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Bioaccumulation of Contaminants in Recreational and Forage Fish in Newport Bay, California in 2000-2002

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(allen et al. 2004)

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BIOACCUMULATION OF CONTAMINANTS IN RECREATIONAL AND FORAGE FISHES IN NEWPORT BAY, CALIFORNIA IN 2000-2002

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June 30, 2004

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ABSTRACT

Newport Bay is an important southern California estuary that is both a developed marina in its lower bay and an ecological reserve in the upper bay. Recreational anglers catch fish for consumption, particularly in the lower bay, and threatened bird species consume small forage fish in the upper bay. Although the ecology of the fish community has been studied, there are few studies of contamination in Newport Bay fishes, and none which provides broad recent information on contaminant levels in much of the fish fauna of the bay nor on potential risks to both human and wildlife predators of the fishes. The objectives of this study are to 1) provide recent data on the distribution and contaminant levels in Newport Bay fishes, 2) identify species that pose a potential health concern because they have contaminant concentrations above screening values (SVs) for human or wildlife consumption of fish, 3) identify what fish contaminants may warrant regulatory focus, and 4) identify species or ecological groups of fishes for possible future monitoring or experimentation. The study focused on recreational fish species during the first year, with a focus on comparing contaminant levels in fish to SVs for human fish consumption. The second year targeted forage fish species consumed by wildlife predators, and hence focused on SVs for wildlife fish consumption. Target contaminants of concern included semivolatile organic compounds (DDTs, other pesticides, and PCBs) and trace metals (arsenic, mercury, selenium, and cadmium). The study found that many fishes of Newport Bay have tissue contaminant levels above SVs for human or wildlife fish consumption. DDT, PCBs, and selenium were the fish contaminants that might warrant regulatory focus. DDT was the most widespread contaminant of concern in fish tissue, followed by PCBs. Of 14 recreational fish species analyzed, one or more composite of jacksmelt (*Atherinopsis californiensis*), California corbina (*Menticirrhus undulatus*), yellowfin croaker (*Umbrina roncador*), spotted sand bass (*Paralabrax maculatofasciatus*), and California halibut (*Paralichthys californicus*) had DDT concentrations above the SV for human fish consumption. One composite each of California corbina, yellowfin croaker, and spotted sand bass had PCB concentrations above the PCB SV. In contrast, all composites of nine forage fish species analyzed had DDT concentrations above the SV for wildlife consumption. However, only topsmelt (*Atherinops affinis*), California killifish (*Fundulus parvipinnis*), cheekspot goby (*Ilypnus gilberti*), and California halibut had PCB concentrations of possible concern to marine mammal fish consumption and these were primarily in the inner lower bay. Trace metal concentrations were below levels of concern for human fish consumption and generally for wildlife fish consumption. Topsmelt, California killifish, and arrow goby (*Clevelandia ios*) caught in the upper bay had selenium levels above the wildlife SV. Nevertheless, trace metal levels in fish showed some ecological patterns. Fishes with high total arsenic levels (but not of fish consumption concern) are typically benthic feeders that feed on polychaetes and/or bivalves (California corbina; diamond turbot, *Hypsopsetta guttulata*; C-O sole, *Pleuronichthys coenosus*; spotted turbot, *Pleuronichthys ritteri*). Fishes with levels of selenium above SVs for wildlife fish consumption tend to feed or live near the edge of the bay. Further studies are needed to better understand the flow of these contaminants through the Newport Bay food web to better understand the potential risks posed to bird and mammal predators in the bay. In addition, monitoring studies are needed to determine if elevated DDT levels in the popular sport fishes noted

above are due to contamination in the bay or to sources outside the bay. Although some fishes in Newport Bay still have contaminant levels of concern to human fish consumption DDT, PCB, and selenium, concentrations of these contaminants were much higher in 1978-1980 and have declined substantially during the past two decades.

INTRODUCTION

Newport Bay is an important southern California estuary, with its upper and lower portions serving different uses (California Coastal Commission 1987). An ecological reserve in the upper bay protects one of the few remaining habitats for coastal wetlands wildlife and estuarine marine life in southern California. The developed lower bay is the focus of recreational boating and fishing. At least 78 species of fish occur in the Bay (L. G. Allen 1976). These are important to recreational anglers (particularly in the lower bay) and predators (mostly birds in the upper bay). Some bird predators are (or potentially are) threatened and found in rapidly disappearing bay and wetlands habitats. The bay fish community includes species assemblages not found in coastal environments, as well as life history stages of many coastal fishes (Horn and L. G. Allen 1981).

Although Newport Bay has important ecological and recreational value, potentially harmful contaminants enter and disperse in the bay from upstream sources, recreational boating, and other sources in the lower bay (USEPA 2002, Bay *et al.* 2003). Most studies in the bay have focused on contaminants in sediments and water or in freshwater fishes (mostly introduced species) in San Diego Creek, which discharges into Newport Bay (USEPA 2002). Relatively few studies have examined contaminant levels in native Newport Bay fishes (Young and Mearns 1978; MBC and SCCWRP 1980; Mearns *et al.* 1991; Coastal Fish Contamination Program (CFCP; Office of Environmental Health Hazard Assessment (OEHHA) and State Water Resources Control Board, Sacramento, CA; current program in progress).

The two fish contamination issues of greatest concern in Newport Bay are the following: 1) Are the fish safe to eat? and 2) Are the resources being protected? The first issue focuses on fish contamination relative to screening values (SVs) for human fish consumption. Specifically, do recreationally caught fish have contaminant levels that may be of potential concern to human fish consumption? The second issue focuses on fish contamination relative to SVs for wildlife fish consumption. Specifically, do forage fish have contaminant levels that may be of potential concern to wildlife fish consumption? Another important concern with regard to both of these issues, is how do contaminants flow through the Newport Bay food web? Because of this, the present study was also focused on differences in contaminant concentrations among species of different feeding or ecological types.

The goal of this study was to determine and evaluate contamination levels in Newport Bay fishes relative to human and wildlife fish consumption concerns. By examining two segments of the fish community (recreationally caught fishes and forage fishes), we hope to get a better assessment of the distribution of contaminants among fishes of different ecological types. The first year of the study focused on contamination of recreationally caught fishes, whereas the second year's study focused on contamination in forage fishes. The objectives of this study are the following: 1) provide recent data on the distribution and levels of contamination in fishes of Newport Bay; 2) identify species that pose a potential health concern because they contain chemicals/contaminants above SVs for human or wildlife fish consumption; 3) identify what fish contaminants may warrant regulatory focus; and 4) identify species or ecological groups of fishes for possible future monitoring or experimentation.

METHODS

FISH SAMPLES

Selection of Target Species

The initial step in this study was to identify target fish species for chemical analysis. We determined what species were commonly targeted by recreational anglers fishing in Newport Bay by interviewing employees at seven tackle shops, scientists from MBC Applied Environmental Sciences (an environmental consulting firm that conducts surveys in the bay), and a scientist-angler (David Tsukada) from the Southern California Water Research Project with knowledge of the area (Appendix 1). The persons interviewed described areas in the bay that are fished, dominant species targeted and/or caught, and types of gear used to catch the fish. They mentioned 17 species and 4 groups of species that were targeted or caught by anglers (Table 1). Of these, sea basses (Serranidae), California halibut (*Paralichthys californicus*), spotted sand bass (*Paralabrax maculatofasciatus*), barred sand bass (*Paralabrax nebulifer*), and croakers (Sciaenidae) were the most commonly mentioned target fishes.

Based on the results of this survey, we focused on California halibut, spotted sand bass, barred sand bass, kelp bass (*Paralabrax clathratus*), yellowfin croaker (*Umbrina roncador*), and jacksmelt (*Atherinopsis californiensis*) as target species. In addition, we added species with a history of tissue contaminant information from the Bay: shiner perch (*Cymatogaster aggregata*); diamond turbot (*Hypsopsetta guttulata*); and spotted turbot (*Pleuronichthys ritteri*). These, as well as yellowfin croaker, were analyzed in the CFCP (Coastal Fish Contamination Program Database, Office of Environmental Health Hazard Assessment (OEHHA) and State Water Resources Control Board, Sacramento, CA). Other potentially consumed fish species were added to the study as a result of incidental catches while fishing for the target species.

Targeted forage fishes included small species and juveniles of larger species found in shallow water (e.g., California killifish, *Fundulus parvipinnis*; arrow goby, *Clevelandia ios*; small (<10 cm) juvenile California halibut; Pacific staghorn sculpin, *Leptocottus armatus*) or at the surface (e.g., topsmelt, *Atherinops affinis*). These were species available to many bird species, including waders (e.g., snowy egrets, *Egretta thula*; great egret, *Casmerodius albus*; great blue heron, *Ardea herodius*), surface skimmers (e.g., black skimmer, *Rhynchops niger*), and diving birds (e.g., least tern, *Sterna antillarum*; brown pelican, *Pelecanus occidentalis*).

Table 1. Fish species most frequently mentioned as being target species for Newport Bay, California anglers in tackle shop and angler survey, June-November 2000[1].

Common Name	Scientific Name	Number of Sources
sea basses	Serranidae	9
California halibut	*Paralichthys californicus*	7
spotted sand bass	*Paralabrax maculatofasciatus*	6
barred sand bass	*Paralabrax nebulifer*	5
croakers	Sciaenidae	4
bat ray	*Myliobatis californica*	3
kelp bass	*Paralabrax clathratus*	3
rays	Rajiformes	3
jacksmelt	*Atherinopsis californiensis*	2
surfperches	Embiotocidae	2
yellowfin croaker	*Umbrina roncador*	2
barred surfperch	*Amphistichus argenteus*	1
sargo	*Anisotremus davidsonii*	1
white sea bass	*Atractoscion nobilis*	1
striped bass	*Morone saxatilis*	1
striped mullet	*Mugil cephalus*	1
diamond turbot	*Hypsopsetta guttulata*	1
shovelnose guitarfish	*Rhinobatos productus*	1
spotfin croaker	*Roncador stearnsii*	1
chub mackerel	*Scomber japonicus*	1
leopard shark	*Triakis semifasciatus*	1

[1] See Appendix 1 for results of tackle shop and angler survey.

Sample Collection

Recreational fish samples were collected in winter 2000-2001 (November-January), and summer (June-July) 2001. Forage fish samples were collected in winter 2002 (March-April), and summer (August-September) 2002. Samples were collected at various sites within the upper and lower bay (Figure 1). However, recreational fishes were not collected on the ecological reserve in the inner upper bay. Although recreational fishing is allowed there, the presurvey angler survey suggested that few people fish there. The type of species targeted determined which collecting methods were used. Recreational fishes were collected by boat using hook-and-line, long-line, 5.3-m otter trawl (1.2 cm cod-end mesh), and gillnet. Hook-and-line, long-line, and otter trawl collections were made during the day in both seasons. However, gillnet collections were made during the day in winter but during day and night in summer. Forage fishes were collected by common seine, beach seine, and lift net during the day.

Recreational species where put in plastic bags, transported to laboratory on ice, sorted, and then frozen (-20°C) until processing. Forage fish were bagged live, transported to the laboratory on ice, washed on stainless steel screen with deionized water, sorted by species into clean glass jars with forceps, and then frozen until processing.

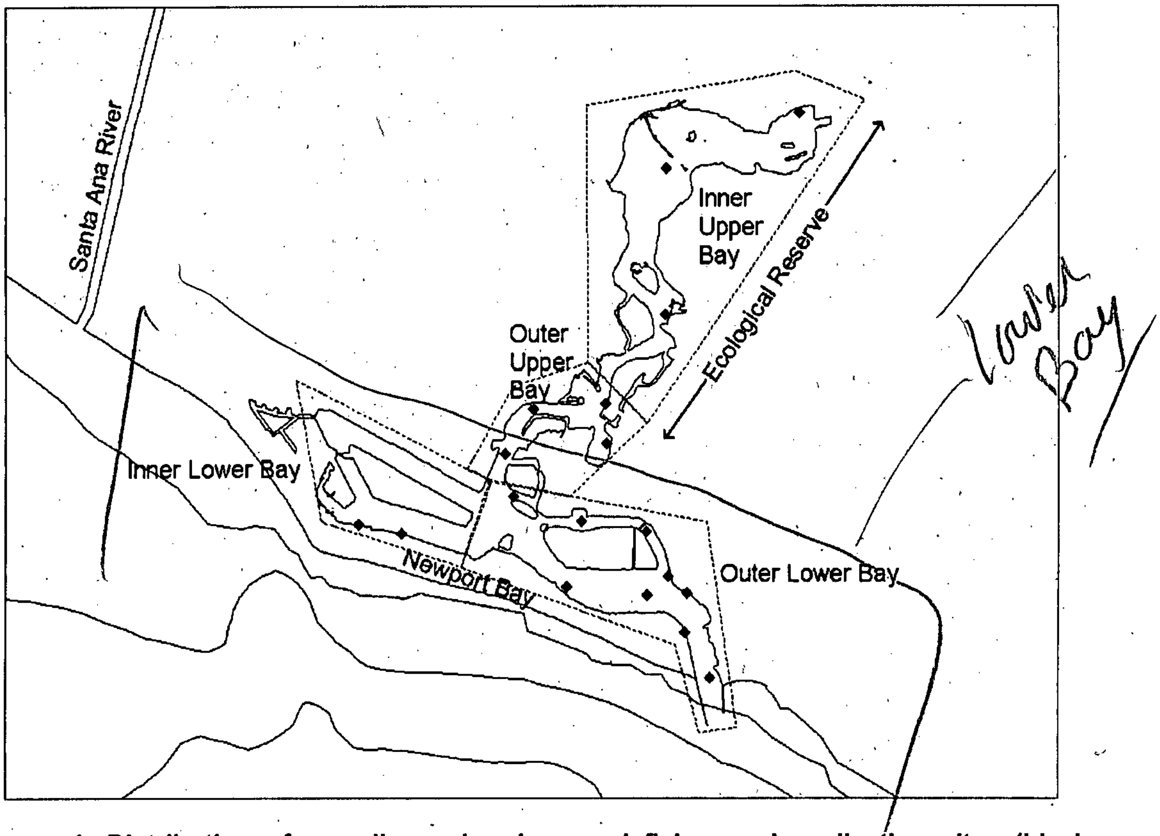

Figure 1. Distribution of sampling subregions and fish sample collection sites (black diamonds) in Newport Bay, California. Fish samples were collected from November 2000 to August 2002.

Sample Processing

Recreational Fish

Composite size for recreational fish was determined by protocol suggested by Dr. Robert Brodberg (OEHHA). To maximize the number of samples across species, the number of fish per composite was constant within species but varied, as needed, between species. Within a given composite, the lengths of the smallest fish were at least 75% of the length of the largest fish. No attempt was made at this stage to determine the gender of the fish; hence, some composites had mixed genders. The same composite size for a given species was used in both winter and summer sampling periods.

For recreational fish, chemical analysis was conducted on muscle tissue, as this is typically the tissue consumed by humans. Prior to dissection, individual fish were measured to nearest millimeter standard length and weighed to the nearest 0.01 g. The gender was noted after tissue dissection. Fish dissections were performed on a Teflon-lined table covered by a positive pressure hood having laminar air flow and a Class 100

HEPA filter. Stainless steel dissection equipment was thoroughly cleaned with soap (nonionic) and water, rinsed with deionized water, and sonicated in methanol. Sterilized stainless steel blades were used during dissections. Fish were rinsed in deionized water to remove visible particles and slime, and then shaken to remove excess water. Fish were dissected on clean Teflon cutting boards. The cleaning procedure for cutting boards consisted of scrubbing with soap and water, rinsing with deionized water, rinsing with 5% nitric acid solution, and finishing with a methanol rinse. All chemistry samples were put in manufacture certified glass jars cleaned to United States Environmental Protection Agency (USEPA) standards.

The dissection procedure first freed the skin from one side of the fillet of a fish by an incision on the outside edges, being careful not to puncture the gut cavity (USEPA 1995). The incision was made with a skin-incision scalpel. The skin was pulled away from the muscle tissue with a designated skin-removal forceps. A muscle-only scalpel cut 4-7 mm inside of the outer edge incision and loosened the inside portion of the muscle fillet. A muscle-only forceps was used to divide equal weight portions of muscle tissue into the respective prelabeled jars. Tissue debris was removed from equipment by rinsing with deionized water in between fish of a composite. All equipment was washed, then rinsed with deionized water, 5% nitric acid solution (except stainless steel), methanol, and deionized water again between all composites of fish. All tissue filled chemistry jars were immediately stored in a freezer.

Forage Fish

Where possible, forage fish composites were made in the same way as recreational fish composites (i.e., number of fish per composite was constant within species but varied, as needed, between species; the smallest fish in a composite was at least 75% of the largest fish). However, some species were extremely small (gobies were about 2 cm in length) and thus it became necessary to focus on a target mass (at least 50 g) of fish tissue per composite that would allow chemical analysis. As a result, different numbers of fish were needed to obtain this tissue mass and hence the number of fish per composite often varied within and between species.

Prior to processing, individual fish were measured to the nearest millimeter standard length and weighed to the nearest 0.01 g. However, when numbers were large, a subsample of 20-60 fish were measured and weighed individually. Forage fish were processed whole. No dissections occurred during this procedure and hence no information on gender was obtained. Composite samples were homogenized whole in a glass or stainless steel blender with 0.5 or 1.0 L stainless steel or glass containers with Teflon® gaskets with Teflon® (or aluminum foil-lined) lids. The fish and an equal weight of deionized water (to facilitate blending) were combined and blended to obtain a smooth homogenate. Aliquots of homogenate were put in clean glass jars and immediately frozen. The blenders were washed with soap and water, followed by repeated homogenization and dumping of an aliquot of deionized water until it was particle free, and finally by homogenization in three aliquots of methanol.

CHEMICAL ANALYSIS

Contaminants Selected for Analysis

A total of 59 semivolatile organic compounds and four trace metals were selected for analysis (Table 2). The analytes included semivolatile organic compounds (pesticides, including aldrin, chlordanes, chlropyrifos, diazinon, dieldrin, endrin, and DDTs; and 42 PCB congeners) and trace metals (total arsenic, total mercury, and total selenium for recreational and forage fishes, and total cadmium for forage species only). Total arsenic was analyzed rather than inorganic arsenic and total mercury rather than methyl mercury as these were being analyzed in the CFCP (R. Brodberg, OEHHA, personal communication). Total DDT (= DDTs) is the sum of metabolites o,p'-DDD; p,p'-DDD; o,p'-DDE; p,p'-DDE; o,p'-DDT; and p,p'-DDT. Total PCB (= PCBs) are the sum of the PCB congeners analyzed (Table 2). Total chlordanes (= chlordanes) is the sum of

Table 2. Contaminants analyzed in recreational and forage fish species collected in Newport Bay, California during 2000-2002.

Semivolatile Organic Compounds				
Pesticides	PCBs			Trace Metals
Aldrin	Total PCB			Total Arsenic
Total Chlordanes[1]	PCB 18	PCB 105	PCB 158	Inorganic Arsenic[5]
Chlordene	PCB 28	PCB 110	PCB 167	Total Mercury
cis-Chlordane[2]	PCB 37	PCB 114	PCB 168	Total Selenium
trans-Chlordane[3]	PCB 44	PCB 118	PCB 169	Total Cadmium[6]
oxy-Chlordane	PCB 49	PCB 119	PCB 170	
cis-Nonachlor	PCB 52	PCB 123	PCB 177	
trans-Nonachlor	PCB 66	PCB 126	PCB 180	
Chlorpyrifos	PCB 70	PCB 128	PCB 183	
Diazinon	PCB 74	PCB 138	PCB 187	
Dieldrin	PCB 77	PCB 149	PCB 189	
Endrin	PCB 81	PCB 151	PCB 194	
Total DDT[4]	PCB 87	PCB 153	PCB 200	
o,p'-DDD	PCB 99	PCB 156	PCB 201	
p,p'-DDD	PCB 101	PCB 157	PCB 206	
o,p'-DDE				
p,p'-DDE				
o,p'-DDT				
p,p'-DDT				

[1] Total Chlordanes = sum of Chlordene, cis-Chlordane, trans-Chlordane, oxy-Chlordane, cis-Nonachlor, and trans-Nonachlor

[2] cis-Chlordane = alpha-Chlordane

[3] trans-Chlordane = gamma-Chlordane

[4] Total DDT = sum of o;p'-DDD; p,p'-DDD; o,p'-DDE; p,p'-DDE; o,p'-DDT; and p,p'-DDT

[5] Analyzed in selected recreational fishes only.

[6] Analyzed in forage fishes only.

Chlordene, cis-Chlordane, trans-Chlordane, oxy-Chlordane, cis-Nonachlor, and trans-Nonachlor.

The DDT metabolites and PCB congeners analyzed were those used in the Southern California Bight 1998 Regional Survey (Allen *et al.* 2002). The remaining pesticides and the trace metals were analyzed at the request of the Regional Water Quality Control Board, Santa Ana Region, as these were regarded as contaminants of potential concern for Newport Bay toxics total maximum daily load (TMDL) determination (USEPA 2002). At the request of Peter Kozelka (USEPA Region IX), aliquots of tissue samples of recreational fishes analyzed for total arsenic were analyzed for inorganic arsenic.

