and ten for PCBs. Although the number of samples met OEHHA's criterion, sample size was greatly reduced after omitting samples between 12 inches (the prior legal size) and 14 inches. Regression analysis for mercury in barred sand bass showed that length explained about 37 percent of the variability in mercury concentrations ($R^2 = 0.37$, $p < 0.01$; Figure 5). The mean mercury concentration for barred sand bass 12 to 14 inches was 112 ppb, and for barred sand bass 14 inches and larger, it was 127 ppb. Both means correspond to the same advice.

FIGURE 5. RELATIONSHIP BETWEEN LENGTH AND MERCURY CONCENTRATION IN BARRED SAND BASS



For PCBs, linear regression suggested an inverse relationship between length and concentration (Figure 6). This relationship was trivial, not significant ($R^2 = 0.06$, $p > 0.6$), and based on a small number of samples. Samples of barred sand bass between 12 and 14 inches had higher concentrations of PCBs than samples 14 inches and larger. The mean concentrations were 94 ppb in the smaller bass (12-14 inches) and 33 ppb in the larger barred sand bass (14 inches and larger). Comparison of the mean PCB concentrations to ATLs showed that advice based on PCBs would be fewer servings than advice based on mercury, if the smaller bass were considered, or the same, if the larger bass were used. To be conservative, OEHHA used the mean concentration from all barred sand bass samples 12 inches and larger (73 ppb), which was greater than the mean for barred sand bass 14 inches and larger (33 ppb), to determine the advice. The result was a recommendation of one serving a week for women over 45 years and men. For the sensitive population, the recommendation was reduced to no consumption based on co-exposure to mercury and PCBs.

FIGURE 6. RELATIONSHIP BETWEEN LENGTH AND PCB CONCENTRATION IN BARRED SAND BASS



In sum for barred sand bass and spotted sand bass, PCBs were the main chemical of concern for both populations. For the sensitive population, OEHHA also considered co-exposure to mercury and PCBs. The evaluation led OEHHA to reduce the advice for these two bass species to no consumption. The advice for eating barred sand bass or spotted sand bass for women over 45 years and men is one serving a week.

SPOTTED TURBOT AND DIAMOND TURBOT

Spotted turbot and diamond turbot belong to the same family (Pleuronectidae, or right-eyed flatfish). Compared to spotted turbot, diamond turbot grow larger: up to 1½ feet for diamond turbot and just under one foot for spotted turbot. Both species mature around the same size (6.5 inches for diamond turbot and 6 inches for spotted turbot). Spotted turbot have one dark spot in the middle of the body and two spots near the rear. Diamond turbot have light-colored spots all over their green or brown bodies. To the non-specialist, the two species might not be easily distinguished.

PCBs were the chemical of concern in diamond turbot and spotted turbot. Mercury levels were low. Diamond turbot were analyzed as composites of skinless fillets. The advice for diamond turbot is two servings a week, based on PCB concentration.

Five composite samples of spotted turbot (21 fish) were analyzed as skinless fillets. One additional composite sample of spotted turbot was made of five whole fish (without head, tail, and gut) with skin on. PCBs tend to accumulate in fatty tissues including the skin. As expected, the whole body sample with skin had a higher level of PCBs compared to the filleted samples. Therefore, advice for spotted turbot fillets would be five servings a week whereas the advice based on PCBs in the whole-fish samples would be two servings a week. Because the species are related and have similar

physical appearances, and to simplify the advice, OEHHA chose to give the same, more conservative advice for all fish consumers: two servings a week of diamond turbot or spotted turbot. OEHHA recommends that fish consumers eat only the fillet because certain chemical contaminants such as PCBs concentrate in the other fish parts.

Shiner Perch

PCBs were the chemical of concern in shiner perch. Mercury levels were low. Of the three composite samples of shiner perch (comprised of 92 fish) analyzed for PCBs, one sample was made of whole bodies (without head, tails, and guts) with skin on. The other two samples were analyzed as skinless fillets. As expected, PCB concentrations were higher in the whole body sample with skin on compared to the samples analyzed as skinless fillets. Even so, the concentrations in both skin-on and skin-off samples of shiner perch were high enough that OEHHA recommends no consumption for all fish consumers.