Trace Metals

Trace metals were analyzed by Columbia Analytical Services (CAS), Kelso, WA. Total arsenic (As) and cadmium (Cd) were analyzed following USEPA Method 200.8, using inductive coupled plasma mass spectroscopy (ICP-MS). Total selenium (Se) was analyzed following USEPA Method 7742, using gaseous hydride atomic absorption spectroscopy. Total mercury was analyzed following USEPA Method 7471A, using cold vapor atomic absorption spectroscopy. For total arsenic, cadmium, and selenium analyses, samples were homogenized, freeze-dried, and subjected to total dissolution in a closed vessel bomb. A standard (nitric-sulfuric-persulfate-permanganate) digestion was used for mercury (Hg), with a slightly larger sample. For quality control, duplicates were analyzed for five samples per batch, a matrix spike recovery analysis was conducted on five samples per batch, and National Research Council of Canada (NRCC) standard reference material (SRM) NRCC DORM-2 were analyzed. The target detection limits were as follows: total Hg, 0.002 mg/kg wet weight (ww); total As, 0.010 mg/kg ww; and total Se, 0.005 mg/kg ww.

Inorganic arsenic was analyzed by Brooks Rand LLC, Seattle, WA. All samples were prepared and analyzed by modified USEPA Draft Method 1632. Samples were prepared by HCL extraction. They were adjusted to a pH of 1.5 and then analyzed by hydride generation with $NaBH_4$ reduction and cryogenic trap precollection. The trapped arsines were thermally desorbed, in order of increasing boiling points, into an inert gas stream that carried them to a quartz furnace of an atomic absorption spectrophotometer for detection. The detection limit was 0.015 µg/kg dw and 0.005 µg/kg ww. For quality control, duplicates were analyzed, a matrix spike recovery analysis, laboratory control samples using SRMs (NRCC DORM-2 for total arsenic and NRCC LCS ID [corn oil] for inorganic arsenic), and method blanks were analyzed.

Semivolatile Organic Compounds

Semivolatile organic compounds (SOCs) were analyzed at the Southern California Coastal Water Research Project (SCCWRP) and CAS, Jacksonville, FL. Due to a change of chemistry staff, SCCWRP used two different extraction procedures during the study. Method one was used for DDT and PCB analysis on recreational fish tissues collected in winter 2000/2001 and summer 2001. Method two was used on PCB analysis of forage fish tissues collected in winter and summer 2002. Quality control checks on both methods showed they were comparable. SCCWRP used the same instrumentation procedure regardless of extraction procedure. CAS used a different extraction and analytical method for total DDT analysis of forage fish tissue collected in winter and summer 2002. The comparability between SCCWRP and CAS DDT results is discussed in detail below in last paragraph of this section.

SCCWRP's first extraction method involved the following procedure. Frozen muscle fillet tissue was thawed, homogenized, and 2 g of tissue was removed and weighed. Each sample was ground with potassium oxalate and Celite 545 to smooth powder and transferred to a syringe with modified and preconditioned C18 SPE column attached to it. The C18 column was modified by adding some Celite 545 before and after C18 silica layer. Organochlorine pesticides were eluted with 20% water in acetone while lipids were trapped in Celite and C18 column. The eluate was partitioned in separatory funnel first with acetone/methylene chloride (0.5:1 v/v). The organic layer was collected in a flask and then the aqueous layer was partitioned a second time with acetone/methylene chloride (1:1 v/v). The bottom layer was combined with the first extract. The final extract was turbo-evaporated at 35°C and solvent exchanged to 1 mL in hexane. Following the second extraction, lipid determination was done on a separate 2 g tissue sample.

SCCWRP's second extraction method involved the following procedure. Frozen tissue was thawed, homogenized, and 25 g removed for extraction. Surrogate standards were added at this time. A mixture of acetonitrile, water, and hexane (2:1:2 volume to weight) was added to the tissue and homogenized with a Brinkman Polytron. The solvent layer was removed to a kilned flask after centrification. The process was repeated twice with hexane (1:1 v/g) added during the homogenization step. The lipid containing solvent was turbo-evaporated at 37°C, transferred to a clean 1-dram vial, and concentrated to 1 ml under nitrogen. Three microliters of extract was used to gravimetrically determine lipid concentrations through evaporation. PCB cleanup was done by adding concentrated sulfuric acid to the extract (1:1 v/v), mixing, centrifuging, and removing the acid layer until the hexane layer was clear. The final step before chromatographic separation was to transfer hexane to an autosampler vial and add internal standards. To determine lipid content, about 3 to 5 μL of extract was transferred using a 10-μL microsyringe to an aluminum boat placed on a microbalance. Solvent was allowed to evaporate until a constant weight was reached. The weight difference was defined as the lipid content.

SCCWRP gas chromatographic (GC) analyses were performed in Varian 3800 GC equipped with a DB-5 capillary column (60 m x 0.32 mm; 0.25 μm film thickness), a Varian Saturn 2000 Ion Trap, and Varian 1079 SPI injector. Helium was used as a carrier gas at constant flow of 1.3 ml/min. Samples were fortified with PCB30 and PCB205 as internal standards and Tetrachloro-m-xylene, PCB65 and PCB209 as surrogate standards. They were injected in split/splitless mode (programmed as following: 1:4 for 0.01 min; off for 2 min; 1:20 afterward) at an injector with the next temperature profile: 60°C for 0.3 min; 60-310°C at 200°C/min. Oven temperature profile was: 60°C for 1 min; 60-180°C at 15°C/min; 180-280°C at 2°C/min; 280-310°C at 5°C/min; 310°C for 3 min. Chromatograms were processed with Varian Saturn 2000 Workstation Software. Blank, duplicate and spike recovery samples were prepared and analyzed with each batch of eight samples.

CAS analyzed forage fish samples for DDT and other organochlorine pesticides using gas chromatography with electron capture detection (GC-ECD). The samples were analyzed using USEPA Method 8081A. Several analytes (Diazinon; o,p'-DDT, o,p'-DDD; o,p'-DDE; Chlordene; Oxychlordane; cis-Nonachlor; and trans-Nonachlor) were outside the scope of the laboratory's NELAC accreditation. These analytes were validated prior to the analysis of samples. Blank, duplicate, spike recovery, and standard reference samples were prepared and analyzed. Splits of homogenized muscle tissue composite from five recreational fish species (jacksmelt; spotted sand bass; California corbina, *Menticirrhus undulatus*; yellowfin croaker; California halibut) analyzed by SCCWRP were analyzed by CAS for DDTs and other pesticides to provide information on comparability of analytical results between laboratories. Lipid content was analyzed using USEPA Methods 3540C/160.3M.

As DDT and pesticide analyses for recreational and forage fish composites were conducted by different laboratories (SCCWRP for recreational fishes, CAS for forage fishes), splits of homogenized muscle tissue of recreational fish species analyzed by SCCWRP in 2001 were analyzed by CAS in 2003. Five jars of recreational fish tissue, one for each of five species collected in winter 2000/2001 and summer 2001 (California corbina, spotted sand bass, yellowfin croaker, and jacksmelt from summer; California halibut from winter), were sent to CAS as splits as a quality control check to compare DDT and other pesticides analyses conducted by SCCWRP and CAS. Comparison of DDT and pesticides from splits of composites of these five recreational fishes showed relative percent differences of 13 to 73% (mean 46%) for DDTs and 0 to 56% (mean 19%) for chlordanes (Appendix 2). For comparison, in an interlaboratory calibration analysis among seven laboratories in a regional survey of sediment contamination in southern California in 1998, the greatest acceptable between-laboratory percent difference in DDT results was 80% (Noblet *et al.* 2003). CAS values for DDT were always lower and percent lipid was higher than SCCWRP values (when detected) whereas chlordane values were higher. As noted by CAS, the composite splits analyzed exceeded the maximum holding time of one year for organochlorine analyses, which may account for some of this variability.

Data Reporting

For recreational fish analyses, the concentration obtained by the analysis was the concentration reported. However, because forage fish homogenates required addition of an equal weight of water, the measured concentrations reflected a 50% dilution. Thus reported concentrations for forage fish samples were doubled that of the original value to correct for this dilution. Metals were reported as mg/kg (ppm = parts per million) and semivolatile organic compounds as µg/kg (ppb = parts per billion; 1 ppm = 1,000 ppb).

DATA ANALYSIS

Contaminant concentrations in fish tissue were summarized by data tables and calculation of means and standard deviations. Data were compared to SVs for human and wildlife fish consumption to determine what fish species had contaminant levels of concern.

The OEHHA SVs for human fish consumption used in this study (Table 3) to evaluate contaminant levels in recreational fish (Brodberg and Pollock 1999). SVs are recommended to identify concentrations of contaminants in fish tissue that may be of concern to persons that frequently consume recreational fishes. SVs are not intended for use in issuing fish consumption advisories but rather to identify species and chemicals from a limited data set for more extensive study (USEPA 1995). The OEHHA SVs were generally equal to or lower than were those of USEPA (2000), except for chlorpyrifos (which was higher). OEHHA semivolatile organic compound SVs for human fish consumption ranged from 2 μg/kg ww (2 ppb) for dieldrin to 10,000 μg/kg ww for chlorpyrifos. SVs for total PCB, chlordane, and total DDT were 20, 30, and 100 μg/kg ww, respectively. Although the OEHHA SV for total PCB was based on the sum of Aroclors 1248, 1254, and 1260 (Brodberg and Pollock 1999), it can also be used for the sum of PCB congeners, if these include a good representation of the higher chlorinated congeners found in the summed Aroclors. Of the PCB congeners analyzed in this study, 40 (26%) were found among the PCB congeners in summed Aroclors 1248, 1254, and 1260 (Frame *et al.* 1996). However, whereas 38% of summed Aroclor PCB congeners were highly chlorinated (six or more chlorine substitutions), 50% of the PCB congeners analyzed here were highly chlorinated. OEHHA trace metal SVs ranged from 0.3 mg/kg (0.3 ppm) for mercury to 2 mg/kg for selenium. Although OEHHA SVs given in Brodberg and Pollock (1999) included 1.0 mg/kg ww for total arsenic and 20 mg/kg ww selenium, these were not used in this study. The appropriate arsenic SV (1.2 mg/kg ww; USEPA 2002) should be for inorganic arsenic rather than for total arsenic (USEPA 2002; P. Kozelka, USEPA, Region IX, and R. Brodberg, OEHHA, personal communication). The appropriate SV for selenium should be 2 mg/kg ww; (Fan *et al.* 1988; R. Brodberg, OEHHA, personal communication).

The semivolatile organic compound SVs for wildlife fish consumption are less well-developed than SVs for human fish consumption. SVs used in this study (Table 3) were those for marine wildlife from the National Academy of Science (NAS 1974) and Environment Canada (1997, 1998). The SV for chlordane was 50 μg/kg ww (NAS 1974). Although the Environment of Canada (1997, 1998) values are designated as 'guidelines' for Canada, they will be regarded here as 'SVs', as the 'guidelines' are not currently binding in the United States. They are used here to provide context for contaminant levels in forage fish. The SV for total DDT was 14.0 μg/kg ww (Environment Canada 1997) and that for PCB was 0.79 ng TEQ/kg ww (Environment Canada 1998) (note: ng/kg = parts per trillion or pptr) (see Table 3). These SVs were also recently used in a regional survey of fish contamination in flatfishes in the Southern California Bight (M. J. Allen *et al.* 2002).

Table 3. Screening values for human and wildlife fish consumption for semivolatile organic compounds and trace metals analyzed in fishes collected in Newport Bay, California in 2000-2002.

	Screening Values for Fish Consumption					
	USEPA[1] Human		OEHHA[2] Human		Wildlife	
Chemical	Value	Units	Value	Units	Value	Units
Metals concentrations in parts per million (ppm or mg/kg)						
Inorganic Arsenic[7]	1.2	ppm ww	1.2	ppm ww	-----	-----
Total Arsenic	-----[8]	-----	-----[8]	-----	-----	-----
Cadmium	4	ppm ww	3	ppm ww	-----	-----
Total Mercury	0.4	ppm ww	0.3	ppm ww	0.03	ppm ww[9]
Selenium	20	ppm ww	2[10]	ppm ww	3.00	ppm dw[11]
					0.60	ppm ww[12]
Semivolatile organic compound concentrations in parts per billion (ppb or µg/kg)						
Aldrin	-----	-----	-----	-----	-----[3]	ppb ww[4]
Chlordanes	114	ppb ww	30	ppb ww	50	ppb ww[4]
Chlorpyrifos	1200	ppb ww	10,000	ppb ww	-----	-----
Diazinon	2800	ppb ww	300	ppb ww	-----	-----
Dieldrin	3	ppb ww	2	ppb ww	-----[3]	ppb ww[4]
Endrin	1200	ppb ww	1,000	ppb ww	-----[3]	ppb ww[4]
Total DDTs	117	ppb ww	100	ppb ww	14	ppb ww[5]
Total PCBs	20	ppb ww	20	ppb ww	-----	-----
Dioxin equivalent concentrations in parts per trillion (pptr or ng/kg)						
PCB Congener TEQ[6]	----	-----	----	-----	0.79	pptr ww[6]

[1]USEPA (2000)
[2]Brodberg and Pollock (1991)
[3]Sum of these three pesticides should not exceed 5 ppb (NAS 1974)
[4]NAS (1974)
[5]Environment Canada (1997)
[6]TEQ = Toxicity Equivalent Quotient (or the equivalent toxicity of the PCB congeners relative to 2,3,7,8-TCDD (tetrachloro-dibenzo-p-dioxin) (Environment Canada 1998).
[7]USEPA (2002)
[8]Total Arsenic screening values for human fish consumption of 3 ppm ww for USEPA and 1 ppm ww for OEHHA given in Brodberg and Pollock (1991) are not included here, as inorganic arsenic is more appropriate (USEPA 2000, 2002)
[9]Johnson and Looker (2004)
[10]Fan *et al*. (1988)
[11]NIWQP (1998), minimum effect threshold
[12]Conversion of NIWQP (1998) screening value of 3.0 ppm dry weight to wet weight screening value. Assumes dry weight solids are 20% of wet weight, giving dilution factor of 5

The PCB SV was based on the toxicity equivalent quotient (TEQ) of the products of the summed PCB congeners and their toxicity equivalency factors (TEFs). These TEFs were used to estimate the relative toxicity of PCBs based on their similar properties and activities to dioxin. Specifically, the TEFs are assigned to the congeners based on their ability to produce a response in the cytochrome system relative to the most potent inducer, 2,3,7,8-TCDD [a dioxin; TCDD = tetrachlorodibenzo-p-dioxin] (Environment Canada 1998). Thus, the TEQ is the total TCDD toxic equivalents concentration and is calculated as follows:

$$TEQ = \Sigma\ (PCBi \times TEFi)$$

where

PCBi	=	Individual PCB congener.
TEFi	=	Toxicity of PCB congener relative to TCCD dioxin.

The TEFs used in this study were those recommended by the World Health Organization (Van den Berg *et al.* 1998). The TEFs were available for 12 PCB congeners found in this study, with TEFs differing for mammals and birds (Table 4).

Table 4. Toxic PCB congeners with congener-specific toxicity equivalent factors (TEFs) for mammals and birds (modified from M. J. Allen *et al.* 2002).

	WHO Congener-specific TEFs[1]	
PCB Congener	Mammals	Birds
PCB 77	0.00010	0.05000
PCB 81	0.00010	0.10000
PCB 105	0.00010	0.00010
PCB 114	0.00050	0.00010
PCB 118	0.00010	0.00001
PCB 123	0.00010	0.00001
PCB 126	0.10000	0.10000
PCB 156	0.00050	0.00010
PCB 157	0.00050	0.00010
PCB 167	0.00001	0.00001
PCB 169	0.01000	0.00100
PCB 189	0.00010	0.00001

WHO = World Health Organization.
[1] Van den Berg, *et al*. (1998).

Wildlife SVs for trace metals have been identified for mercury and selenium (Table 3). The SV for mercury is 0.03 ppm ww (Johnson and Looker 2004) and that for selenium is 3 ppm dry weight (dw) (NIWQP 1998). As SVs used for human and wildlife fish consumption in this study (NAS 1974; Fan *et al.* 1988; USEPA 1995, Environment Canada 1997, 1998; Brodberg and Pollock 1999; USEPA 2000, 2002) have been expressed in wet weight, we converted the selenium dry weight SV to a wet weight SV, using a dilution factor of 5. Thus the wet weight SV for selenium used here is the following: Se SV ww = Se dw/dilution factor or Se SV ww = 3 ppm dw/5 = 0.6 ppm ww. This assumes a mean percent fish tissue solids of 20%, with the dilution factor = 100% ppm ww/20% ppm dw = 5. Dilution factors of 4 or 5 have been discussed for converting fish tissue from dry weight to weight but 5 was chosen here as it was more conservative and corresponded to average percent solids (20%) in whole fish samples analyzed in this study.

Relationships of contaminant concentrations with percent lipid of fish tissue and mean fish length in composites were determined using Pearson product-moment correlation analysis.

RESULTS

FISH SPECIES COLLECTED

Fish sampling conducted in Newport Bay for this study during 2000-2002 collected 58 species of fish representing 29 families and two classes: Elasmobranchii (sharks and rays) and Actinopterygii (ray-finned fishes) (Appendix 3). Six species and four families were elasmobranchs and the remaining 52 species and 25 families were ray-finned fishes. The most diverse families of fish in the bay were Sciaenidae (croakers) with six species, Gobiidae (gobies) with five species, and Syngnathidae (pipefishes) and Embiotocidae (surfperches) with four species each. All but four of the angler target species from the tackle shop survey (Table 1) were taken during this period. Angler target species that were not taken included barred surfperch (*Amphistichus argenteus*), striped bass (*Morone saxatilis*), shovelnose guitarfish (*Rhinobatos productus*), and chub mackerel (*Scomber japonicus*).

Of the 58 species taken, 19 were analyzed for contaminants (Table 5). Of these, 14 species were used in recreational fish analyses using muscle tissue and 9 were used in forage fish analyses (using whole body tissue). Four species (shiner perch, black perch (*Embiotoca jacksoni*), California halibut, and diamond turbot) used in both analyses, with smaller individuals being used in forage fish analyses. For recreational fish, 25 samples were analyzed in winter and 25 in summer, with number of composites analyzed ranging from 1 to 5 per species and number of fish per composite ranging from 3 to 8 (but generally constant per species, except where this did not yield enough fish for analysis). For forage fish, 5 samples were analyzed in winter and 19 in summer, with the number of fish per composite kept constant for a species where possible. If fish were too small, the number of fish per composite was that which would yield about 50 g of tissue (Table 5). The number of forage fish composites analyzed per species ranged from 1 to 5, with number of fish per composite ranging from 4 to 620. Note that the contaminant concentration of a homogenized fish composite is the estimated mean contaminant concentration (in µg/kg or mg/kg) of tissue (muscle tissue or whole body) for all fish in the composite.

Table 5. Number of composites and number of fish per composite for recreational and forage fish species collected in Newport Bay in 2000-2002 and analyzed for tissue contamination.

Fish Species		Recreational Fishes		Forage Fishes	
Common Name	Scientifiic Name	Winter 2000/2001	Summer 2001	Winter 2002	Summer 2002
topsmelt	*Atherinops affinis*	-	-	-	5(172-245)*
jacksmelt	*Atherinopsis californiensis*	-	3(6)	-	-
California killifish	*Fundulus parvipinnis*	-	-	1(31)*	2(20)*
Pacific staghorn sculpin	*Leptocottus armatus*	-	-	1(36)	3(36)
kelp bass	*Paralabrax clathratus*	-	1(5)	-	-
spotted sand bass	*Paralabrax maculatofasciatus*	2(3)	3(3)	-	-
barred sand bass	*Paralabrax nebulifer*	1(3)	1(3)	-	-
California corbina	*Menticirrhus undulatus*	-	3(3)	-	-
spotfin croaker	*Roncador stearnsii*	-	2(6)	-	-
yellowfin croaker	*Umbrina roncador*	-	5(4)	-	-
shiner perch	*Cymatogaster aggregata*	1(8)	-	-	1(22)*
black perch	*Embiotoca jacksoni*	4(3-4)*	3(3)	-	1(8)*
arrow goby	*Clevelandia ios*	-	-	2(460-620)*	3(210-500)*
cheekspot goby	*Ilypnus gilberti*	-	-	-	1(266)*
California halibut	*Paralichthys californicus*	5(4)	1(4)	1(4)	2(4)
fantail sole	*Xystreurys liolepis*	1(5)	-	-	-
diamond turbot	*Hypsopsetta guttulata*	5(6)	3(6)	-	1(6)
C-O sole	*Pleuronichthys coenosus*	2(4)	-	-	-
spotted turbot	*Pleuronichthys ritteri*	4(4)	-	-	-

Number of fish per composite in parentheses; thus, 5(4) = 5 composites with 4 fish per composite.
* Because of small size of fish, target sample was 50 g of tissue homogenate; thus, number of fish per composite varies greatly.

The species analyzed had sufficient numbers of individuals for composites, were good representatives of recreational or forage fishes, and represented a variety of ecological lifestyles. California halibut was the only species collected and analyzed in winter and summer of both years. Many recreational species (particularly croakers) were collected only in the summer. Species that were collected in winter and summer samples included California killifish, Pacific staghorn sculpin, spotted sand bass, barred sand bass, black perch, arrow goby, California halibut, and diamond turbot.

RECREATIONAL FISH CONTAMINATION

Trace Metals

Recreational fish muscle tissue was analyzed for three trace metals: total arsenic, total mercury, and total selenium. Total arsenic ranged from 0.22 to 8.57 mg/kg across all composites and species (Table 6; Appendices 4, 5). Highest values of 8.57, 5.74, 4.20, and 1.57 mg/kg, were found in spotted turbot, C-O sole, diamond turbot, and California corbina, respectively (Table 6; Figures 2, 3). Composite means were also highest in these species, with 6.33, 5.38, 2.97, and 1.32 mg/kg (Table 6).

[redacted]

Table 6. Trace metal concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in 2000-2001 (winter and summer samples combined).

Fish Species	No. Comp.	Total Arsenic (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
barred sand bass	2	0.44	0.65	0.54	0.148	27	214 - 260
black perch	7	0.40	0.96	0.65	0.202	31	103 - 193
California corbina	3	1.15	1.57	1.32	0.221	17	274 - 393
California halibut	6	0.41	0.91	0.62	0.207	33	138 - 422
C-O sole	2	5.01	5.74	5.38	0.516	10	154 - 212
diamond turbot	8	1.82	4.20	2.97	0.833	28	153 - 250
fantail sole	1	--	--	0.97	--	--	177 - 218
jacksmelt	3	0.51	0.58	0.54	0.036	7	275 - 310
kelp bass	1	--	--	0.49	--	--	93 - 118
shiner perch	1	--	--	0.67	--	--	73 - 83
spotfin croaker	2	0.68	0.93	0.81	0.177	22	232 - 328
spotted sand bass	5	0.22	0.63	0.36	0.181	50	233 - 300
spotted turbot	4	3.92	8.57	6.33	2.030	32	159 - 196
yellowfin croaker	5	0.27	0.49	0.39	0.092	24	212 - 306

Fish Species	No. Comp.	Total Mercury (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
barred sand bass	2	0.057	0.100	0.079	0.0304	39	214 - 260
black perch	7	0.024	0.042	0.033	0.0061	18	103 - 193
California corbina	3	0.056	0.077	0.065	0.0108	17	274 - 393
California halibut	6	0.022	0.075	0.036	0.0194	54	138 - 422
C-O sole	2	0.026	0.059	0.043	0.0233	55	154 - 212
diamond turbot	8	0.009	0.051	0.026	0.0143	55	153 - 250
fantail sole	1	--	--	0.046	--	--	177 - 218
jacksmelt	3	0.103	0.136	0.119	0.0165	14	275 - 310
kelp bass	1	--	--	0.019	--	--	93 - 118
shiner perch	1	--	--	0.023	--	--	73 - 83
spotfin croaker	2	0.027	0.030	0.029	0.0021	7	232 - 328
spotted sand bass	5	0.077	0.165	0.112	0.0350	31	233 - 300
spotted turbot	4	0.021	0.053	0.038	0.0153	40	159 - 196
yellowfin croaker	5	0.069	0.238	0.120	0.0688	57	212 - 306

Fish Species	No. Comp.	Total Selenium (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
barred sand bass	2	0.17	0.18	0.18	0.007	4	214 - 260
black perch	7	0.08	0.17	0.11	0.030	26	103 - 193
California corbina	3	0.11	0.14	0.12	0.017	14	274 - 393
California halibut	6	0.02	0.38	0.23	0.120	53	138 - 422
C-O sole	2	0.11	0.12	0.12	0.007	6	154 - 212
diamond turbot	8	0.18	0.64	0.39	0.150	39	153 - 250
fantail sole	1	--	--	0.14	--	--	177 - 218
jacksmelt	3	0.15	0.18	0.17	0.017	10	275 - 310
kelp bass	1	--	--	0.16	--	--	93 - 118
shiner perch	1	--	--	0.13	--	--	73 - 83
spotfin croaker	2	0.23	0.36	0.30	0.092	31	232 - 328
spotted sand bass	5	0.21	0.30	0.24	0.041	17	233 - 300
spotted turbot	4	0.13	0.25	0.18	0.055	31	159 - 196
yellowfin croaker	5	0.14	0.24	0.19	0.042	23	212 - 306

No. Comp. = number of composites; Min = minimum; Max = maximum; SD = standard deviation; CV = coefficient of variation;
Std. Length = Tip of snout to end of hypural plate (at base of caudal fin); does not include caudal fin.
See Appendices 3 and 5 for reporting limits.

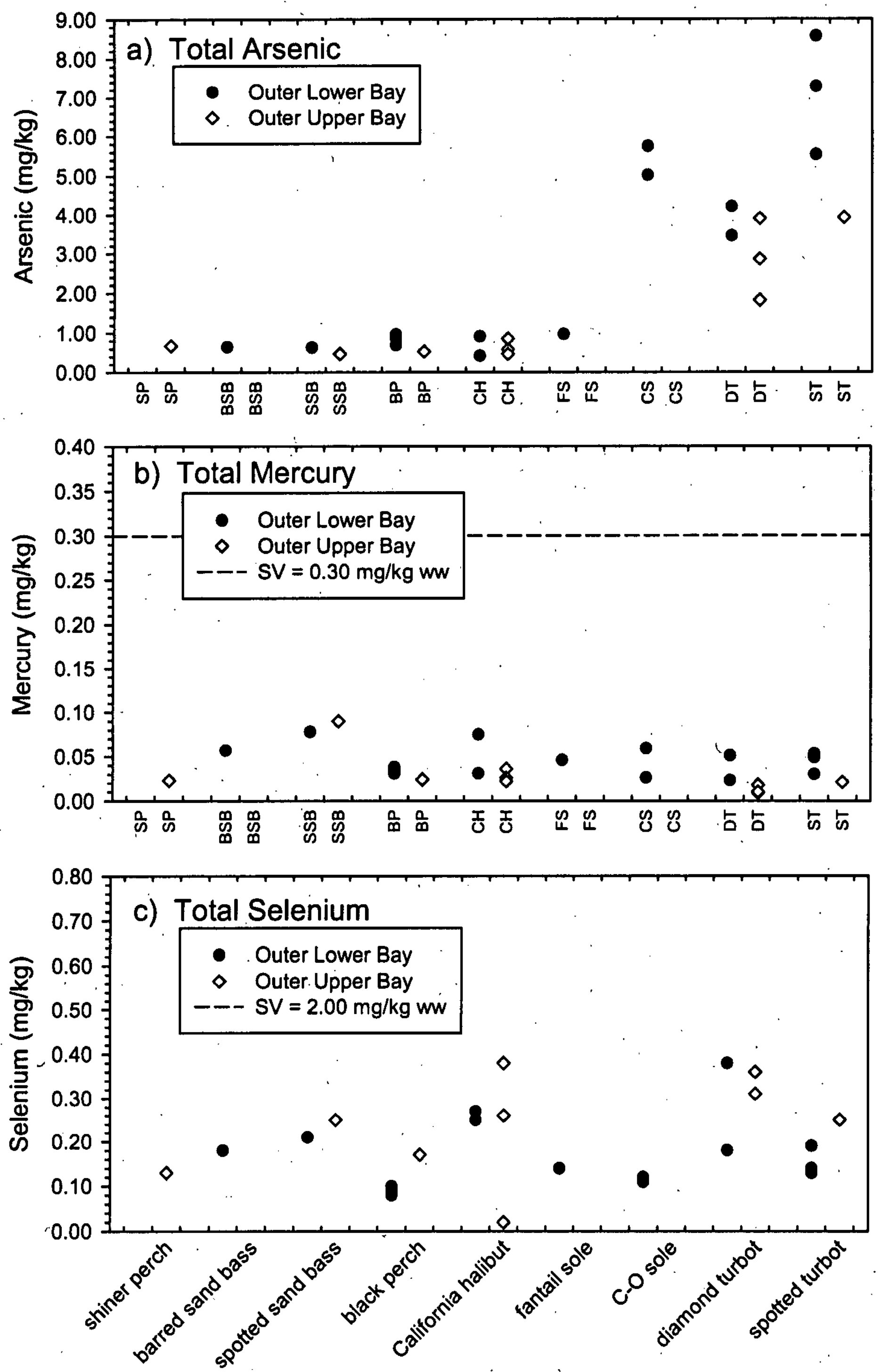

Figure 2. Trace metal concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in winter (November-January) 2000-2001. SV = OEHHA screening value for human fish consumption (see Table 3).

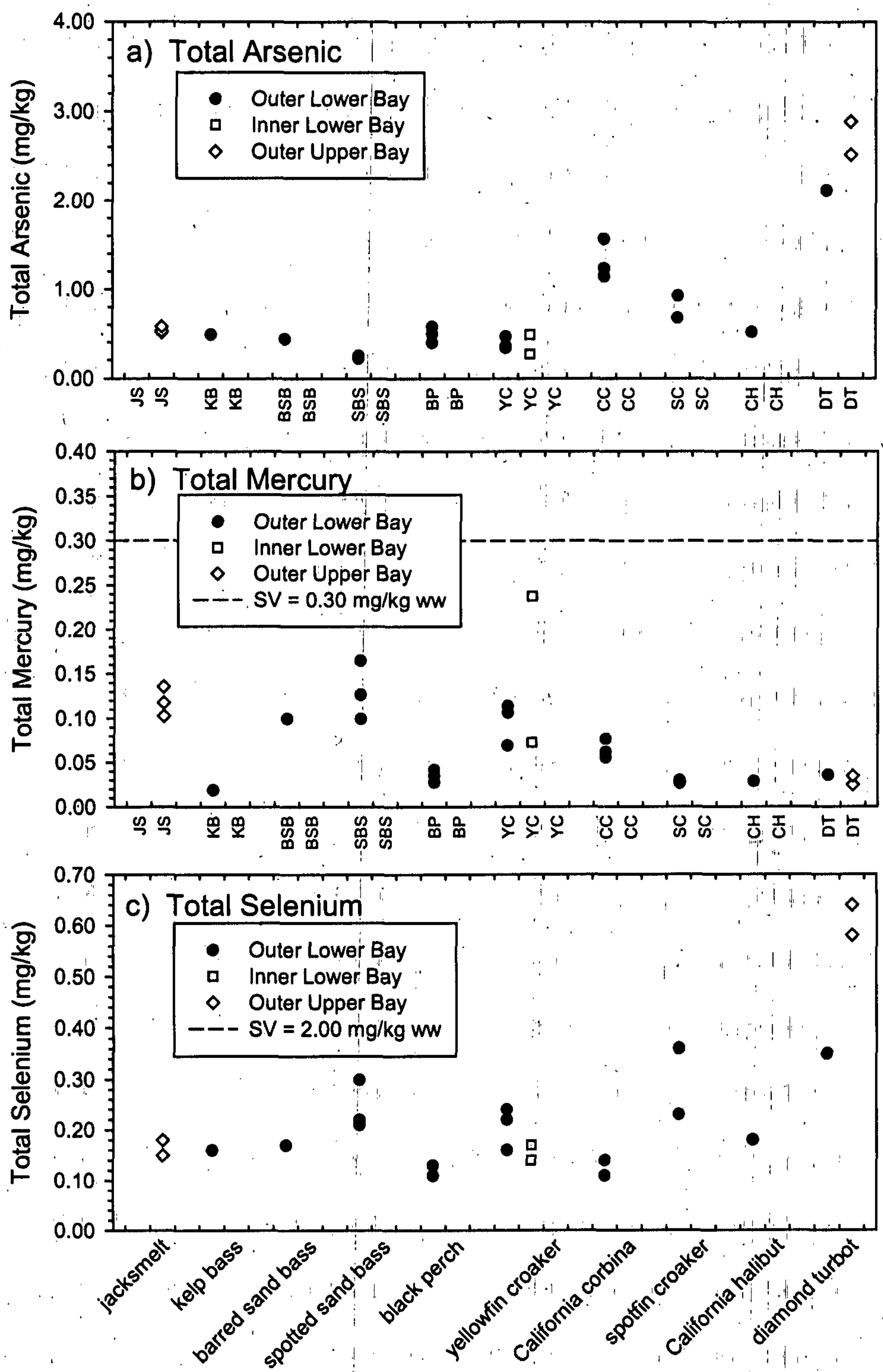

Figure 3. Trace metal concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in summer (June-July) 2001. SV = OEHHA screening value for human fish consumption (see Table 3).

Inorganic arsenic concentrations from extra muscle tissue of fishes (black perch, California halibut, C-O sole, diamond turbot, spotted sand bass, spotted turbot) that had been analyzed for total arsenic were extremely low, ranging from 0.003 to 0.020 mg/kg ww, well below the 1.2 mg/kg ww SV (Appendix 6, Table 3). These values were 0.07 to 1.23% of the total arsenic.

Total mercury ranged from 0.009 to 0.238 mg/kg across all composites and species (Table 6, Appendices 4, 5). Highest values of 0.238, 0.165, and 0.136 were found in yellowfin croaker, spotted sand bass, and jacksmelt, respectively (Table 6). Composite means were highest in yellowfin croaker, jacksmelt, and spotted sand bass, with 0.120, 0.119, and 0.112 mg/kg, respectively. None of the composites were above the SV of 0.3 mg/kg (Figures 2, 3; Table 6)

Total selenium ranged from 0.02 to 0.64 mg/kg across all composites and species (Table 6; Appendices 4, 5). Highest concentrations of 0.64, 0.38, and 0.36 were found in diamond turbot, California halibut, and spotfin croaker (*Roncador stearnsii*). Composite means were highest in diamond turbot, spotfin croaker, and spotted sand bass, with 0.39, 0.30, and 0.24 mg/kg, respectively (Table 6). All of the composites were far below the SV of 2.00 mg/kg (Figures 2, 3).

Semivolatile Organic Compounds

Recreational fish muscle tissue was analyzed for 59 semivolatile organic compounds. PCBs, DDTs, and chlordanes were detected but the pesticides aldrin, chlorpyrifos, diazinon, dieldrin, and endrin were not detected.

Total PCB ranged from not detected to 57.8 μg/kg across all composites and species (Table 7; Appendices 7, 8). Highest values of 57.8, 41.2, and 24.2 μg/kg were found in California corbina, yellowfin croaker, and spotted sand bass (Table 7). Composite means were highest in California corbina, yellowfin croaker, and spotted sand bass, with 20.8, 12.0, and 6.9 μg/kg, respectively. PCBs were not detected in muscle tissue of recreational fish samples in winter (Figure 4) but were relatively widespread in the summer (Figure 5). One composite each of California corbina, yellowfin croaker, and spotted sand bass were above the OEHHA SV of 20 μg/kg (Figure 5). The total PCB found in summer recreational fish samples were comprised of relatively few PCB congeners (Appendix 9).

Of DDT metabolites, only p,p'-DDE was detected. This is referred to here as Total DDT so comparisons could be made to SVs for human fish consumption. Total DDT ranged from 15 to 490 μg/kg in recreational fish tissue (Table 7; Appendices 7, 8). Concentrations were highest in California corbina, jacksmelt, and yellowfin croaker, with maximum values of 490, 232, and 130 μg/kg and means of 361, 139, and 101 μg/kg (Table 7). In the winter, one composite of California halibut was above the OEHHA SV of 100 μg/kg, with a value of 104 μg/kg (Figure 4, Appendix 7). In summer, all composites of California corbina were above the SV, and some composites of jacksmelt, yellowfin croaker, and spotted sand bass were above the SV (Figure 5, Appendix 8).

Table 7. Semivolatile organic compound concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in 2000-2001 (winter and summer samples combined).

Fish Species	No. Comp.	Total PCB (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
barred sand bass	2	--	--	ND	--	--	1.04	214 - 260
black perch	7	--	--	ND	--	--	0.71	103 - 193
California corbina	3	0.0	57.8	20.8	32.18	155	4.60	274 - 393
California halibut	6	--	--	ND	--	--	0.51	138 - 422
C-O sole	2	--	--	ND	--	--	0.50	154 - 212
diamond turbot	8	--	--	ND	--	--	0.58	153 - 250
fantail sole	1	--	--	ND	--	--	0.39	177 - 218
jacksmelt	3	0.0	9.9	3.3	5.70	173	1.30	275 - 310
kelp bass	1	--	--	ND	--	--	0.69	93 - 118
shiner perch	1	--	--	ND	--	--	0.46	73 - 83
spotfin croaker	2	--	--	ND	--	--	1.73	232 - 328
spotted sand bass	5	0.0	24.2	6.9	10.67	154	0.78	233 - 300
spotted turbot	4	--	--	ND	--	--	0.55	159 - 196
yellowfin croaker	5	0.0	41.2	12.0	17.00	141	1.70	212 - 306

Fish Species	No. Comp.	Total DDT (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
barred sand bass	2	45	66	56	15.1	27	1.04	214 - 260
black perch	7	29	61	40	10.9	27	0.71	103 - 193
California corbina	3	259	490	361	118.1	33	4.60	274 - 393
California halibut	6	41	104	69	19.8	29	0.51	138 - 422
C-O sole	2	30	38	34	5.9	18	0.50	154 - 212
diamond turbot	8	22	66	37	14.0	38	0.58	153 - 250
fantail sole	1	--	--	36	--	--	0.39	177 - 218
jacksmelt	3	52	232	139	89.9	65	1.30	275 - 310
kelp bass	1	--	--	19	--	--	0.69	93 - 118
shiner perch	1	--	--	40	--	--	0.46	73 - 83
spotfin croaker	2	38	98	68	42.2	62	1.73	232 - 328
spotted sand bass	5	15	108	68	37.8	55	0.78	233 - 300
spotted turbot	4	23	57	40	14.1	35	0.55	159 - 196
yellowfin croaker	5	47	130	101	34.5	34	1.70	212 - 306

Fish Species	No. Comp.	Total Chlordanes (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
barred sand bass	2	--	--	ND	--	--	1.04	214 - 260
black perch	7	--	--	ND	--	--	0.71	103 - 193
California corbina	3	9.4	19.9	16.0	5.78	36	4.60	274 - 393
California halibut	6	--	--	ND	--	--	0.51	138 - 422
C-O sole	2	--	--	ND	--	--	0.50	154 - 212
diamond turbot	8	--	--	ND	--	--	0.58	153 - 250
fantail sole	1	--	--	ND	--	--	0.39	177 - 218
jacksmelt	3	0.0	8.1	2.7	4.69	2	1.30	275 - 310
kelp bass	1	--	--	ND	--	--	0.69	93 - 118
shiner perch	1	--	--	ND	--	--	0.46	73 - 83
spotfin croaker	2	0.0	6.4	3.2	4.51	141	1.73	232 - 328
spotted sand bass	5	0.0	5.4	2.1	2.93	137	0.78	233 - 300
spotted turbot	4	--	--	ND	--	--	0.55	159 - 196
yellowfin croaker	5	0.0	5.9	2.3	3.13	137	1.70	212 - 306

Minimum detection limit = 5 µg/kg; ND = nondetect; these were treated as 0 in statistical calculations.

No. Comp. = number of composites; Min = minimum; Max = maximum; SD = standard deviation; CV = coefficient of variation;

Std. Length = Tip of snout to end of hypural plate (at base of caudal fin), but doesn't include tail fin;

Boxes enclose values above OEHHA screening values for human fish consumption (see Table 3).

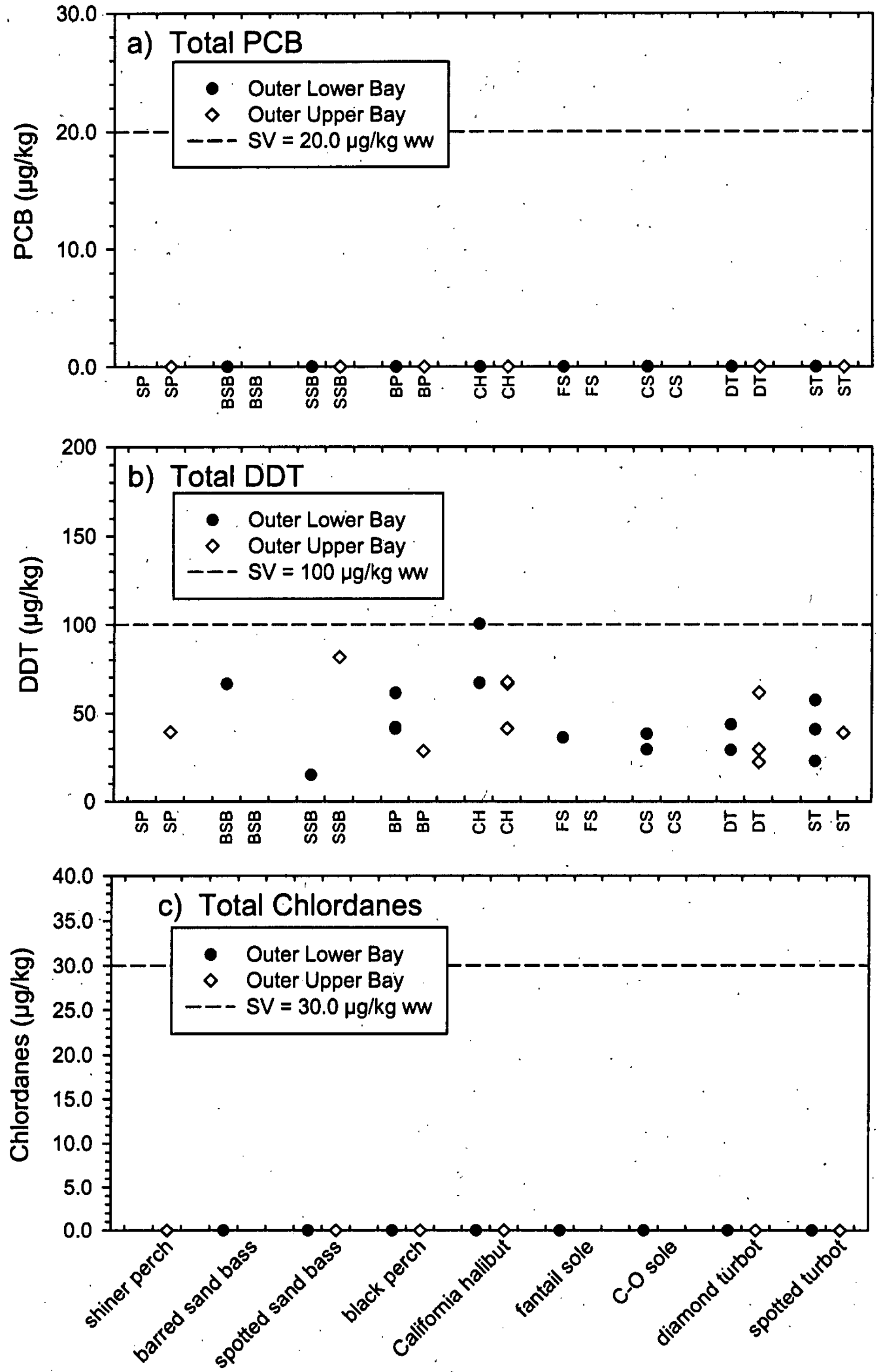

Figure 4. Semivolatile organic compound concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in winter (November-January) 2000-2001. SV = OEHHA screening value for human fish consumption (see Table 3).