Other Surfperch Species

In addition to shiner perch, other members of the surfperch family sampled from San Diego Bay included black perch, pike surfperch, and rainbow seaperch. Sample size was highest for black perch (a total of 47 fish), moderate for pile surfperch (12 fish), and insufficient for rainbow seaperch (5 fish). Concentrations of PCBs in these three surfperch species were well below those in shiner perch. However, comparison of PCB levels to ATLs resulted in OEHHA recommending fewer servings based on PCBs than based on mercury. Therefore, PCBs were the chemical of concern in these surfperch species.

There are many surfperch species, and they have been assigned to one of two groups based on their feeding habits (NOAA, 2007). Shiner perch are in the group that feeds in the water column. The other species sampled from San Diego Bay, black perch, pile surfperch, and rainbow seaperch, feed in or near the bottom sediments (sand or mud). Because the three bottom-feeding surfperch species were less contaminated by PCBs than shiner perch, OEHHA chose to give separate advice for them. Although sample size for rainbow seaperch was too small to issue advice for that species alone, they were included with the other species following the same feeding style. The advice for bottom-feeding surfperch is two servings a week for all consumers based on PCBs.

Sharks

Only three legal-sized (36 inches or larger, equivalent to 914 mm) leopard sharks were collected from San Diego Bay. In general, OEHHA requires at least nine fish of a species to be minimally representative of the population in a water body. Even so, the mercury concentrations in the leopard sharks were very high (477-1925 ppb) and PCB levels (6 ppb) were low. These results are consistent with mercury and PCB concentrations in leopard sharks sampled over many years from San Francisco Bay.

Because sharks are known to accumulate high levels of mercury and the chemical levels in the three leopard sharks from San Diego Bay were characteristic for the species, OEHHA included this species in the advisory. Based on mercury, the advice is no consumption for the sensitive population and one serving a week for women over 45 years and men.

The average mercury level in gray smoothhound sharks from San Diego Bay was lower than in leopard shark. When the concentration of PCBs was also considered, although relatively low, the combination was enough to warrant no-consumption advice for the sensitive population.

For women over 45 years and men, comparison of the mean mercury concentration in gray smoothhound shark to the ATL for mercury for this population indicates advice of two servings a week. But because the mercury level was close to the ATL for 1 serving a week and to simplify the advisory, the advice given for women over 45 years and men is 1 serving a week for gray smoothhound shark.

California Halibut

Only three halibut were sampled from San Diego Bay. The average mercury concentration was lower than for halibut from San Francisco Bay and the average PCB level was higher. Sample size was not sufficient to represent the population in San Diego Bay, and OEHHA did not include this species in the advisory.

Opaleye

Five opaleye were collected and analyzed as a composite sample. With this small sample size and no related species in the dataset, OEHHA could not develop advice for this species.

Other Species

For the other species sampled from San Diego Bay (lizardfish, guitarfish, round stingray, chub mackerel, topsmelt, and yellowfin croaker), determining advice based on comparison of average concentrations of mercury and PCBs to ATLs was straightforward.

For the sensitive population, the advice was based on mercury for shovelnose guitarfish and sting ray. For lizardfish, chub mackerel, and topsmelt, advice was based on PCBs. The advice for yellowfin croaker was reduced to no consumption based on co-exposure to mercury and PCBs.

For women over 45 years and men, advice was based on mercury for sting ray, and the advice for shovelnose guitarfish is the same based on mercury or PCBs. Advice for the other species was based on PCBs.

The recommended numbers of servings per week for fish from San Diego Bay are shown in Table 5. The table includes those species that met sample size criteria, and leopard sharks and rainbow seaperch, as explained above.