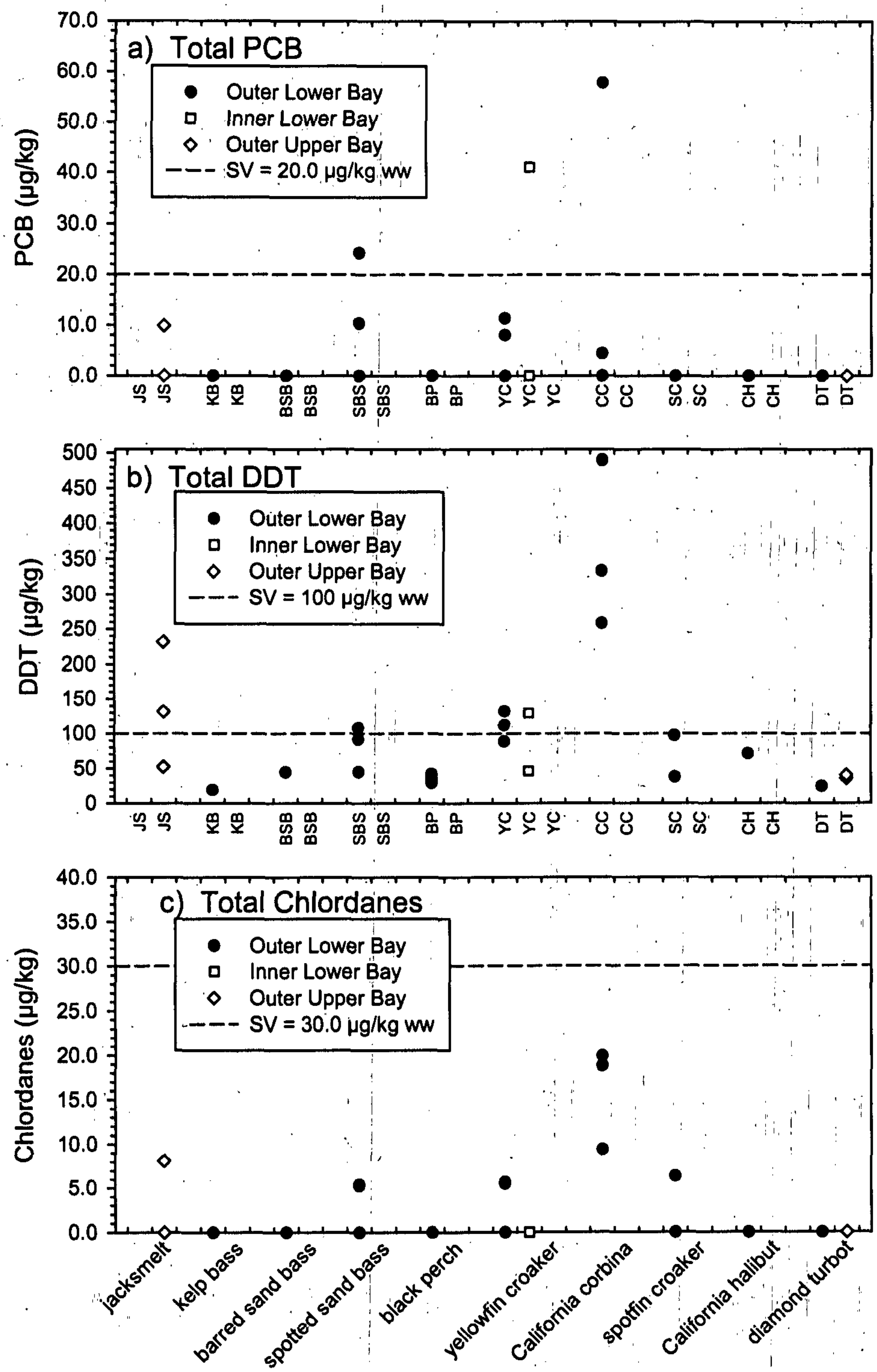

Figure 5. Semivolatile organic compound concentrations in muscle tissue of recreational fish species collected from Newport Bay, California in summer (June-July) 2001. SV = OEHHA screening value for human fish consumption (see Table 3).

Total chlordane ranged from not detectable to 19.9 μg/kg among recreational fish samples (Table 7; Appendices 7,8). California corbina, jacksmelt, and spotfin croaker had the highest values (19.9, 8.1, and 6.4 μg/kg). California corbina, spotfin croaker, and jacksmelt also had the highest composite means (16.0, 3.2, and 2.7 μg/kg) (Table 7). Chlordane was not detected in winter composites and all summer composites were below the SV of 30 μg/kg (Figures 4, 5).

Aldrin, chlorpyrifos, diazinon, dieldrin, and endrin were not detected. Thus the high percent recovery (outside limits) for chlorpyrifos, diazinon, and dieldrin in the spike recoveries are not meaningful (Appendix 7).

FORAGE FISH CONTAMINATION

Trace Metals

Whole fish tissue of forage fish was analyzed for four trace metals: total arsenic, total mercury, total selenium, and total cadmium. Pertinent SVs for wildlife fish consumption were found for mercury and selenium but not for total arsenic and cadmium (Table 3).

Total arsenic ranged from 0.26 to 1.20 mg/kg across all composites and species (Table 8, Appendix 10). Highest values of 1.20, 1.00, and 0.92 mg/kg, were found in diamond turbot, California halibut, and California killifish, respectively (Table 8). Composite means were highest in diamond turbot, California killifish, and black perch (1.20, 0.77, and 0.76 mg/kg).

Total mercury ranged from 0.004 to 0.026 mg/kg among all samples (Table 8, Appendix 10). The highest values were found among California halibut, cheekspot goby (*Ilypnus gilberti*), and Pacific staghorn sculpin (0.026, 0.020, and 0.18, respectively) (Table 8; Figures 6, 7). Cheekspot goby, California halibut, and Pacific staghorn sculpin also had the highest composite means (0.020, 0.019, and 0.013, respectively) (Table 8).

Total selenium in forage fishes ranged from 0.22 to 1.92 mg/kg (Table 8, Appendix 10). Four composites of three species had selenium concentrations above the screening value of 0.60 mg/kg ww (Figures 6, 7; Appendices 10, 11). These composites were collected in the inner upper bay and included summer composites of California killifish, topsmelt, and arrow goby (1.92, 1.66, and 1.42 mg/kg, respectively), and a winter composite of arrow goby (0.62 mg/kg) (Appendices 10, 11).

Total cadmium was detected only in topsmelt and Pacific staghorn sculpin (Table 8, Figures 6, 7; Appendix 10). In topsmelt, values ranged from 0.0 to 0.26 mg/kg, with a mean of 0.08 mg/kg (Table 8). In Pacific staghorn sculpin, values ranged from 0.0 to 0.010 mg/kg, with a mean of 0.005 mg/kg.

[redacted]

Table 8. Trace metal concentrations in whole fish tissue of forage fish species collected from Newport Bay, California in 2002 (winter and summer samples combined).

Fish Species	No. Comp.	Total Arsenic (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
California killifish	3	0.50	0.92	0.77	0.232	30	38 - 76
Topsmelt	5	0.26	0.50	0.36	0.108	30	18 - 44
Pacfic staghorn sculpin	4	0.36	0.80	0.52	0.199	39	45 - 95
Black perch	1	-	-	0.76	-	-	75 - 89
Shiner perch	1	-	-	0.68	-	-	45 - 60
Arrow goby	5	0.26	0.88	0.46	0.251	55	16 - 36
Cheekspot goby	1	-	-	0.52	-	-	18 - 30
California halibut	3	0.44	1.00	0.66	0.299	45	89 - 144
Diamond turbot	1	-	-	1.20	-	-	70 - 85

Fish Species	No. Comp.	Total Mercury (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
California killifish	3	0.008	0.012	0.009	0.0023	25	38 - 76
Topsmelt	5	0.006	0.008	0.006	0.0009	14	18 - 44
Pacific staghorn sculpin	4	0.008	0.018	0.013	0.0048	37	45 - 95
Black perch	1	-	-	0.012	-	-	75 - 89
Shiner perch	1	-	-	0.008	-	-	45 - 60
Arrow goby	5	0.004	0.014	0.008	0.0043	57	16 - 36
Cheekspot goby	1	-	-	0.020	-	-	18 - 30
California halibut	3	0.014	0.026	0.019	0.0064	34	89 - 144
Diamond turbot	1	-	-	0.010	-	-	70 - 85

Fish Species	No. Comp.	Total Selenium (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
California killifish	3	0.38	1.92	0.95	0.842	88	38 - 76
Topsmelt	5	0.22	1.66	0.53	0.631	119	18 - 44
Pacific staghorn sculpin	4	0.34	0.46	0.39	0.053	14	45 - 95
Black perch	1	-	-	0.22	-	-	75 - 89
Shiner perch	1	-	-	0.22	-	-	45 - 60
Arrow goby	5	0.22	1.42	0.59	0.488	82	16 - 36
Cheekspot goby	1	-	-	0.24	-	-	18 - 30
California halibut	3	0.22	0.26	0.23	0.023	10	89 - 144
Diamond turbot	1	-	-	0.24	-	-	70 - 85

Fish Species	No. Comp.	Total Cadmium (mg/kg) Min	Max	Mean	SD	CV%	Std. Length Range (mm)
California killifish	3	ND	ND	ND	-	-	38 - 76
Topsmelt	5	0.000	0.026	0.008	0.0117	147	18 - 44
Pacific staghorn sculpin	4	0.000	0.010	0.005	0.0058	115	45 - 95
Black perch	1	-	-	ND	-	-	75 - 89
Shiner perch	1	-	-	ND	-	-	45 - 60
Arrow goby	5	ND	ND	ND	-	-	16 - 36
Cheekspot goby	1	-	-	ND	-	-	18 - 30
California halibut	3	ND	ND	ND	-	-	89 - 144
Diamond turbot	1	-	-	ND	-	-	70 - 85

See Appendix 8 for reporting limits; ND = nondetect; these were treated as 0 in statistical calculations.
No. Comp. = number of composites; Min = minimum; Max = maximum; SD = standard deviation; CV = coefficient of variation;
Std. Length = Tip of snout to end of hypural plate (at base of caudal fin), but doesn't include tail fin.
Boxes enclose values above screening value for wildlife consumption (see Table 3).

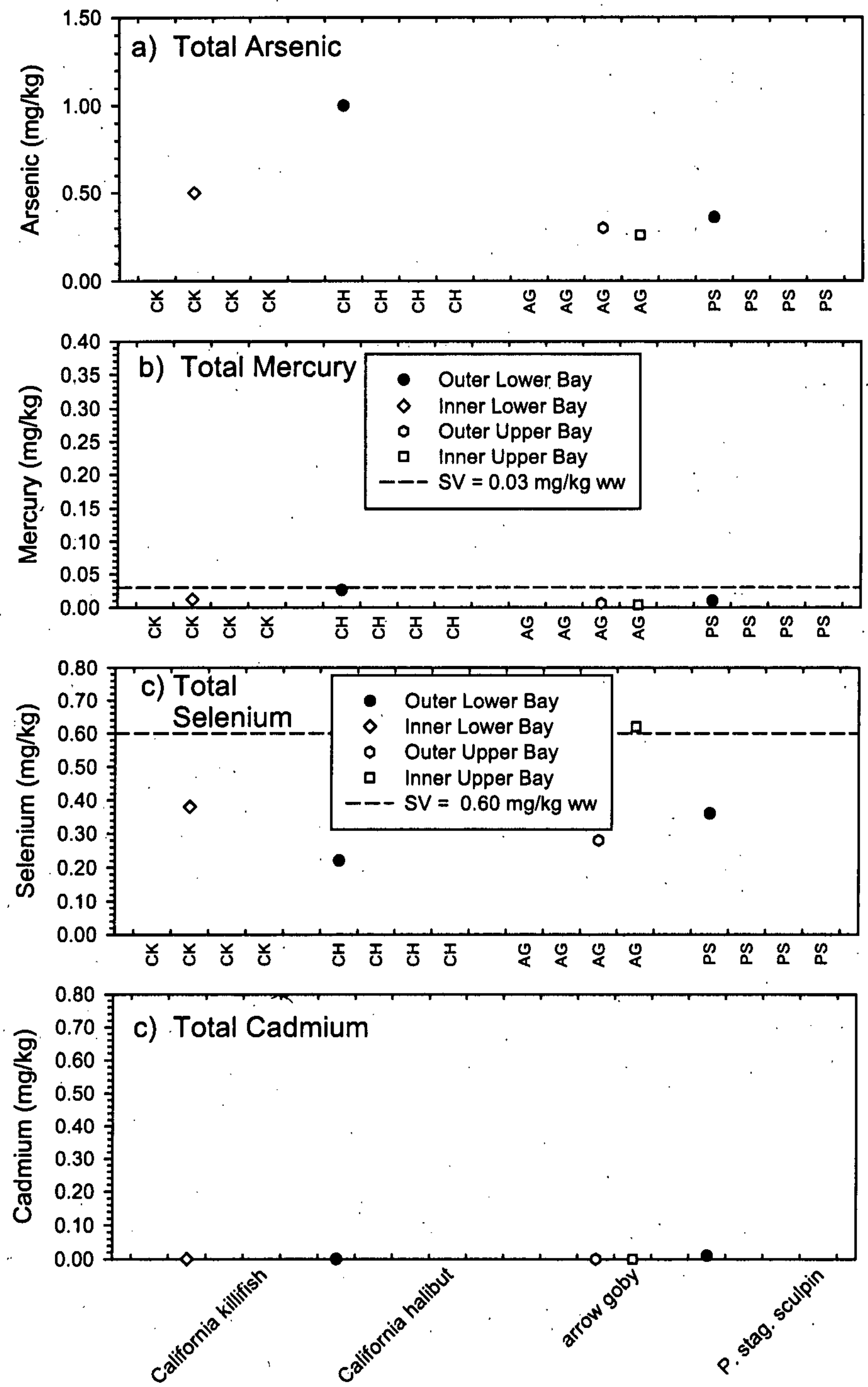

Figure 6. Trace metal concentrations in whole fish tissue of forage fish species collected from Newport Bay, California in winter (March-April) 2002. SV = screening value for wildlife fish consumption (see Table 3).

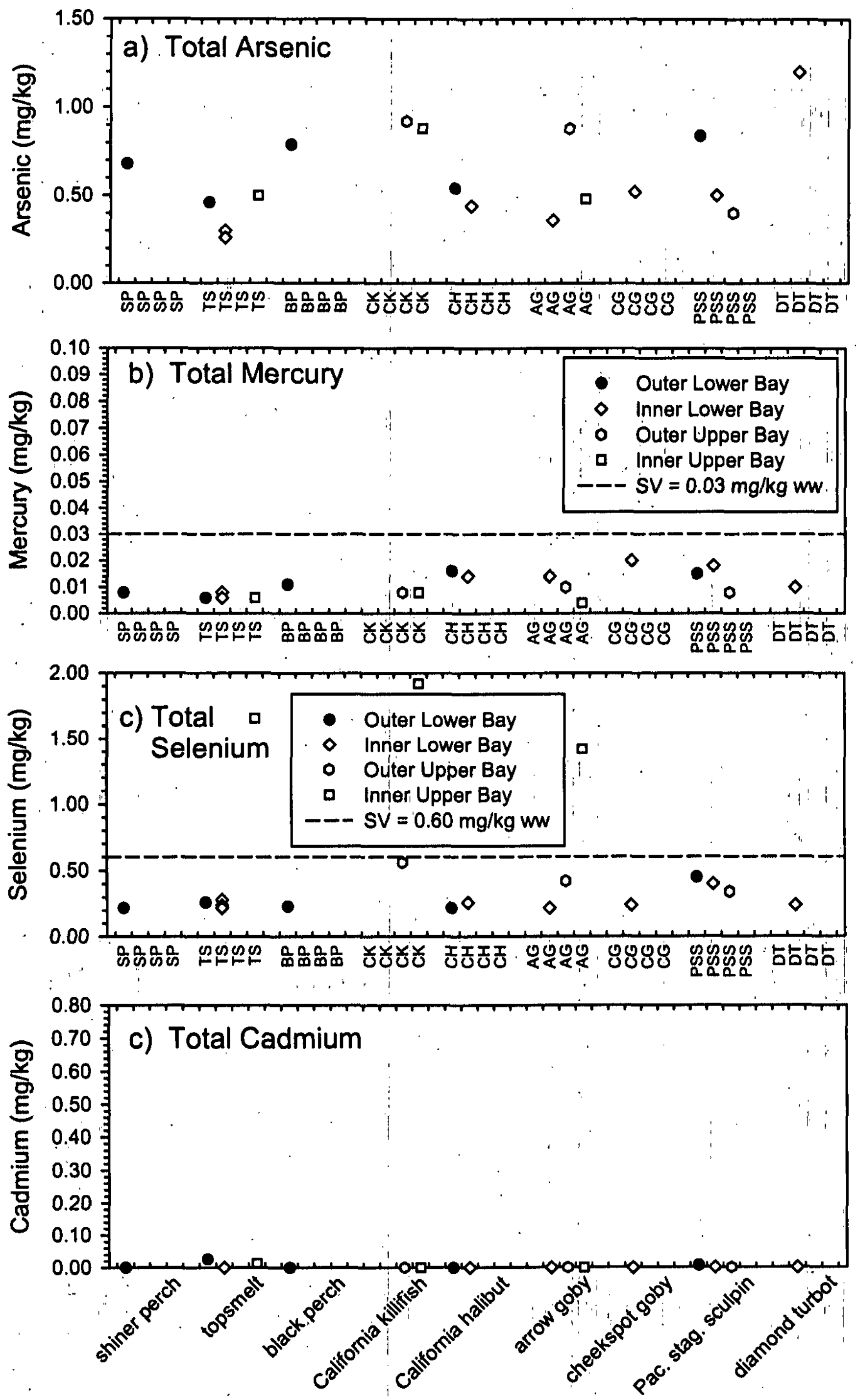

Figure 7. Trace metal concentrations in whole fish tissue of forage fish species collected from Newport Bay, California in summer (August-September) 2002. SV = screening value for wildlife fish consumption (see Table 3).

Semivolatile Organic Compounds

Whole fish tissue of forage fishes were analyzed for 59 semivolatile organic compounds. Only PCBs, DDTs, and chlordanes were detected.

Total PCBs in forage fishes ranged from not detectable to 136 μg/kg (Table 9, Appendix 12). PCBs were only found in four species: California halibut, topsmelt, California killifish, and cheekspot goby. Maximum concentrations in these species were 136, 101, 98, and 53 μg/kg (Table 9; Figures 8, 9). Mean composite concentrations were highest for California halibut, cheekspot goby, California killifish, and topsmelt (65, 53, 33, and 29 μg/kg, respectively). Concentrations of toxic PCB congeners with TEFs (Table 4; Appendices 13, 14) in whole fish were compared to SVs for wildlife fish consumption developed by Environment Canada (1998) (Tables 3, 10). Of the four species with PCBs, all except one California halibut composite were above the SV for mammal fish consumption, and this composite was barely below the SV. PCBs in these fish did not pose a potential risk to birds. The only toxic PCB congener with a wildlife TEF found in these fishes was PCB 118. Three of four composites from the inner lower bay were above the SV, and a California halibut composite from the outer lower bay was also above this SV; the California halibut composite from the inner lower bay was just barely below the SV.

Total DDT was found in all forage fish composites (Appendix 12). Concentrations ranged from 50 to 262 μg/kg (Table 9). Highest values were found in arrow goby, Pacific staghorn sculpin, and cheekspot goby (262, 204, and 195 μg/kg); means for these were 141, 143, and 195 μg/kg. All forage fish composites were above the Environment Canada (1997) SV for wildlife fish consumption for Total DDT of 14 μg/kg (Table 9).

Total chlordane ranged from not detectable to 22.2 μg/kg among forage fish samples (Table 9; Appendix 12). Arrow goby, Pacific staghorn sculpin, and black perch had the highest values (22.2, 21.2, and 12.6 μg/kg) (Table 9). Species with highest composite means were Pacific staghorn sculpin, black perch, and cheekspot goby (14.1, 12.6, and 11.0 μg/kg). None of the composites were above the SV for wildlife fish consumption of 50 μg/kg (NAS 1974) (Table 3).

RELATIONSHIP OF DDT CONCENTRATIONS TO PERCENT LIPID, FISH LENGTH, AND SEASON

DDT was the most widespread contaminant of concern in Newport Bay and hence provided some data for examining relationships of concentrations in fish tissue relative to other variables.

Among recreational fish species, DDT concentrations were correlated with percent lipid in muscle tissue only in diamond turbot (Table 11) and were not correlated with mean fish length of fish (Table 12). Among species that occurred at the same site, there was generally little difference in DDT concentrations between seasons (Table 13).

Table 9. Concentrations of semivolatile organic compounds in whole fish tissue of forage fish species collected in Newport Bay, California in 2002 (winter and summer samples combined).

Fish Species	No. Comp.	Total PCB (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
California killifish	3	0	98	33	56.4	173	1.48	38 - 76
Topsmelt	5	0	101	29	42.6	147	1.57	18 - 44
Pacfic staghorn sculpin	4	ND	ND	ND	-	-	1.34	45 - 95
Black perch	1	-	-	ND	-	-	1.14	75 - 89
Shiner perch	1	-	-	ND	-	-	1.02	45 - 60
Arrow goby	5	ND	ND	ND	-	-	1.30	16 - 36
Cheekspot goby	1	-	-	53	-	-	1.54	18 - 30
California halibut	3	0	136	65	68.0	105	0.94	89 - 144
Diamond turbot	1	-	-	ND	-	-	0.84	70 - 85

Fish Species	No. Comp.	Total DDT (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
California killifish	3	84	116	100	16.2	16	1.48	38 - 76
Topsmelt	5	50	160	109	40.8	37	1.57	18 - 44
Pacfic staghorn sculpin	4	57	204	143	62.3	43	1.34	45 - 95
Black perch	1	-	-	117	-	-	1.14	75 - 89
Shiner perch	1	-	-	95	-	-	1.02	45 - 60
Arrow goby	5	56	262	141	78.2	56	1.30	16 - 36
Cheekspot goby	1	-	-	195	-	-	1.54	18 - 30
California halibut	3	73	97	86	12.1	14	0.94	89 - 144
Diamond turbot	1	-	-	119	-	-	0.84	70 - 85

Fish Species	No. Comp.	Total Chlordanes (µg/kg) Min	Max	Mean	SD	CV%	Mean % Lipid	Std. Length Range (mm)
California killifish	3	ND	ND	ND	-	-	1.48	38 - 76
Topsmelt	5	0.0	6.4	2.6	2.74	104	1.57	18 - 44
Pacfic staghorn sculpin	4	3.0	21.2	14.1	7.88	56	1.34	45 - 95
Black perch	1	-	-	12.6	-	-	1.14	75 - 89
Shiner perch	1	-	-	ND	-	-	1.02	45 - 60
Arrow goby	5	0.0	22.2	4.4	9.93	2	1.30	16 - 36
Cheekspot goby	1	-	-	11.0	-	-	1.54	18 - 30
California halibut	3	0.0	12.2	4.1	7.04	173	0.94	89 - 144
Diamond turbot	1	-	-	6.4	-	-	0.84	70 - 85

Minimum detection limit = 5 µg/kg; ND = nondetect; these were treated as 0 in statistical calculations.
No. Comp. = number of composites; Min = minimum; Max = maximum; SD = standard deviation; CV = coefficient of variation;
Std. Length = Tip of snout to end of hypural plate (at base of caudal fin), but doesn't include tail fin;
Boxes enclose values above Environment Canada (1997) screening values for wildlife fish consumption of DDT (= 14 µg/kg).

Among forage fish species, DDT concentrations were correlated with percent lipid in whole body tissue only in juvenile California halibut and arrow goby (Table 11). DDT concentrations in arrow goby was significantly correlated with mean length of fish in a composite (Table 12). However, due to the large number of fish in the composites (210-500), the small number of fish measured per composite (20), and the small range of mean lengths (22-29 mm), this may not be meaningful. Among species that occurred at the same location, DDT concentrations were higher in summer for Pacific staghorn sculpin and arrow goby but slightly lower in summer for California halibut (Table 13). The mean size of fish in composites of these species was slightly larger in summer than in winter.

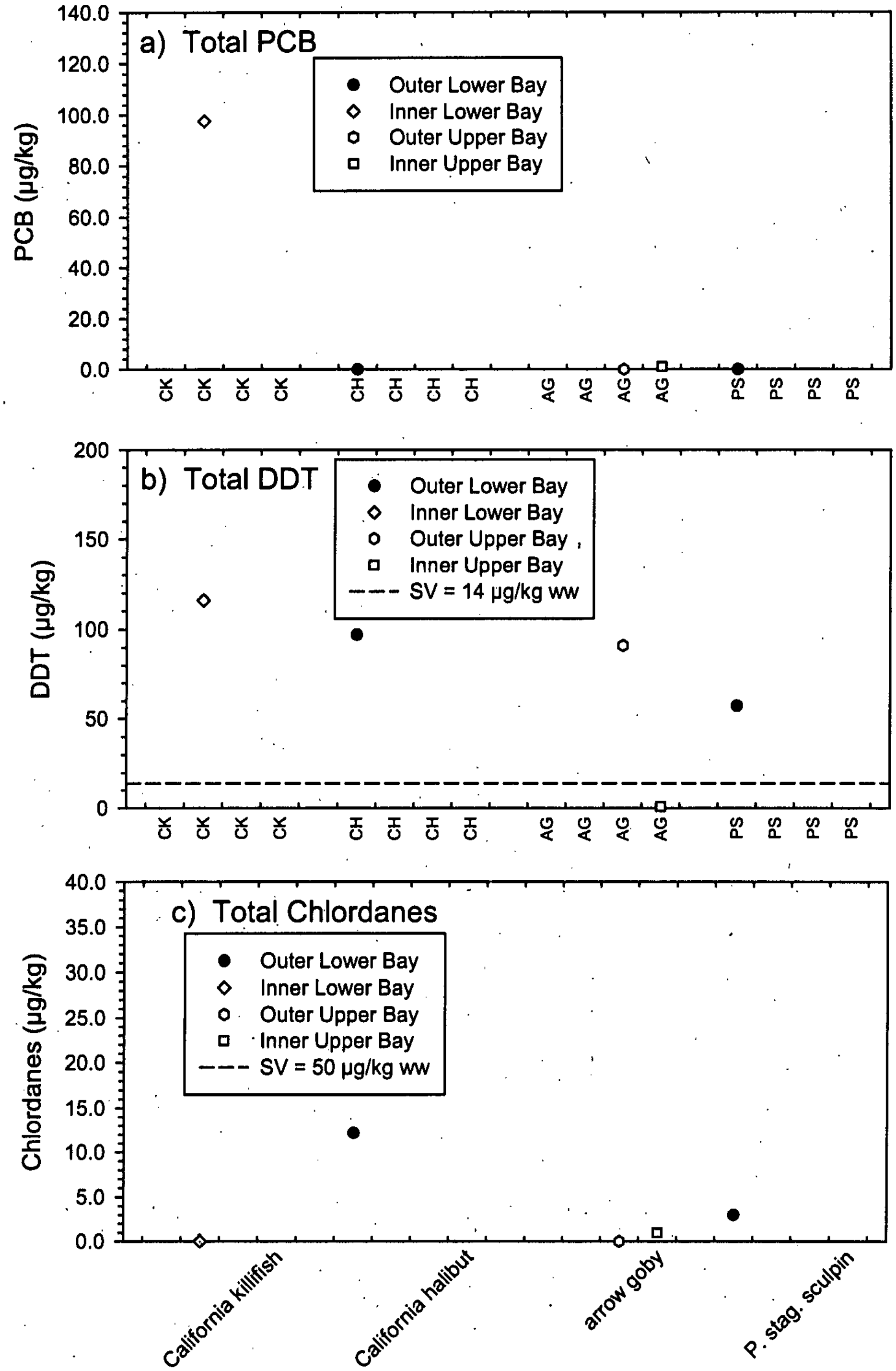

Figure 8. Semivolatile organic compound concentrations in whole fish tissue of forage fish species collected from Newport Bay, California in winter (March-April) 2002. SV = screening value for wildlife fish consumption (see Table 3).

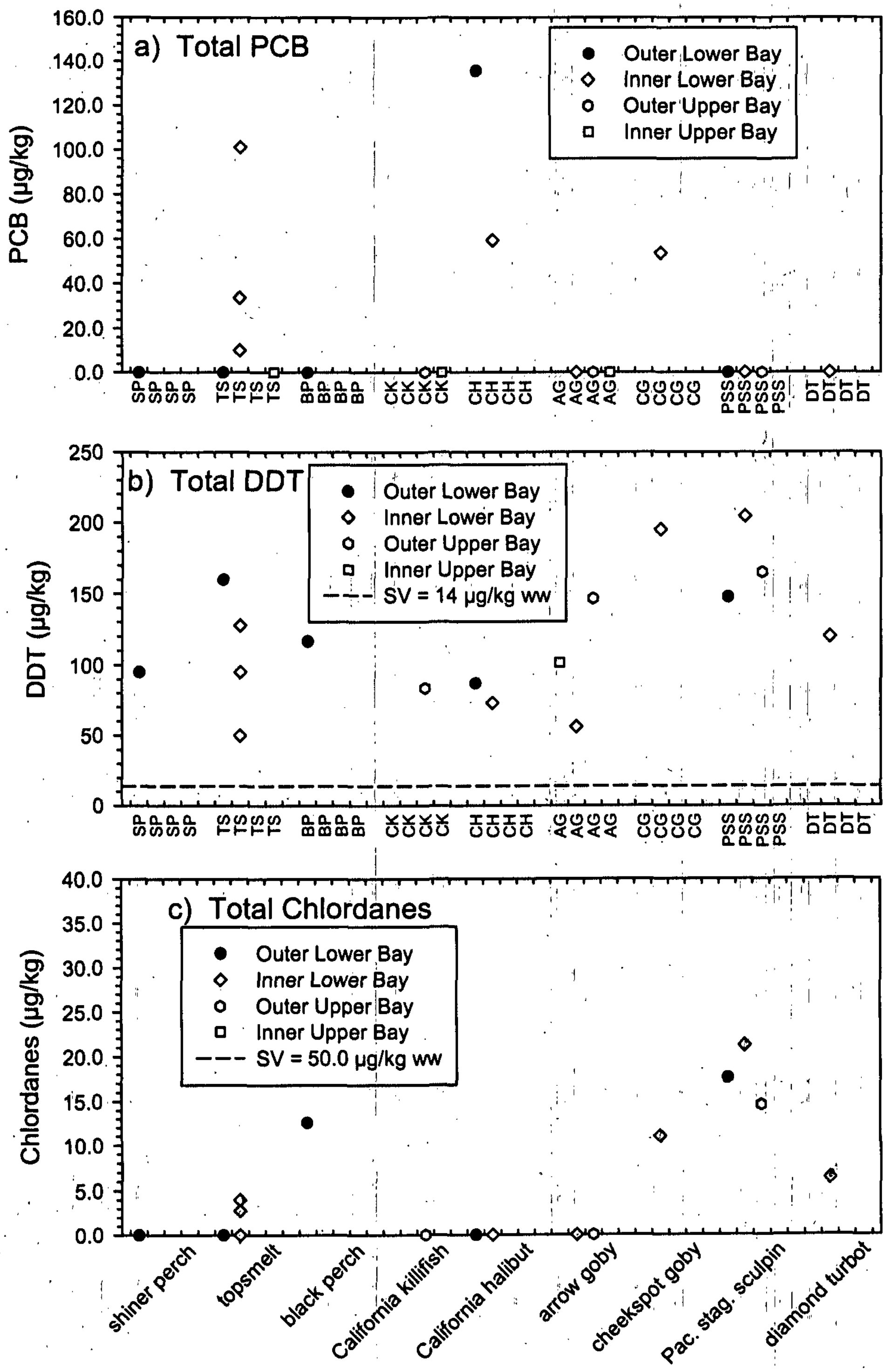

Figure 9. Semivolatile organic compound concentrations in whole fish tissue of forage fish species collected from Newport Bay, California in summer (August-September) 2002. SV = screening value (see Table 3).

Table 10. PCB 118 concentrations in forage fishes of Newport Bay, California in 2002 relative to a screening value for wildlife fish consumption.

Species	Season	Location	PCB 118 (µg/kg)	Bird TEQ (ng/kg)	Mam TEQ (ng/kg)
California killifish	W	IL	16	0.16	1.60
Topsmelt (medium)	S	IL	13	0.13	1.33
Cheekspot goby	S	IL	10	0.10	0.95
California halibut	S	IL	8	0.08	0.78
California halibut	S	OL	22	0.22	2.22

Environment Canada (1998) screening value for wildlife fish consumption = 0.79ng TEQ/kg
Values enclosed in blocks are greater than screening value.
TEQ = toxicity equivalent quotient; TEF = toxicity equivalent factor
Bird TEF = 0.00001; mammal TEF = 0.0001 (see Table 4); Van den Berg *et al.* (1998)
W = winter; S = summer; IL = inner lower bay; OL = outer lower bay

Table 11. Correlation of DDT concentrations to percent lipid in recreational fishes and forage fishes collected in Newport Bay, California in 2000-2002.

Species						
Common Name	Scientific Name	n	df	r	r^2	p
Recreational Fishes (Muscle Fillet)						
diamond turbot	*Hypsopsetta guttulata*	8	6	0.76	0.58	*
California corbina	*Menticirrhus undulatus*	3	1	0.99	0.98	ns
spotted sand bass	*Paralabrax maculatofasciatus*	5	3	0.74	0.55	ns
yellowfin croaker	*Umbrina roncador*	5	3	0.64	0.41	ns
jacksmelt	*Atherinopsis californiensis*	3	1	0.57	0.32	ns
spotted turbot	*Pleuronichthys ritteri*	4	2	0.52	0.27	ns
black perch	*Embiotoca jacksoni*	7	5	0.13	0.02	ns
California halibut	*Paralichthys californicus*	6	4	0.04	0.00	ns
Forage Fishes (Whole Body)						
California halibut	*Paralichthys californicus*	3	1	1.00	1.00	**
arrow goby	*Clevelandia ios*	5	3	0.92	0.84	*
Pacific staghorn sculpin	*Leptocottus armatus*	4	2	0.92	0.84	ns
California killifish	*Fundulus parvipinnis*	3	1	0.87	0.76	ns
topsmelt	*Atherinops affinis*	5	3	0.80	0.63	ns

n = number of composites
df = degrees of freedom = n-2
r = product-moment correlation coefficient
r^2 = percent variability characterized by correlation
p = probability; ** = significant at 0.01; * = significant at 0.05; ns = not significant, p>0.05
Species not included did not have a sufficient number of composites for analysis.

Table 12. Correlation of DDT concentrations to mean standard length in recreational and forage fishes collected in Newport Bay, California in 2000-2002.

Species						
Common Name	Scientific Name	n	df	r	r^2	p
Recreational Fishes (Muscle Fillet)						
jacksmelt	*Atherinopsis californiensis*	3	1	0.94	0.88	ns
spotted sand bass	*Paralabrax maculatofasciatus*	5	3	0.41	0.17	ns
California halibut	*Paralichthys californicus*	6	4	0.29	0.08	ns
diamond turbot	*Hypsopsetta guttulata*	8	6	0.25	0.06	ns
yellowfin croaker	*Umbrina roncador*	5	3	0.22	0.05	ns
black perch	*Embiotoca jacksoni*	7	5	-0.01	0.00	ns
California corbina	*Menticirrhus undulatus*	3	1	-0.46	0.21	ns
spotted turbot	*Pleuronichthys ritteri*	4	2	-0.76	0.59	ns
Forage Fishes (Whole Body)						
arrow goby	*Clevelandia ios*	5	3	0.89	0.79	*
topsmelt	*Atherinops affinis*	3	1	0.99	0.98	ns
Pacific staghorn sculpin	*Leptocottus armatus*	4	2	0.60	0.35	ns
California halibut	*Paralichthys californicus*	3	1	-0.05	0.00	ns
California killifish	*Fundulus parvipinnis*	3	1	-0.81	0.65	ns

n = number of composites
df = degrees of freedom = n-2
r = product-moment correlation coefficient
r^2 = percent variability characterized by correlation
p = probability; ** = significant at 0.01; * = significant at 0.05; ns = not significant, p>0.05
SL = standard length
Species not included did not have a sufficient number of composites for analysis.

DISCUSSION

Many of the fishes of Newport Bay have elevated tissue concentrations of some contaminants. Some of these contaminants are found at levels that may be of potential concern to human and wildlife fish consumption. Total DDT and total PCB are the most important contaminants of concern for human fish consumption. DDT is the most widespread contaminant of concern for wildlife fish consumption, followed by PCB118, and selenium. Other pesticides such as diazinon, chlorpyrifos, and dieldrin that have been considered a potential concern in Newport Bay were not elevated in this study.

Concentrations of contaminants of concern varied in species with different ecology and behaviors. Some recreational species (jacksmelt, California corbina, yellowfin croaker, spotfin croaker, and California halibut) occur commonly on the coast and may move between the coast and Newport Bay as adults (Table 14). All of these except spotfin croaker had DDT and/or PCB concentrations above screening values for human fish consumption in one or more composites analyzed. These typically coastal species may

Table 13. Comparison of PCB and DDT concentrations, gender, and lengths in recreational and forage fish species at the same location in Newport Bay, California in winter and summer (2000-2001 for recreational fishes, 2002 for forage fishes).

Species	Loc.	NC		Gender		Mean Length (mm) of Fish in Composites		Total PCB (µg/kg)		Total DDT (µg/kg)	
		W	S	W	S	W	S	W	S	W	S
Recreational Fishes											
diamond turbot	OU	3	2	B,B,B	B,B	158, 193, 175	177, 195	ND,ND,ND	ND,ND	30, 66, 22	34, 43
diamond turbot	OL	2	1	B,B	B	175, 207	187	ND,ND	ND	44, 29	25
spotted sand bass	OL	1	3	F	B,M,M	259	244, 284, 277	ND	ND, 10.4, **24.2**	82	45, 92, **108**
barred sand bass	OL	1	1	F	B	250	225	ND	ND	66	45
black perch	OL	3	3	F,F,B	B,B,B	169, 145, 113	125, 146, 182	ND,ND,ND	ND,ND,ND	42, 41, 61	30, 36, 42
California halibut	OL	2	1	B,B	B	152, 374	183	ND,ND	ND	67, **104**	71
Forage Fishes											
arrow goby	IU	1	1	-	-	22	29	ND	ND	**148**	**262**
arrow goby	OU	1	1	-	-	23	25	ND	ND	91	**146**
P. staghorn sculpin	OL	1	1	-	-	55	77	ND	ND	57	**147**
California halibut	OL	1	1	-	-	96	122	ND	**136***	97	87

W = winter; S = summer
Loc. = Location; IU = inner upper bay; OL = outer lower bay; OU = outer upper bay; NC = Number of composites; ND = not detected
Composite values are arranged in order so that lengths or PCB and DDT concentrations can be compared by composite.
Concentrations in bold and underline are above OEHHA screening values for human fish consumption (Brodberg and Pollock 1999).
Concentrations in boxes are above Environment Canada (1997, 1998) screening values of DDT and PCB for wildlife fish consumption.
* Note that there is no screening value for total PCB. However, concentrations of PCB118 in this composite are above the screening value for wildlife (mammal) fish consumption of Environment Canada (1998). See Tables 3, 10.
P. = Pacific; B = both genders; F = female; M = male

accumulate their contaminant load on the coast, in the bay, or in both locations. Fish consumption advisories for California corbina are posted on the coast at Newport Pier. In contrast, high levels of DDTs in arrow goby, a resident bay species that is not likely to move far, are almost certainly accumulated within Newport Bay. Arrow goby lives in echiuroid burrows on mudflats at low tide, and hence is likely exposed to DDT-contaminated sediments in burrows beneath the sediment surface. Hence, DDT concentrations in resident fishes may have a strong relationship to local sediment contamination levels.

Composites with high DDT levels were found among fishes feeding in different ways (Table 14). Composites of recreational fish with DDT concentrations above the OEHHA SV of 100 ppb occurred primarily in summer among species that are typically coastal although a composite of large California halibut was above the screening value in the winter. This species is a resident of estuarine bays as a juvenile but moves to the coast at a length of 200 mm, and adults are typically coastal (Haaker 1975). Among forage fishes, DDT concentrations above Environment Canada (1997) SVs for wildlife fish consumption were found in all fish examined. This may be of potential concern for birds consuming fish from the Bay. This SV of 14 ppb is a Canadian, not a United States or California, guideline and was used here as a SV to provide some context to the range of DDT values encountered in forage fishes. In a coastal study (M. J. Allen *et al.* 2002),

Table 14. Distribution of contaminant levels of concern among Newport Bay, California recreational and forage fishes by adaptive zone and foraging guild in 2000-2002.

			Recreational Fishes				Forage Fishes			
		Primary	Winter - Muscle		Summer - Muscle		Winter - Whole		Summer - Whole	
Guild	Fish Species	Adaptive Zone	Metals	SOC	Metals	SOC	Metals	SOC	Metals	SOC
Water-column Species										
1a1	jacksmelt	Coast			x	DDT				
1a2a	kelp bass	Coast			x	x				
1b1a	shiner perch	Estuary/Coast	x	x					x	DDT
1d1b	topsmelt	Estuary/Coast							Se	PCB/DDT
1c1	black perch	Coast	x	x	x	x			x	DDT
1c1	California killifish	Estuary					x	PCB/DDT	Se	DDT
1c2	yellowfin croaker	Coast			x	PCB/DDT				
1c2	California corbina	Coast			x	PCB/DDT				
1d1	spotfin croaker	Coast				x				
Benthic Species										
2a	California halibut	Estuary/Coast	x	DDT	x	x	x	DDT	x	PCB/DDT
2b	arrow goby	Estuary					Se	DDT	Se	DDT
2b	cheekspot goby	Estuary							x	PCB/DDT
2c2c	fantail sole	Coast	x	x						
2c2c	Pacific staghorn sculpin	Estuary					x	DDT	x	DDT
2c2d	barred sand bass	Coast	x	x	x	x				
2c2d	spotted sand bass	Estuary	x	x	x	PCB/DDT				
2d1a	C-O sole	Coast	x	x						
2d1a	diamond turbot	Estuary	x	x	x	x			x	DDT
2d1a	spotted turbot	Coast	x	x						

SOC = semivolatile organic compounds; x = species analyzed but contaminants were not above screening values.