TABLE 5. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK

Fish species	Women 18-45 years and children 1-17 years	Women over 45 years and men
Shiner Perch	0	0
Topsmelt	0	0
Leopard Shark	0	1
Gray Smoothhound Shark	0	1
Yellowfin Croaker	0	1
Barred Sand Bass	0	1
Spotted Sand Bass	0	1
Chub Mackerel	1	1
Round Stingray	1	2
Shovelnose guitarfish	1	2
Bottom-feeding surfperch[2]	2	2
California Lizardfish	2	2
Diamond Turbot	2	2
Spotted Turbot	2	2

[2] Bottom-feeding surfperch includes black perch, pile surfperch, and rainbow seaperch.

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APPENDIX I. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs) guide the development of advice for people eating sport fish. ATLs show maximum numbers of recommended fish servings that correspond to the chemical levels found in fish. OEHHA uses ATLs to provide advice to prevent consumers from being exposed to:

- More than the average daily reference dose[1] 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 U.S. EPA (2000) for fish advisories.

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for a range of consumption rates. 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 three servings per week. Exposure to chemicals in fish from San Diego Bay will be at or below the average daily reference dose or the cancer risk probability of one in ten thousand if the guidelines for eating fish from San Diego Bay are followed.

Advisory Tissue Levels (ATLs)
Based on Cancer or Non-Cancer Risk Using an 8-Ounce Serving Size

Chemical	**Consumption Frequency Categories[a] and ATLs[b] (in ppb)**			
	Three Servings per Week	Two Servings per Week	One Serving per Week	No consumption
Chlordanes	>140-190	>190-280	>280-560	>560
DDTs	>390-520	>520-1,000	>1,000-2,100	>2,100
Dieldrin	>11-15	>15-23	>23-46	>46
Methylmercury (Women 18 to 45 years and children 1 to 17 years of age)	>55-70	>70-150	>150-440	>440
Methylmercury (Women over age 45 years and men)	>160-220	>220-440	>440-1,310	>1,310
PCBs	>15-21	>21-42	>42-120	>120

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

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

APPENDIX II. PESTICIDE CONCENTRATIONS IN SAN DIEGO BAY FISH

DDTs: Concentrations of DDTs (the sum of *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDE, and *p,p'*-DDD) are shown in the table below. As explained in the report, they are below levels of concern.

Fish Species[a]		Number of Samples	Total Number of Fish[c]	Mean Length[d] (mm)	Minimum DDTs (ppb)	Maximum DDTs (ppb)	Mean DDTs[d] (ppb)
Barred Sand Bass	≥ 12"	7	35	346	3	19	8
	≥ 14"	2	10	371	3	5	4
Spotted Sand Bass	≥ 12"	12	60	329	0	16	6
	≥ 14"	1	5	369	5	5	5
Kelp Bass	≥ 12"	3	18	324	4	4	4
	≥ 14"	0	0	NA	NA	NA	NA
Black Perch		10	52	226	ND	15	3
Rainbow Surfperch		1	5	249	6	6	6
Shiner Perch	fillet	2	19	153	25	30	27
	whole[b]	3	73	114	10	12	11
California Halibut		1	3	599	7	7	7
California Lizardfish		3	16	241	2	3	2
Chub Mackerel		5	34	297	11	47	28
Diamond Turbot		2	10	218	0	5	2
Spotted Turbot[b]		1	5	235	2	2	2
Gray Smoothhound Shark		3	11	678	2	5	4
Leopard shark		1	1	916	0	0	0
Shovelnose guitarfish		3	12	824	2	4	3
Opaleye		1	5	185	0	0	0
Topsmelt[b]		3	66	134	11	17	13
Yellowfin Croaker		3	13	323	6	15	10

[a] The type of sample is fillet with the skin off unless otherwise specified
[b] Whole without head, tail, and guts; preparation is skin on
[c] The number of fish can be greater than the number of samples because composite samples contain more than one fish.
[d] Averages are weighted according to number of fish in each sample
NA Not applicable
≥ 12" Greater than or equal to 12 inches
≥ 14" Greater than or equal to 14 inches

Chlordanes: concentrations of chlordanes (the sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane) are shown in the table below. As explained in the report, they are below levels of concern.