Boxes indicate that at least one composite of each species had contaminant levels above screening values for human or wildlife fish consumption for PCB, total DDT, or selenium.

Screening values for human fish consumption: total DDT = 100 ug/kg; total PCB = 20 ug/kg

Screening values for wildlife fish consumption for total DDT = 14 ppb (0.014 ppm); PCB congeners = 0.79 ng TEQ/kg; Environment Canada (1997, 1998).

Screening value for wildlife fish consumption for selenium = 0.60 ppm ww, based on NIWQP (1998) SV of 3.0 ppm dw

Guild classification modified from M. J. Allen (1982).

1a1 = schooling pelagivore (plankton); 1a2a = bottom-refuge pelagivore (fish/squid);
1b1a = midwater pelagobenthivore (plankton/some amphipods);
1b1b = midwater pelagobenthivore (plankton/detritus); 1c1 = cruising benthopelagivore (diurnal) (amphipods);
1c2 = cruising benthopelagivore (nocturnal) (amphipods/shrimp); 1d = cruising benthivore (crabs/shrimps/clams)
2a = ambushing pelagivore (fish/mysids); 2b = pelagobenthivore (burrow-refuge) (amphipods);
2c2c = benthopelagivore (medium) (amphipods/shrimp); 2c2d = benthopelagivore (large) (crabs/clams/fish);
2d1a = extracting benthivore (polychaetes/clam siphons)

pelag-' = water column; 'benth-' = bottom; '-ivore' = feeder

sanddab-guild flatfishes had tissue levels above this SV in 70% of the area of the southern California shelf. Based on the findings of the present study, DDT occurs broadly in Newport Bay fishes. DDT is also found in Newport Bay sediments throughout the Bay (Bay *et al.* 2003), presumably from upstream San Diego Creek sources (USEPA 2002).

PCB concentrations of possible concern to human fish consumption were also found in coastal species (jacksmelt, yellowfin croaker, California corbina) collected in Newport Bay only during the summer. However, relatively high levels were also found in spotted sand bass, a likely resident of the bay. PCB concentrations of potential concern to wildlife fish consumption were found in California killifish, topsmelt, cheekspot goby, and juvenile California halibut in the inner lower bay in Newport Channel (and outer upper bay for the latter species) (Table 10). The composite of juvenile California halibut with high concentrations from the outer upper bay had a larger mean length (96 mm SL) than those in the inner channel (59 mm SL) and was perhaps able to move to the outer upper bay from the inner. This potential risk was based on concentrations of a single PCB congener, PCB118. Identification of a discrete PCB congener may provide a basis for tracking the source. Bay *et al.* (2003) found this congener only in the inner lower bay in the Turning Basin of the Lido Isle Reach and the Rhine Channel at the end of Newport Channel. The source of this historic congener to the sediments and fishes is presumably confined in this area.

Composites of three species of forage fishes (topsmelt, California killifish, arrow goby) from the inner upper bay had selenium concentrations greater than the screening value for wildlife fish consumption (Appendix 9). These fishes typically live and/or forage in the intertidal fringe of the upper bay. All species forage at high tide over the mudflats but topsmelt and killifish typically retreat with the receding tide whereas arrow goby moves into burrows in the mudflats. Selenium appears to be most available to small estuarine fishes foraging in the intertidal mudflat zone at high tide, suggesting an upper bay sediment source.

Although the study initially focused on total arsenic, inorganic arsenic (the more toxic form of arsenic) was analyzed late in the study at the suggestion of Peter Kozelka (USEPA, Region IX). Inorganic arsenic concentrations in the recreational fish analyzed did not pose a possible health risk to human fish consumption (Appendix 4). Although total arsenic was not a contaminant of concern, it nevertheless provided interesting foodweb information. Total arsenic levels were high (greater than 1.0 ppm ww) in recreational fish species that were benthic feeders in winter and summer (Figures 2 and 3). It was high in flatfishes that feed on polychaetes and clam siphons (C-O sole, diamond turbot, spotted turbot) and in California corbina, which feeds on sand crabs and clams. The higher concentrations in more strictly benthic feeders suggests a sediment source of arsenic to the fish. The relationship between sediment, infaunal invertebrate, and fish contamination needs further study.

In the present survey, catches of many important recreational and forage fishes were lower in winter. This may in part be due to seasonal differences in environmental conditions in Newport Bay, such as increased freshwater input during storms and decreased salinities during the winter. It should be noted that except for some resident estuarine or coastal/estuarine species (e.g., topsmelt, California killifish, Pacific staghorn sculpin, spotted sand bass, shiner perch, arrow goby, cheekspot goby, California halibut, diamond turbot) (Table 14), most species are stenohaline marine, and hence intolerant of low salinities that may occur at times during the winter. However, the recreational fish catches may be biased due to collection method by gillnet during the day in the winter and both day and night during the summer. Summer sampling employed an opportunistic approach to get fish samples from a scientific gillnet survey of the bay conducted at night by Hubbs Sea World Research Institute. Although it is uncertain whether the croaker species, which were largely collected by gillnet at night were not in the bay during the winter, the angler survey at the start of this study indicated that anglers generally did not catch croakers in the bay during the winter. Of note, low catches of forage fishes also occurred in the winter although sampling was conducted during the day in both seasons.

The study was not designed to rigorously test relationships between contaminant concentrations in fishes and percent lipid, fish length, or season. These relationships generally were not significant, in part due to low numbers of composites per species. DDT was significantly correlated with percent lipid in diamond turbot, small California halibut, and arrow goby (Table 11). DDT was also significantly correlated with mean length of arrow goby (Table 12). However, as noted above, the implied relationship may not be meaningful due to the large number of fish per composite, the low number of fish measured, and the very small range of mean fish lengths. These relationships should be explored more thoroughly in a study designed for that purpose.

Contaminant concentrations of recreational fishes collected in this study can be compared with results of the CFCP surveys conducted in 1999. Although the CFCP is a multiyear program that assesses recreational fish contamination along the California coast (including Newport Bay), only the first two sets data are available at present: May 1999 ('Year 1') and October 1999 ('Year 2'). Species were collected in the Outer Lower Bay and Outer Upper Bay of the present study. These included California scorpionfish (*Scorpaena guttata*), shiner perch, black perch, spotted turbot, diamond turbot, and yellowfin croaker.

Although the CFCP analyzed 10 trace metals (including silver, chromium, copper, nickel, lead, and zinc)), only arsenic, cadmium, mercury, and selenium were detected. Arsenic, selenium, and mercury were detected in at least some composites of all species examined, cadmium was only detected in shiner perch. All of these species were below OEHHA screening levels for total mercury and total selenium. Similarly, all recreational fish samples analyzed in the present study were also below OEHHA screening values for trace metals.

The CFCP analyzed 41 semivolatile organic compounds but only chlordanes (cis-Chlordane, cis-Nonachlor, trans-Nonachlor, oxy-Chlordane), DDTs (o,p'-DDD; p,p'-DDD; p,p'-DDE; p,p'-DDMU), PCBs (Aroclor 1254, 1260), and methyl-parathion were detected. Of these, p,p'-DDMU and methyl-parathion were not analyzed in the present study. DDTs were found in all fish species and time periods examined, and total DDT exceeded the OEHHA SV of 100 μg/kg for all shiner perch composites, ranging from 197 to 227 μg/kg. PCBs were detected in all species except diamond turbot, with all shiner perch and yellowfin croaker, exceeding the OEHHA SV of 20 μg/kg for total PCBs. Total PCB in shiner perch ranged from 39 to 94 μg/kg and was 30 μg/kg for yellowfin croaker. In the present study, shiner perch did not have detectable levels of PCBs. Shiner perch was the most contaminated fish species in the CFCP data from Newport Bay, with all four metals and all 11 semivolatile organic compounds detected in any species also being detected in this species. Among species examined in both studies, mean concentrations of DDT were higher (except in shiner perch) in the present survey, but were lower for PCB and selenium (Appendices 15, 16, 17).

Although concentrations of DDT, PCB, and selenium in some Newport Bay fishes were above screening values for human or wildlife fish consumption in 2000-2002, these were generally lower than those found in coastal and Newport Bay fishes in the late 1970s and early 1980s (Appendices 15, 16, 17) (Mearns et al. 1991). In general, the highest concentrations have been found on the southern California coast, both in the past and present.

Concentrations of total DDT in Newport Bay fishes were much higher in the 1970s and 1980s, with adult striped mullet (*Mugil cephalus*) muscle tissue having the highest concentrations (up to 5,760 µg/kg) (Appendix 15) (Mearns *et al.* 1991). In contrast, the highest concentration in Newport Bay fish in 2001 was 490 µg/kg in California corbina. Where historical comparisons can be made for the same species, DDT concentrations in Newport Bay fishes decreased between 1978-1980 and 2000-2002. DDT concentrations decreased in topsmelt from 1,830 µg/kg (possibly muscle tissue) in 1980 to 160 µg/kg (whole body) in 2002; in spotted sand bass (muscle tissue), from 1,370 µg/kg in 1978 to 108 µg/kg in 2000/2001; in California halibut from 1,170 µg/kg in 1980 to 101 µg/kg in 2000-2001; and in yellowfin croaker from 815 µg/kg in 1980 to 132 in 2001 (Mearns *et al.* 1991; present study).

Among recreational fishes, those classified as coastal or coastal-estuarine had the highest DDT concentrations in Newport Bay. This suggests that high concentrations could be primarily or in part from coastal exposure to DDT. The widespread occurrence of DDT along the southern California coast is not unexpected due to past discharges from the manufacturer of DDT in wastewater effluents on the Palos Verdes Shelf (NOAA *et al.* 1991). Coastal studies conducted over time have demonstrated a reduction of DDT levels in fish at contaminated and reference sites during the past two to three decades although in some areas concentrations are still sufficiently high to be of concern (M. J. Allen and Cross 1994, Schiff and M. J. Allen 2000, CSDLAC 2002). Total DDT in white croaker (*Genyonemus lineatus*) muscle tissue from the Palos Verdes Shelf in 1975 was 176,400 µg/kg but was 18,336 µg/kg in 1990 (Mearns et al. 1991; M. J. Allen and Cross 1994); however, in 2002 a white croaker composite from that location had a concentration of 79,000 µg/kg (CSDLAC 2002). Muscle tissue composites of spiny dogfish (*Squalus acanthias*) from the Palos Verdes Shelf in 1980-1981 had total DDT concentrations up to 200,000 µg/kg (Mearns *et al.* 1991).

Concentrations of total PCB were also higher in the 1970s and 1980s than in 2000-2002 (Mearns et al. 1991). Historically in Newport Bay, adult striped mullet muscle tissue in 1978 had the highest concentration of total PCB (1,320 µg/kg) (Mearns et al. 1991), whereas highest muscle tissue concentration in the present study (58 µg/kg) was found in California corbina in 2001 and in whole body tissue in juvenile California halibut (136 μg/kg) in 2002 (Appendix 16). Where historical comparisons can be made for the same species in Newport Bay, spotted sand bass muscle tissue had a high concentration of 465 μg/kg in 1978 (Mearns et al. 1991) and 24 μg/kg in 2000-2001 and yellowfin croaker muscle tissue had a high concentration of 69 μg/kg in 1978 (Mearns et al. 1991) and 41 μg/kg in the 2001 (Appendix 16). Along the coast, the highest muscle tissue concentrations (14,815 μg/kg) were found in spiny dogfish on the Palos Verdes Shelf in 1981 (Mearns et al. 1991).

Historically, the highest total selenium concentration (3.29 mg/kg ww) in southern California fishes was found in northern anchovy (*Engraulis mordax*) from Huntington Beach from the early 1980s (Mearns et al. 1991). The highest concentration (1.92 mg/kg ww) from Newport Bay fishes was whole body tissue of California killifish in 2002 in the present study (Appendix 17). Where historical comparisons can be made, mean selenium concentrations decreased between earlier studies and the present study in yellowfin croaker (1978-2001) and spotted sand bass (1982-2001).

Although levels of DDTs, PCBs, and selenium in Newport Bay fishes were at levels of concern in 2000-2002, contaminant levels have decreased during the past two decades. The present study has provided some information on what species still have contaminant levels of concern and some information on the relationship of this contamination to the ecology of the species. These species or ecological groups of fishes will hopefully provide the basis for future monitoring or experimentation to better understand effects of these contaminants on the Newport Bay ecosystem.

CONCLUSIONS

1. The results of this study provide recent data on the distribution and concentrations of contamination in fishes of Newport Bay.

    a. Trace metals and semivolatile organic compounds were found in all 19 species of recreational and forage fish examined.

    b. Total arsenic, total mercury, and total selenium were detected in all fish species examined.

        1) Total cadmium (only analyzed in nine forage fish species) was only detected in Pacific staghorn sculpin and topsmelt.

        2) Inorganic arsenic was examined and detected in five recreational fish species collected in the winter.

    c. Total DDT, total PCB, and total chlordanes were the only semivolatile organic compounds detected in the fishes examined.

1) Total DDT was found in all composites of all fish species examined.

2) Total PCB and total chlordanes were not found in recreational fish species in the winter but were found in some recreational fish species in the summer and some forage fish species in both winter and summer.

2. A number of fish species were identified with contaminant concentrations above SVs for human and wildlife fish consumption.

a. Five (36%) recreational fish species (jacksmelt, spotted sand bass, California corbina, yellowfin croaker, California halibut) had mean or maximum DDT concentrations above SVs for human fish consumption and all of these except jacksmelt and California halibut had PCB concentrations above the SV.

b. Fish composites with DDT concentrations above SVs for wildlife fish consumption occurred in all samples (winter and summer) of all forage fishes examined (topsmelt, California killifish, Pacific staghorn sculpin, shiner perch, juvenile black perch, arrow goby, cheekspot goby, juvenile California halibut, and juvenile diamond turbot).

c. Fish composites with PCB congener (specifically PCB 118) concentrations above SVs for mammal fish consumption were highest in small juvenile California halibut, California killifish, topsmelt, and cheekspot goby but all fish examined were below SVs for bird fish consumption.

d. Some composites of topsmelt, California killifish, and arrow goby had selenium concentrations above SVs for wildlife fish consumption.

3. Contaminants in Newport Bay fishes that may warrant regulatory focus are total DDT (recreational and forage fishes), total PCB (recreational fishes), PCB 118, and selenium (forage fishes).

4. Species or ecological groups of fishes identified for possible future monitoring or experimentation.

a. Fishes with DDT and PCB concentrations of concern to human or wildlife fish consumption were found among benthic feeders, planktivores, and those feeding on benthic and pelagic prey.

b. Some recreational species with high DDT and/or PCBs (jacksmelt, California corbina, yellowfin croaker, and California halibut) are likely to move between the coast and Newport Bay; additional studies are needed to determine the relative contribution of DDT and PCB from the coast and from Newport Bay to tissue concentrations found in these fishes.

c. Arrow goby (a small forage fish with high DDT concentrations and that lives in burrows in the intertidal mudflats at low tide), would be a good candidate for establishing links between sediment and fish concentrations of DDT.

d. Forage fishes with elevated levels of PCB 118 (topsmelt, California killifish, cheekspot goby, and juvenile California halibut) occurred primarily in the inner lower bay; PCB 118 was elevated in Newport Channel near Rhine Channel area sediments in the inner lower bay and in sediments in the Turning Basin.

e. Forage fishes with high levels of selenium (juvenile topsmelt, California killifish, and arrow goby) live and feed in the intertidal area near the tidal prism area of the inner upper bay (the ecological reserve), where selenium enters the bay from San Diego Creek.

f. Although inorganic arsenic levels did not pose a potential concern for human fish consumption, total arsenic levels showed interesting foodweb patterns, with highest concentrations found in benthic feeders that feed on polychaetes and/or bivalves (spotted turbot, C-O sole, diamond turbot, California corbina).

g. Further studies on forage fishes are needed to better understand the flow of these contaminants through the Newport Bay food web to piscivorous bird and mammal species of concern in the bay.

5. Although contaminant concentrations in some fishes in 2000-2002 were above screening values for human or wildlife fish consumption, concentrations were generally lower (and often much lower) than concentrations found in fishes in Newport Bay and along the southern California coast in the late 1970s and early 1980s.

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APPENDICES

Appendix 1. Presurvey interviews of tackle shops and persons familiar with fishing in Newport Bay, California for information on fishing locations and species caught (interviews conducted from June to November, 2000).

	Fish Species		
Source	Common Name	Scientific Name	Location & Method
Angler Center 419 Old Newport Blvd. Newport Beach, CA 949/642-6662 Ed? Avial? (angler)	kelp bass spotted sand bass California halibut croakers	*Paralabrax clathratus* *Paralabrax maculatofasciatus* *Paralichthys californicus* Sciaenidae	
Fisherman's Hardware 16942 Gothard St. Huntington Beach, CA 714/841-6878	California halibut white sea bass (small) barred sand bass spotted sand bass	*Paralichthys californicus* *Atractoscion nobilis* *Paralabrax nebulifer* *Paralabrax maculatofasciatus*	Mooring area, middle channel by barge/ Bait on bottom
Bob Marriott's Fly Fishing 2700 W. Orangethorpe Ave. Fullerton, CA 714/525-1827	kelp bass California halibut (deep) barred surfperch chub mackerel (maybe)	*Paralabrax clathratus* *Paralichthys californicus* *Amphistichus argenteus* *Scomber japonicus*	Float tub, back channels
Mike Scott's Fly Shop 1892 N. Tustin St. Orange, CA 714/998-9400	spotted sand bass	*Paralabrax maculatofasciatus*	Closser flies, olive & white or lime & white
Grant Boys 1750 Newport Blvd. Costa Mesa, CA 949/645-3400	barred sand bass spotted sand bass jacksmelt bat ray shovelnose guitarfish leopard shark surfperches California halibut	*Paralabrax nebulifer* *Paralabrax maculatofasciatus* *Atherinopsis californiensis* *Myliobatis californica* *Rhinobatos productus* *Triakis semifasciata* Embiotocidae *Paralichthys californicus*	Structures (basses) Sandy areas (halibut) Live bait near bottom bottom for basses and halibut
Glenn's Tackle Shop 1145 Baker St. Costa Mesa, CA 714/957-1408 Bob (fishes bay)	barred sand bass California halibut bat ray	*Paralabrax nebulifer* *Paralichthys californicus* *Myliobatis californica*	Mouth of harbor, third of way on either side

Appendix 1(continued)

Source	Fish Species: Common Name	Fish Species: Scientific Name	Location & Method
His and Her Fly Fishing Store	78 species		Bait barge (=BB)
1566 Newport Blvd.	croakers –BB	Sciaenidae	Bridge/Ruben Lee
Costa Mesa, CA	California halibut -BB,BL	*Paralichthys californicus*	(=BL)
949/548-9449	spotted sand bass -BB	*Paralabrax maculatofasciatus*	Old Cannery 18th St.
	barred sand bass -BB,OC	*Paralabrax nebulifer*	(=OC)
	kelp bass –OC	*Paralabrax clathratus*	Yellow & white or
	yellowfin croaker -OC	*Umbrina roncador*	purple flies
MBC Applied Environmental Sciences	sargo	*Anisotremus davidsonii*	bait barge, outer bay
3000 Redhill Ave.	barred sand bass	*Paralabrax nebulifer*	jetties, private boats
Costa Mesa, CA	spotted sand bass	*Paralabrax maculatofasciatus*	from jetties to PCH
714/850-4830	jacksmelt	*Atherinopsis californiensis*	Pavilion dock, sandy
Mike Curtis, Bob Moore	California halibut	*Paralichthys californicus*	beaches, docks
	diamond turbot	*Hypsopsetta guttulata*	
	bat ray	*Myliobatis californica*	
Southern California Coastal Water Research Project	yellowfin croaker	*Umbrina roncador*	
7171 Fenwick Lane	spotfin croaker	*Roncador stearnsii*	
Westminster, CA	sea basses	Serranidae	
714/894-2222	rays	Rajiformes	
Dave Tsukada (angler)	striped bass	*Morone saxatilis*	
	striped mullet	*Mugil cephalus*	

Appendix 2. Duplicate semivolatile organic compound results found in muscle tissue of fishes collected in Newport Bay, California in winter (2000/2001) and summer (June-July) 2001 analyzed as splits by Southern California Coastal Water Research Project (SCCWRP) in 2000-2001 and Columbia Analytical Services (CAS) in 2003.

						Mean		Concentration (µg/kg)									Relative %	
Sam.			Composite			SL	Wt.	Total	Total	Total		Chloro-	Diaz-	Diel-		Lipid	Difference	
No.	Fish Species	Loc.	ID	NF/C	Gen.	(mm)	(g)	PCB	DDT	Chlor.	Aldrin	pyrifos	non	drin	Endrin	(%)	DDT	Chlor.
3s	jacksmelt	OU	S3	6	B	302	352	ND	232	8.1	ND	ND	ND	ND	ND	1.33		
3c	jacksmelt	OU	S3					NA	122	8.7	ND	ND	ND	ND	ND	1.17		
																	62	7
5s	yellowfin croaker	OL	S1	4	M	242	308	11.0	128	5.9	ND	ND	ND	ND	ND	2.89		
5sD	yellowfin croaker	OL	S1					11.7	137	5.6	ND	ND	ND	ND	ND			
5c	yellowfin croaker	OL	S1	4	M	242	308	NA	109	9.6	ND	ND	ND	ND	ND	2.01		
																	19	56
16	spotted sand bass	OL	S3	3	M	277	457	24.2	108	5.3	ND	ND	ND	ND	ND	0.75		
16c	spotted sand bass	OL	S3					NA	95	6.4	ND	ND	ND	ND	ND	0.63		
																	13	20
18s	California corbina	OL	S2	3	B	324	597	65.9	490	19.9	ND	ND	ND	ND	ND	4.94		
18c	California corbina	OL	S2					NA	227	22.7	ND	ND	ND	ND	ND	4.25		
																	73	13
10s	California halibut	OL	W2	4	B	374	1058	ND	104	ND	ND	ND	ND	ND	ND	0.43		
10sD	California halibut	OL	W2					ND	98	ND	ND	ND	ND	ND	ND			
10c	California halibut	OL	W2					ND	47	ND	ND	ND	ND	ND	ND	0.08		
																	64	0

Sam. No. = sample number; SL = standard length; Wt. = weight; Loc. = location; SL = standard length; Wt. = weight; Chlor. = Chlordanes
OL = Outer Lower Bay; OU = Outer Upper Bay; ND = not detected;
Total PCB = sum of following congeners:
PCB 18, 28, 52, 49, 44, 37, 74, 70, 66, 101, 99, 119, 87, 110, 81, 151, 77, 149, 123, 118, 114, 153, 168, 105, 138, 158, 187, 126, 128, 167, 177, 200, 156, 157, 180, 170, 201, 169, 189, 194, and 206. Total DDTs are the sum of o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, trans-Monachlor, and cis-Nonachlor. Minimum dection limits were 5 µg/kg.
Relative % difference = ((SCCWRP value-CAS value)/mean(SCCWRP value, CAS value))*100
Where SCCWRP duplicates exist, duplicate values were averaged and treated as 'SCCWRP value'.
ID = composite identification number; NF/C = number of fish per composite; Gen. = gender
Boxes enclose values above OEHHA screening values for human fish consumption: 20 µg/kg ww total PCB; 100 µg/kg ww for DDT (Brodberg and Pollock 1999).
Note: Samples analyzed by CAS exceeded recommended holding time limit for SOC.

Appendix 3. Taxonomic list of fish species collected in Newport Bay, California by hook-and-line, otter trawl, gillnet, and seine in Newport Bay, California from November 2000 to September 2002.

TAXON/SPECIES	AUTHOR	COMMON NAME
ELASMOBRANCHII		ELASMOBRANCHS
Heterodontidae		
Heterodontus francisci	(Girard 1855)	horn shark
Triakidae		
Mustelus californicus	Gill 1864	gray smoothhound
Mustelus henlei	(Gill 1863)	brown smoothhound
Triakis semifasciata	Girard 1855	leopard shark
Myliobatidae		
Myliobatis californica	Gill 1865	bat ray
Urolophidae		
Urobatis (=*Urolophus*) *halleri*	(Cooper 1863)	round stingray
ACTINOPTERYGII		RAY-FINNED FISHES
Engraulidae		
Anchoa compressa	(Girard 1858)	deepbody anchovy
Salmonidae		
Oncorhynchus mykiss	(Walbaum 1792)	rainbow trout (= steelhead)
Synodontidae		
Synodus lucioceps	(Ayres 1855)	California lizardfish
Batrachoididae		
Porichthys myriaster	Hubbs & Schultz 1939	specklefin midshipman
Atherinidae		
Atherinops affinis	(Ayres 1860)	topsmelt
Atherinopsis californiensis	Girard 1854	jacksmelt
Fundulidae		
Fundulus parvipinnis	Girard 1854	California killifish
Belonidae		
Strongylura exilis	(Girard 1854)	California needlefish
Syngnathidae		
Syngnathus auliscus	(Swain 1882)	barred pipefish
Syngnathus californiensis	Storer 1845	kelp pipefish
Syngnathus exilis	(Osburn & Nichols 1916)	barcheek pipefish
Syngnathus leptorhynchus	Girard 1854	bay pipefish
Scorpaenidae		
Scorpaena guttata	Girard 1854	California scorpionfish
Cottidae		
Leptocottus armatus	Girard 1854	Pacific staghorn sculpin
Polyprionidae		
Stereolepis gigas	Ayres 1859	giant sea bass
Serranidae		
Paralabrax clathratus	(Girard 1854)	kelp bass
Paralabrax maculatofasciatus	(Steindachner 1868)	spotted sand bass
Paralabrax nebulifer	(Girard 1854)	barred sand bass

Appendix 3 (continued)

TAXON/SPECIES	AUTHOR	COMMON NAME
Haemulidae		
Anisotremus davidsonii	(Steindachner 1876)	sargo
Xenistius californiensis	(Steindachner 1876)	salema
Sciaenidae		
Atractoscion nobilis	(Ayres 1860)	white seabass
Cheilotrema saturnum	(Girard 1858)	black croaker
Menticirrhus undulatus	(Girard 1854)	California corbina
Roncador stearnsii	(Steindachner 1876)	spotfin croaker
Seriphus politus	Ayres 1860	queenfish
Umbrina roncador	Jordan & Gilbert 1882	yellowfin croaker
Kyphosidae		
Girella nigricans	(Ayres 1860)	opaleye
Hermosilla azurea	Jenkins & Evermann 1889	zebra perch
Mugilidae		
Mugil cephalus	Linnaeus 1758	striped mullet
Embiotocidae		
Cymatogaster aggregata	Gibbons 1854	shiner perch
Embiotoca jacksoni	Agassiz 1853	black perch
Micrometrus minimus	(Gibbons 1854)	dwarf perch
Phanerodon furcatus	Girard 1854	white seaperch
Labridae		
Halichoeres semicinctus	(Ayres 1859)	rock wrasse
Oxyjulis californica	(Gunther 1861)	señorita
Clinidae		
Gibbonsia elegans (=evides)	(Cooper 1864)	spotted kelpfish
Heterostichus rostratus	Girard 1854	giant kelpfish
Blenniidae		
Hypsoblennius gentilis	(Girard 1854)	bay blenny
Gobiidae		
Acanthogobius flavimanus	(Temminck & Schlegel 1845)	yellowfin goby
Clevelandia ios	(Jordan & Gilbert 1882)	arrow goby
Gillichthys mirabilis	Cooper 1864	longjaw mudsucker
Ilypnus gilberti	(Eigenmann & Eigenmann 1889)	cheekspot goby
Quietula y-cauda	(Jenkins & Evermann 1889)	shadow goby
Sphyraenidae		
Sphyraena argentea	Girard 1854	Pacific barracuda
Paralichthyidae		
Citharichthys stigmaeus	Jordan & Gilbert 1882	speckled sanddab
Paralichthys californicus	(Ayres 1859)	California halibut
Xystreurys liolepis	Jordan & Gilbert 1880	fantail sole
Pleuronectidae		
Hypsopsetta guttulata (=*Pleuronicthys guttulatus*)	Girard 1856	diamond turbot
Pleuronichthys coenosus	Girard 1854	C-O sole
Pleuronichthys ritteri	Starks & Morris 1907	spotted turbot
Pleuronichthys verticalis	Jordan & Gilbert 1880	hornyhead turbot

Appendix 3 (continued)

TAXON/SPECIES	AUTHOR	COMMON NAME
Cynoglossidae		
Symphurus atricaudus (=*atricauda*)	(Jordan & Gilbert 1880)	California tonguefish

Includes additional species collected during study but not used for tissue analysis.

Taxonomic arrangement and scientific names, except where noted, from Eschmeyer (1998) and on-line updates at http://www.calacademy.org/research/ichthyology/catalog/fishcatsearch.html. Names current as of 18 June, 2004.

Common names from Robins *et al*. (1991)

[redacted]

Appendix 4. Selected trace metals found in muscle tissue from fishes collected in Newport Bay, California in winter (November-January) 2000-2001, with quality control (QC) duplicates and matrix spike sample recovery results.

Sample Number	Fish Species	Newport Bay Location	Composite ID	Composite NF/C	Gen.	Mean SL(mm)	Mean Wt(g)	Total Solids (% ww)	Concentration(mg/kg) Total Arsenic	Total Mercury	Total Selenium
1	barred sand bass	Outer Lower	1	3	F	250	390	21.3	0.65	0.057	0.18
2	black perch	Outer Upper	1	3	F	117	73	21.2	0.53	0.024	0.17
3	black perch	Outer Lower	1	3	F	169	193	21.2	0.96	0.038	0.08
4	black perch	Outer Lower	2	3	F	145	132	20.4	0.86	0.033	0.09
5	black perch	Outer Lower	3	4	B	113	64	20.1	0.69	0.031	0.10
6	California halibut	Outer Upper	1	4	B	322	604	21.9	0.58	0.035	0.26
7	California halibut	Outer Upper	2	4	B	153	63	21.6	0.85	0.026	0.02
8	California halibut	Outer Upper	3	4	B	230	213	22.8	0.47	0.022	0.38
9	California halibut	Outer Lower	1	4	B	152	64	20.7	0.91	0.031	0.25
10	California halibut	Outer Lower	2	4	B	374	1058	21.4	0.41	0.075	0.27
11	C-O sole	Outer Lower	1	4	F	191	206	20.3	5.74	0.059	0.11
12	C-O sole	Outer Lower	2	4	B	188	206	21.0	5.01	0.026	0.12
13	diamond turbot	Outer Upper	1	6	B	158	108	20.7	1.82	0.009	0.31
14	diamond turbot	Outer Upper	2	6	B	193	220	23.2	3.89	0.018	0.31
15	diamond turbot	Outer Upper	3	6	B	175	152	22.0	2.85	0.010	0.36
16	diamond turbot	Outer Lower	1	6	B	175	157	22.4	4.20	0.023	0.38
17	diamond turbot	Outer Lower	2	6	B	207	280	23.1	3.45	0.051	0.18
18	fantail sole	Outer Lower	1	5	B	206	214	19.8	0.97	0.046	0.14
19	shiner perch	Outer Upper	1	8	B	80	15	21.0	0.67	0.023	0.13
20	spotted sand bass	Outer Lower	1	3	F	271	511	22.0	0.47	0.090	0.27
21	spotted sand bass	Outer Upper	1	3	F	259	456	21.9	0.63	0.077	0.21
22	spotted turbot	Outer Upper	1	4	F	180	175	21.0	3.92	0.021	0.25
23	spotted turbot	Outer Lower	1	4	B	177	159	20.9	7.28	0.053	0.19
24	spotted turbot	Outer Lower	2	4	B	162	129	21.4	8.57	0.030	0.14
25	spotted turbot	Outer Lower	3	4	B	177	162	20.8	5.53	0.049	0.13
	QC Duplicates										
1D	barred sand bass	Outer Lower	1					20.3	0.64	--	--
6D	California halibut	Outer Upper	1					--	--	0.037	0.26
10D	California halibut	Outer Lower	2					21.4	0.43	--	--
20D	spotted sand bass	Outer Upper	1					--	--	0.079	--
21D	spotted sand bass	Outer Lower	1					--	--	--	0.23
	QC Spike Sample Recovery								QC Limits (% Recovery) (70 - 130)	(60 - 130)	(60 - 130)
1S	barred sand bass	Outer Lower	1					--	106	--	--
6S	California halibut	Outer Upper	1					--	--	73	90
10S	California halibut	Outer Lower	2					--	123	--	--
20S	spotted sand bass	Outer Upper	1					--	--	--	100
21S	spotted sand bass	Outer Lower	1					--	--	76	--

Gen. = gender; B = both male and female; F = female; M = male; SL = standard length; Wt. = weight.
Sample numbers 1 - 19 had target reporting limits of 0.02, 0.002, 0.01 for arsenic, mercury, and selenium.
Sample numbers 20 - 25 had target reporting limits of 0.02, 0.005, 0.01 for arsenic, mercury, and selenium.
QC limits are the expected ranges that should be met by spike sample recoveries.
ID = composite identification number; NF/C = number of fish per composite

Appendix 5. Selected trace metals found in muscle tissue from fishes collected at Newport Bay, California in summer (June-July) 2001, with quality control (QC) duplicates and matrix spike sample recovery results.

Sample Number	Fish Species	Newport Bay Location	Composite ID	Composite NF/C	Gen.	Mean SL(mm)	Mean Wt.(g)	Total Solids (% ww)	Concentration (mg/kg) Total Arsenic	Total Mercury	Total Selenium
1	jacksmelt	Outer Upper	1	6	B	290	289	25.5	0.51	0.118	0.18
2	jacksmelt	Outer Upper	2	6	B	299	313	26.4	0.63	0.103	0.15
3	jacksmelt	Outer Upper	3	6	B	302	352	25.1	0.58	0.136	0.18
4	kelp bass	Outer Lower	1	5	B	105	28	19.8	0.49	0.019	0.16
5	yellowfin croaker	Inner Lower	1	4	B	226	253	19.8	0.49	0.073	0.14
6	yellowfin croaker	Inner Lower	2	4	B	243	352	22.3	0.34	0.114	0.24
7	yellowfin croaker	Outer Lower	1	4	M	242	308	23.3	0.36	0.069	0.16
8	yellowfin croaker	Outer Lower	2	4	M	244	342	20.9	0.27	0.238	0.17
9	yellowfin croaker	Outer Lower	3	4	B	274	430	21.9	0.47	0.107	0.22
10	black perch	Outer Lower	1	3	B	125	84	17.9	0.50	0.028	0.11
11	black perch	Outer Lower	2	3	B	146	144	18.9	0.40	0.035	0.11
12	black perch	Outer Lower	3	3	B	182	236	18.5	0.58	0.042	0.13
13	barred sand bass	Outer Lower	1	3	B	225	297	20.2	0.44	0.100	0.17
14	spotted sand bass	Outer Lower	1	3	B	244	430	20.5	0.22	0.100	0.21
15	spotted sand bass	Outer Lower	2	3	M	284	742	21.0	0.24	0.127	0.30
16	spotted sand bass	Outer Lower	3	3	M	277	457	20.1	0.25	0.165	0.22
17	California corbina	Outer Lower	1	3	B	288	406	24.9	1.24	0.056	0.11
18	California corbina	Outer Lower	2	3	B	324	597	23.6	1.15	0.062	0.11
19	California corbina	Outer Lower	3	3	F	386	1002	24.5	1.57	0.077	0.14
20	diamond turbot	Outer Upper	1	6	B	177	163	22.3	2.52	0.025	0.64
21	diamond turbot	Outer Upper	2	6	B	195	237	22.3	2.89	0.035	0.58
22	diamond turbot	Outer Lower	1	6	B	187	212	21.3	2.12	0.036	0.35
23	spotfin croaker	Outer Lower	1	6	B	264	405	22.0	0.68	0.030	0.23
24	spotfin croaker	Outer Lower	2	6	F	288	597	23.4	0.93	0.027	0.36
25	California halibut	Outer Lower	1	4	B	183	111	19.1	0.52	0.029	0.18
	Quality Control (QC) Duplicates										
1D	jacksmelt	Outer Upper	1					25.3	0.52	--	0.18
5D	yellowfin croaker	Outer Lower	1					--	--	0.070	--
19D	California corbina	Outer Lower	3					25.9	1.59	0.066	0.14
	QC Spike Sample Recovery								QC Limits (% Recovery) (70 - 130)	(60 - 130)	(60 - 130)
1S	jacksmelt	Outer Upper	1					--	88	--	82
5S	yellowfin croaker	Outer Lower	1					--	--	106	--
19S	California corbina	Outer Lower	3					--	77	101	74

Gen. = gender; B = both; F = female; M = male; SL= standard length; Wt. = weight

Sample numbers 1-3,5,17-19,24 had total arsenic target reporting limits of 0.05, all others had 0.04 reporting limits.

Sample numbers 9,16 had total mercury target reporting limits of 0.004, sample number 3 had a reporting limit of 0.003, all others had 0.002 reporting limits. Sample numbers 1-25 had total selenium target reporting limits of 0.01.

Mg/kg is equivelent to ppm (parts per million).; ww = wet weight

Methods:Freeze dry for tissue solids; PSEP 6020 for arsenic; METHOD 7471A for mercury; METHOD 7472 for selenium.

Dilution factors for samples ranged from 5 for all arsenic samples, 1or 2 for mercury, and 2 for selenium.

All method blanks had non detectable results. All laboratory control spiked samples were within expected recoveries.

ID = composite identification number; NF/C = number of fish per composite

Appendix 6. Arsenic speciation concentrations found in recreational fish muscle tissue from fishes collected in Newport Bay, California in winter (November-January) 2000-2001, with quality control (QC) duplicates and matrix spike recovery results (data from P. Kozelka, USEPA, Region IX; 03/23/04).

Sam. No.	Fish Species	Newport Bay Location	Composite ID	Composite NF/C	Gen.	Mean SL(mm)	Mean Wt(g)	Total Solids (% ww)	Total Arsenic Dry Wt. (mg/kg)	Total Arsenic Wet Wt. (mg/kg)	Inorganic Arsenic Dry Wt. (mg/kg)	Inorganic Arsenic Wet Wt. (mg/kg)	Inorganic Arsenic % Total Arsenic
3	black perch	Outer Lower	1	3	F	169	193	0.210	3.164	0.665	0.019	0.004	0.60
6	California halibut	Outer Upper	1	4	B	322	604	0.238	3.276	0.778	0.013	0.003	0.39
10	California halibut	Outer Lower	2	4	B	374	1058	0.226	1.883	0.426	0.013	0.003	0.70
11	C-O sole	Outer Lower	1	4	F	191	206	0.218	30.766	6.710	0.046	0.010	0.15
12	C-O sole	Outer Lower	2	4	B	188	206	0.221	31.369	6.920	0.023	0.005	0.07
15	diamond turbot	Outer Upper	3	6	B	175	152	0.240	5.461	1.310	0.021	0.005	0.38
17	diamond turbot	Outer Lower	2	6	B	207	280	0.243	10.814	2.630	0.012	0.003	0.11
20	spotted sand bass	Outer Upper	1	3	F	271	511	0.232	2.110	0.489	0.026	0.006	1.23
21	spotted sand bass	Outer Lower	1	3	F	259	456	0.217	2.871	0.623	0.014	0.003	0.48
23	spotted turbot	Outer Lower	1	4	B	177	159	0.210	28.952	6.080	0.095	0.020	0.33

	QC Samples		Analysis	% Recovery
	DORM-2	SRM	As-total	98.4
	LCS (corn oil)	SRM	As-inorg.	98.6

	QC Spike Sample Recovery		ID	Analysis	Mean % Recovery
6S	California halibut	Outer Upper	1	As-total	112
23S	spotted turbot	Outer Lower	1	As-inorg.	74

Minimum detection limits = 0.015 mg/kg ww As-total; 0.005 mg/kg ww As-inorganic
QC control limits are expected ranges which spike sample recoveries should meet.
% R = average percent recovery (expected range 70-130%)
Sam. No. = sample number here corresponds to sample number in Appendix 3.
QC limits are the expected ranges that should be met by spike sample recoveries.
ID = composite identification number; NF/C = number of fish per composite; SL = standard length; Wt. = weight
Gen. = gender; B = both; F = female; M = male
SRM = Standard Reference Material

Appendix 7. Semivolatile organic compounds found in muscle tissue of fishes collected from Newport Bay California, in winter (November-January) 2000-2001, with quality control (QC) duplicates and spike sample recovery results.

Sam. No.	Fish Species	Loc.	Composite ID	Composite NF/C	Gen.	Mean SL(mm)	Mean Wt(g)	Total PCB	Total DDT	Total Chlor.	Aldrin	Chloro-pyrifos	Diaz-non	Diel-drin	Endrin	Lipid (%)
								Concentration (µg/kg)								
1	barred sand bass	OL	1	3	F	250	390	ND	66	ND	ND	ND	ND	ND	ND	0.75
2	black perch	OU	1	3	F	117	73	ND	29	ND	ND	ND	ND	ND	ND	0.83
3	black perch	OL	1	3	F	169	193	ND	42	ND	ND	ND	ND	ND	ND	0.77
4	black perch	OL	2	3	F	145	132	ND	41	ND	ND	ND	ND	ND	ND	0.63
5	black perch	OL	3	4	B	113	64	ND	61	ND	ND	ND	ND	ND	ND	0.76
6	California halibut	OU	1	4	B	322	604	ND	41	ND	ND	ND	ND	ND	ND	0.39
7	California halibut	OU	2	4	B	153	63	ND	66	ND	ND	ND	ND	ND	ND	0.61
8	California halibut	OU	3	4	B	230	213	ND	68	ND	ND	ND	ND	ND	ND	0.55
9	California halibut	OL	1	4	B	152	64	ND	67	ND	ND	ND	ND	ND	ND	0.51
10	California halibut	OL	2	4	B	374	1058	ND	104	ND	ND	ND	ND	ND	ND	0.43
11	C-O sole	OL	1	4	F	191	206	ND	30	ND	ND	ND	ND	ND	ND	0.53
12	C-O sole	OL	2	4	B	188	206	ND	38	ND	ND	ND	ND	ND	ND	0.46
13	diamond turbot	OU	1	6	B	158	108	ND	30	ND	ND	ND	ND	ND	ND	0.40
14	diamond turbot	OU	2	6	B	193	220	ND	66	ND	ND	ND	ND	ND	ND	0.86
15	diamond turbot	OU	3	6	B	175	152	ND	22	ND	ND	ND	ND	ND	ND	0.41
16	diamond turbot	OL	1	6	B	175	157	ND	44	ND	ND	ND	ND	ND	ND	0.56
17	diamond turbot	OL	2	6	B	207	280	ND	29	ND	ND	ND	ND	ND	ND	0.63
18	fantail sole	OL	1	5	B	206	214	ND	36	ND	ND	ND	ND	ND	ND	0.39
19	shiner perch	OU	1	8	B	80	15	ND	40	ND	ND	ND	ND	ND	ND	0.46
20	spotted sand bass	OU	1	3	F	259	456	ND	82	ND	ND	ND	ND	ND	ND	0.90
21	spotted sand bass	OL	1	3	F	271	511	ND	15	ND	ND	ND	ND	ND	ND	0.52
22	spotted turbot	OU	1	4	F	180	175	ND	39	ND	ND	ND	ND	ND	ND	0.59
23	spotted turbot	OL	1	4	B	177	159	ND	41	ND	ND	ND	ND	ND	ND	0.60
24	spotted turbot	OL	2	4	B	162	129	ND	57	ND	ND	ND	ND	ND	ND	0.55
25	spotted turbot	OL	3	4	B	177	162	ND	23	ND	ND	ND	ND	ND	ND	0.48
	QC Duplicates															
10D	California halibut	OL	2					ND	98	ND	ND	ND	ND	ND	ND	
12D	C-O sole	OL	2					ND	39	ND	ND	ND	ND	ND	ND	
14D	diamond turbot	OU	2					ND	57	ND	ND	ND	ND	ND	ND	
	QC Mean Spike Recovery							QC Percent Recovery Range Limits (70-130%)								
10S	California halibut	OL	2					108	113	114	115	618	205	113	123	
12S	C-O sole	OL	2					95	104	93	73	121	129	167	97	
14S	diamond turbot	OU	2					100	104	104	79	94	129	124	104	

Sam. No. = sample number; SL = standard length; Chlor. = chlordane; ND = not detected; Wt. = weight

Gen. = gender; B = both; F = female; M = male; Box encloses value above OEHHA screening value for human fish consumption.