Fish Species[a]		Number of Samples	Total Number of Fish[c]	Mean Length[d] (mm)	Minimum Chlordane (ppb)	Maximum Chlordane (ppb)	Mean Chlordane[d] (ppb)
Barred Sand Bass	≥ 12”	7	35	346	0	3	0
	≥ 14”	2	10	371	0	0	0
Spotted Sand Bass	≥ 12”	12	60	329	0	2	0
	≥ 14”	1	5	369	0	0	0
Kelp Bass	≥ 12”	3	18	324	0	0	0
	≥ 14”	0	0	NA	NA	NA	NA
Black Perch		4	19	247	0	1	0
Rainbow Surfperch		1	5	249	0	0	0
Shiner Perch	fillet	2	19	153	0	2	1
	whole[b]	3	73	114	2	4	3
California Halibut		1	3	599	0	0	0
California Lizardfish		3	16	241	0	0	0
Chub Mackerel		5	34	297	0	2	1
Diamond Turbot		2	10	218	0	0	0
Spotted Turbot[b]		1	5	235	0	0	0
Gray Smoothhound Shark		3	11	678	0	1	0
Leopard shark		1	1	916	0	0	0
Shovelnose guitarfish		3	12	824	0	0	0
Opaleye		1	5	185	0	0	0
Topsmelt[b]		3	66	134	0	3	1
Yellowfin Croaker		3	13	323	0	2	1

[a] The type of sample is fillet with the skin off unless otherwise specified
[b] Whole without head, tail, and guts; preparation is skin on
[c] The number of fish can be greater than the number of samples because composite samples contain more than one fish.
[d] Averages are weighted according to number of fish in each sample
NA Not applicable
≥ 12” Greater than or equal to 12 inches
≥ 14” Greater than or equal to 14 inches

Dieldrin: Concentrations of dieldrin are shown in the table below. The concentrations are below levels of concern, as explained in the report.

Fish Species[a]		Number of Samples	Total Number of Fish[c]	Average Length[d] (mm)	Minimum Dieldrin (ppb)	Maximum Dieldrin (ppb)	Average Dieldrin[d] (ppb)
Barred Sand Bass	≥ 12”	7	35	346	0	0	0
	≥ 14”	1	5	363	0	0	0
Spotted Sand Bass	≥ 12”	12	60	329	0	0	0
	≥ 14”	1	5	369	0	0	0
Kelp Bass	≥ 12”	3	18	324	0	0	0
	≥ 14”	0	0	NA	NA	NA	NA
Black Perch		4	19	247	0	0	0
Rainbow Surfperch		1	5	249	0	0	0
Shiner Perch	fillet	2	19	153	0	2	1
	whole[b]	3	73	114	0	1	0
Shiner Perch							
California Halibut		1	3	599	0	0	0
California Lizardfish		3	16	241	0	0	0
Chub Mackerel		5	34	297	0	0	0
Diamond Turbot		2	10	218	0	0	0
Spotted Turbot[b]		1	5	235	0	0	0
Gray Smoothhound Shark		3	11	678	0	0	0
Leopard shark		1	1	916	0	0	0
Shovelnose guitarfish		3	12	824	0	0	0
Opaleye		1	5	185	0	0	0
Topsmelt[b]		3	66	134	0	1	0
Yellowfin Croaker		3	13	323	0	0	0

[a] The type of sample is fillet with the skin off unless otherwise specified
[b] Whole without head, tail, and guts; preparation is skin on
[c] The number of fish can be greater than the number of samples because composite samples contain more than one fish.
[d] Averages are weighted according to number of fish in each sample
NA Not applicable
≥ 12” Greater than or equal to 12 inches
≥ 14” Greater than or equal to 14 inches