OL = Outer Lower Bay (i.e., Newport Bay entrance); OU = Outer Upper Bay (i.e., lower part of back bay).

Loc means Location. Comp no. means composite number. Total PCBs are the sum of PCB congeners 18, 28, 52, 49, 44, 37, 74, 70, 66, 101, 99, 119, 87, 110, 81, 151, 77, 149, 123, 118, 114, 153, 168, 105, 138, 158, 187, 126, 128, 167, 177, 200, 156, 157, 180, 170, 201, 169, 189, 194, and 206. Total DDTs are the sum of o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, and p,p'-DDE. 100% of the total DDT value was represented p,p'-DDE. Chlordane class are the sum of chlordene, oxichlordane, gamma-chlordane, alpha-chlordane, trans-chlordane, trans-nonachlor, and cis-nonachlor. Minimum detection limits were 5 µg/kg.

QC control limit is the expected range for spike sample recoveries. % R = percent recovery; underlined values outside limit.

ID = composite identification number; NF/C = number of fish per composite

Appendix 8. Semivolatile organic compounds found in muscle tissue of fishes collected in Newport Bay, California in summer (June-July) 2001, with quality control (QC) duplicates and spike sample recovery results.

Sam No.	Fish Species	Loc.	Composite ID	Composite NF/C	Gen.	Mean SL(mm)	Mean Wt.(g)	Concentration (µg/kg) Total PCB	Total DDT	Total Chlor.	Aldrin	Chloro-pyrifos	Diaz-non	Diel-drin	Endrin	Lipid (%)
1	jacksmelt	OU	1	6	B	290	289	ND	52	ND	ND	ND	ND	ND	ND	1.13
2	jacksmelt	OU	2	6	B	299	313	9.9	132	ND	ND	ND	ND	ND	ND	1.45
3	jacksmelt	OU	3	6	B	302	352	ND	232	8.1	ND	ND	ND	ND	ND	1.33
4	kelp bass	OL	1	5	B	105	28	ND	19	ND	ND	ND	ND	ND	ND	0.69
5	yellowfin croaker	IL	1	4	B	226	253	ND	47	ND	ND	ND	ND	ND	ND	0.80
6	yellowfin croaker	IL	2	4	B	243	352	41.2	130	ND	ND	ND	ND	ND	ND	1.37
7	yellowfin croaker	OL	1	4	M	242	308	11.0	128	5.9	ND	ND	ND	ND	ND	2.89
8	yellowfin croaker	OL	2	4	M	244	342	8.1	113	ND	ND	ND	ND	ND	ND	1.52
9	yellowfin croaker	OL	3	4	B	274	430	ND	89	5.5	ND	ND	ND	ND	ND	1.92
10	black perch	OL	1	3	B	125	84	ND	30	ND	ND	ND	ND	ND	ND	0.56
11	black perch	OL	2	3	B	146	144	ND	36	ND	ND	ND	ND	ND	ND	0.77
12	black perch	OL	3	3	B	182	236	ND	42	ND	ND	ND	ND	ND	ND	0.63
13	barred sand bass	OL	1	3	B	225	297	ND	45	ND	ND	ND	ND	ND	ND	1.33
14	spotted sand bass	OL	1	3	B	244	430	ND	45	ND	ND	ND	ND	ND	ND	0.66
15	spotted sand bass	OL	2	3	M	284	742	10.4	92	5.4	ND	ND	ND	ND	ND	1.07
16	spotted sand bass	OL	3	3	M	277	457	24.2	108	5.3	ND	ND	ND	ND	ND	0.75
17	California corbina	OL	1	3	B	288	406	ND	333	18.8	ND	ND	ND	ND	ND	4.48
18	California corbina	OL	2	3	B	324	597	57.8	490	19.9	ND	ND	ND	ND	ND	4.94
19	California corbina	OL	3	3	F	386	1002	4.4	259	9.4	ND	ND	ND	ND	ND	4.38
20	diamond turbot	OU	1	6	B	177	163	ND	34	ND	ND	ND	ND	ND	ND	0.47
21	diamond turbot	OU	2	6	B	195	237	ND	43	ND	ND	ND	ND	ND	ND	0.68
22	diamond turbot	OL	1	6	B	187	212	ND	25	ND	ND	ND	ND	ND	ND	0.63
23	spotfin croaker	OL	1	6	B	264	405	ND	38	ND	ND	ND	ND	ND	ND	0.97
24	spotfin croaker	OL	2	6	F	288	597	ND	98	6.4	ND	ND	ND	ND	ND	2.50
25	California halibut	OL	1	4	B	183	111	ND	71	ND	ND	ND	ND	ND	ND	0.58
	QC Duplicates															
5D	yellowfin croaker	OL	1					11.7	137	5.6	ND	ND	ND	ND	ND	
20D	diamond turbot	OU	1					ND	37	ND	ND	ND	ND	ND	ND	
21D	diamond turbot	OU	2					ND	38	ND	ND	ND	ND	ND	ND	
	QC Mean Spike Recovery							QC Percent Recovery Range Limits (70-130%)								
5S	yellowfin croaker	OL	1					106	106	103	102	116	113	112	97	
20S	diamond turbot	OU	1					99	102	102	103	116	109	108	96	
21S	diamond turbot	OU	2					100	100	99	96	109	100	109	98	

Sam. No. = sample number; SL = standard length; Wt. = weight

OL = Outer Lower Bay (i.e., Newport Bay entrance); IL = Inner Lower Bay (i.e., back part of lower bay); OU = Outer Upper Bay (i.e., 'lower part of back bay). Loc means Location. Comp # means composite number. Total PCBs are the sum of PCB numbers 18, 28, 52, 49, 44, 37, 74, 70, 66, 101, 99, 119, 87, 110, 81, 151, 77, 149, 123, 118, 114, 153, 168, 105, 138, 158, 187, 126, 128, 167, 177, 200, 156, 157, 180, 170, 201, 169, 189, 194, and 206. Total DDTs are the sum of o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, trans-Monachlor, and cis-Nonachlor. Minimum dection limits were 5 µg/kg. QC control limits are expected ranges which spike 'sample recoveries should meet. % R means percent recovery.

ID = composite identification number; NF/C = number of fish per composite

Boxes enclose values above OEHHA screening values for human fish consumption: 20 µg/kg ww total PCB; 100 µg/kg ww for DDT (Brodberg and Pollock 1999).

Appendix 9. Concentrations of PCB congeners found in muscle tissue of recreational fish species collected in Newport Bay, California in summer (June-July) 2001. Note: PCB congeners were not detected in muscle tissue of recreational fish species caught there during winter (November-January) 2000-2001.

PCB Congener	Concentration (µg/kg) black perch Outer Lower Bay			BSBass OL	California corbina Outer Lower Bay			CHalibut OL	spotfin croaker Outer Lower		diamond turbot Outer Upper	
PCB18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB37	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB66	nd	nd	nd	nd	nd	6.8	nd	nd	nd	nd	nd	nd
PCB70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB77	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB81	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB87	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB99	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB101	nd	nd	nd	nd	nd	10.1	nd	nd	nd	nd	nd	nd
PCB105	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB110	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB114	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB118	**nd**	**nd**	**nd**	**nd**	**nd**	**14.1**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB119	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB123	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB126	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB138	nd	nd	nd	nd	nd	17.0	nd	nd	nd	nd	nd	nd
PCB149	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB153/168	nd	nd	nd	nd	nd	9.8	4.4	nd	nd	nd	nd	nd
PCB156	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB157	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB158	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB167	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB169	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB170	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB180	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB187	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB189	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB194	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCBs	0.0	0.0	0.0	0.0	0.0	57.8	4.4	0.0	0.0	0.0	0.0	0.0

BSBass = barred sand bass; CHalibut = California halibut; OL = outer lower bay; Outer Upper = outer upper bay;
Detection limit = 5 µg/kg; nd = not detected; Congeners in bold and underlined are toxic to birds and mammals (see Van den Berg *et al.* (1998).

Appendix 9 (continued).

PCB Congener	Concentration (µg/kg) DTurbot OL	jacksmelt Outer Upper			KBass OL	spotted sandbass Outer Lower			yellowfin croaker Outer Lower				
PCB18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB37	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB66	nd	nd	nd	nd	nd	nd	nd	nd	6.4	nd	nd	8.1	nd
PCB70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB77	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB81	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB87	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB99	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB101	nd	nd	9.9	nd	nd	nd	nd	nd	11.0	nd	nd	nd	nd
PCB105	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB110	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB114	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB118	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**7.3**	**nd**	**11.7**	**nd**	**nd**	**nd**	**5.7**
PCB119	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB123	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB126	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB138	nd	nd	nd	nd	nd	6.1	11.5	nd	nd	nd	nd	nd	5.7
PCB149	nd	nd	nd	nd	nd	nd	nd	nd	6.2	nd	nd	nd	nd
PCB151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB153/168	nd	nd	nd	nd	nd	4.2	5.5	nd	5.9	nd	nd	nd	nd
PCB156	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB157	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB158	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB167	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB169	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB170	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB180	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB187	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB189	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB194	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCBs	0.0	0.0	9.9	0.0	0.0	10.4	24.2	0.0	34.8	0.0	0.0	0.0	11.4

DTurbot = diamond turbot; KBass = kelp bass; OL = outer lower bay; nd = not detected

Detection limit = 5 µg/kg; nd = not detected; Congeners in bold and underlined are toxic to birds and mammals (see Van den Berg *et al.* (1998)

[redacted]

Appendix 10. Selected trace metals found in whole fish composites collected at Newport Bay, California in late winter (March-April) and summer (August-September) 2002, with quality control (QC) duplicates and matrix spike sample recovery results.

Sample Number	Fish Species	Loc.	Composite ID	Composite NF/C	NFM	Mean SL(mm)	Mean Wt.(g)	Total Solids (% ww)	Concentration(mg/kg) Total Arsenic	Total Mercury	Total Selenium	Total Cadmium
1	California killifish	IL	W-1	31	31	47	2.6	23.2	0.50	0.012	0.38	ND
2	Pac. staghorn sculpin	OL	W-1	36	36	55	4.0	15.1	0.36	0.010	0.36	0.014
3	Arrow goby	OU	W-1	620	20	23	0.1	15.2	0.30	0.006	0.28	ND
4	Arrow goby	IU	W-1	460	60	22	0.0	14.2	0.26	0.004	0.62	ND
5	California halibut	OL	W-1	4	4	96	15.9	23.6	1.00	0.026	0.22	ND
6	California killifish	OU	S-1	20	20	66	8.4	21.2	0.92	0.008	0.56	ND
7	California killifish	IU	S-1	20	20	67	8.2	20.2	0.88	0.008	1.92	ND
8	Topsmelt*	OL	S-1	172	60	33	0.4	19.7	0.46	0.006	0.26	0.026
9	Topsmelt*	IL	S-1	240	60	28	0.2	18.1	0.30	0.008	0.28	ND
10	Topsmelt*	IL	S-2	240	--	--	--	16.7	0.30	0.006	0.24	ND
11	Topsmelt*	IL	S-3	245	--	--	--	15.1	0.26	0.006	0.22	ND
12	Topsmelt*	IU	S-1	230	60	27	0.2	20.8	0.50	0.006	1.66	0.014
13	Pac. staghorn sculpin	OL	S-1	36	36	77	9.2	23.2	0.80	0.016	0.46	0.012
14	Pac. staghorn sculpin	IL	S-1	36	35	67	6.3	24.2	0.50	0.018	0.40	ND
15	Pac. staghorn sculpin	OU	S-1	36	36	64	5.5	21.2	0.40	0.008	0.34	ND
16	Black perch	OL	S-1	8	8	80	16.8	18.4	0.76	0.012	0.22	ND
17	Shiner perch	OL	S-1	22	22	52	3.4	19.1	0.68	0.008	0.22	ND
18	Arrow goby	IL	S-1	500	20	22	0.1	14.0	0.36	0.014	0.22	ND
19	Arrow goby	OU	S-1	280	20	25	0.2	20.8	0.88	0.010	0.42	ND
20	Arrow goby	IU	S-1	210	20	29	0.3	17.9	0.48	0.004	1.42	ND
21	Cheekspot goby	IL	S-1	266	20	24	0.2	17.7	0.52	0.020	0.24	ND
22	California halibut	OL	S-1	4	4	122	31.8	24.0	0.54	0.016	0.22	ND
23	California halibut	IL	S-1	4	4	100	17.2	24.6	0.44	0.014	0.26	ND
24	Diamond turbot	IL	S-1	6	6	77	14.1	15.8	1.20	0.010	0.24	ND
	Quality Control (QC) Duplicates											
13D	Pac. staghorn sculpin	OL	S-1					20.2	0.88	0.014	0.44	ND
16D	Black perch	OL	S-1					21.0	0.82	0.010	0.24	ND
								QC Limits (% Recovery)	70-130%	60-130%	60-130%	70-130%
	Avg. Spike Recovery											
13D	Pac. staghorn sculpin	OL	S-1					--	96	86	88	90
16D	Black perch	OL	S-1					--	100	92	90	96

Boxes enclose values above wet weight screening value of 0.60 mg/kg ww, based on NIWQP (1998) SV of 3.00 mg/kg dw. Total arsenic target reporting limits: 0.04 mg/Kg for samples 3, 11, 12, 16, 19-21, 23, 24; 0.05 mg/Kg for4, 6-10, 17, 18, 22; and 0.06 mg/Kg for 1, 2, 5, 13-15. Total mercury had reporting limits of 0.002 mg/Kg for samples 1-24. Total selenium reporting limits: 0.01 mg/Kg for samples 1-6, 9-19, 21-24; 0.04 mg/Kg for 20; and 0.05 mg/Kg for 7, 8. Total cadmium reporting limits: 0.004 mg/Kg for samples 3, 11, 12, 16, 19-21, 23, 24; 0.005 mg/Kg for 4, 6-10, 17, 18, 22; and 0.006 mg/Kg for 1, 2, 5, 13-15. Methods:Freeze dry for tissue solids; EPA 200.8 for arsenic and cadmium; EPA 7471A for mercury; EPA 7472 for selenium. Analysis dilution factors were 5 for arsenic and cadmium, 1 for mercury (5 for spikes), and 2, 4, or 10 for selenium (100 for spikes). All method blanks were nondetectable; all laboratory control spiked samples were within expected recoveries. Comp No. = season and composite number after dissections. Lab sample no. = number assigned to the sample by the analytical laboratory; ID = composite identification number; NF/C = number of fish per composite. Wt. = weight
* number of fish per composite estimated by weight.; Pac. = Pacific; NFM = number of fish measured; SL = standard length
Loc. = sampling locations: IU = inner upper bay; OU = outer upper bay; IL = inner lower bay; OL = outer lower bay.
Contaminant concentrations are corrected (doubled) to compensate for 1:1 tissue to water dilution during homogenization.

Appendix 11. Wet-weight and dry weight selenium concentrations in whole fish composites of forage fishes collected in Newport Bay, California in late winter (March-April) and summer (August-September) 2002.

Sample Number	Fish Species	Loc.	Composite ID	Composite NF/C	NFM	Mean SL(mm)	Mean Wt.(g)	Total Solids (% ww)	Dilution Factor	Total Se (mg/kg) ww	Total Se (mg/kg) dw
1	California killifish	IL	W-1	31	31	47	2.6	23.20	4.31	0.38	1.64
2	Pacific staghorn sculpin	OL	W-1	36	36	55	4.0	15.10	6.62	0.36	2.38
3	Arrow goby	OU	W-1	620	20	23	0.1	15.22	6.57	0.28	1.84
4	Arrow goby	IU	W-1	460	60	22	0.0	14.20	7.04	0.62	4.37
5	California halibut	OL	W-1	4	4	96	15.9	23.60	4.24	0.22	0.93
6	California killifish	OU	S-1	20	20	66	8.4	21.20	4.72	0.56	2.64
7	California killifish	IU	S-1	20	20	67	8.2	20.20	4.95	1.92	9.50
8	Topsmelt	OL	S-1	172*	60	33	0.4	19.74	5.07	0.26	1.32
9	Topsmelt	IL	S-1	240*	60	28	0.2	18.10	5.52	0.28	1.55
10	Topsmelt	IL	S-2	240*	--	--	--	16.72	5.98	0.24	1.44
11	Topsmelt	IL	S-3	245*	--	--	--	15.06	6.64	0.22	1.46
12	Topsmelt	IU	S-1	230*	60	27	0.2	20.80	4.81	1.66	7.98
13	Pacific staghorn sculpin	OL	S-1	36	36	77	9.2	23.20	4.31	0.46	1.98
14	Pacific staghorn sculpin	IL	S-1	36	35	67	6.3	24.20	4.13	0.40	1.65
15	Pacific staghorn sculpin	OU	S-1	36	36	64	5.5	21.20	4.72	0.34	1.60
16	Black perch	OL	S-1	8	8	80	16.8	18.44	5.42	0.22	1.19
17	Shiner perch	OL	S-1	22	22	52	3.4	19.12	5.23	0.22	1.15
18	Arrow goby	IL	S-1	500	20	22	0.1	14.02	7.13	0.22	1.57
19	Arrow goby	OU	S-1	280	20	25	0.2	20.80	4.81	0.42	2.02
20	Arrow goby	IU	S-1	210	20	29	0.3	17.86	5.60	1.42	7.95
21	Cheekspot goby	IL	S-1	266	20	24	0.2	17.72	5.64	0.24	1.35
22	California halibut	OL	S-1	4	4	122	31.8	24.00	4.17	0.22	0.92
23	California halibut	IL	S-1	4	4	100	17.2	24.60	4.07	0.26	1.06
24	Diamond turbot	IL	S-1	6	6	77	14.1	15.78	6.34	0.24	1.52
Means								19.34	5.17		
	Quality Control (QC) Duplicates										
13D	Pacific staghorn sculpin	OL	S-1					20.20	4.95	0.44	2.18
16D	Black perch	OL	S-1					21.00	4.76	0.24	1.14

NFM = number of fish measured; SL = standard length; Wt. = weight

Total reporting limits: 0.01 mg/kg for samples 1-6, 9-19, 21-24; 0.04 mg/kg for 20; and 0.05 mg/kg for 7, 8.

Methods:Freeze dry for tissue solids; EPA 7472 for selenium. Analysis dilution factors were 2, 4, or 10 (100 for spikes).

All method blanks were nondetectable; all laboratory control spiked samples were within expected recoveries.

Comp No. = season and composite number after dissections. Lab sample no. = number assigned to the sample by the analytical laboratory; ID = composite identification number; NF/C = number of fish per composite. ww = weight weight; dw = dry weight.

* number of fish per composite was estimated by weight.;

Loc. = sampling locations: IU = inner upper bay; OU = outer upper bay; IL = inner lower bay; OL = outer lower bay.

Contaminant concentrations are corrected (doubled) to compensate for 1:1 tissue to water dilution during homogenization.

Boxes enclose values above screening values for wildlife fish consumption: dry weight screening value = 3 mg/kg (NIWQP 1998).

Wet weight screening value = 0.6 mg/kg derived by dividing 3 mg/kg dw by average dilution factor of 5.

Appendix 12. Semivolatile organic compounds found in whole fish composites collected from Newport Bay, California in late winter (March-April) and summer (August-September) 2002, with quality control (QC) duplicates and matrix spike sample recovery results.

Sam. No.	Fish Species	Loc.	Composite ID	Composite NF/C	NFM	Mean SL(mm)	Mean Wt.(g)	Total PCB	Total DDT	Total Chlor.	Aldrin	Chloro-pyrifos	Diaz-non	Diel-drin	Endrin	Lipid (%)
								Concentration (µg/kg)								
1	Calif. killifish	IL	W-1	31	31	47	2.6	98	116	ND	ND	ND	ND	ND	ND	1.57
2	P. S. sculpin	OL	W-1	36	36	55	4.0	ND	57	3.0	ND	ND	ND	ND	ND	0.85
3	Arrow goby	OU	W-1	620	20	23	0.1	ND	91	ND	ND	ND	ND	ND	ND	1.21
4	Arrow goby	IU	W-1	460	60	22	0.0	ND	148	ND	ND	ND	ND	ND	ND	1.17
5	Calif. halibut	OL	W-1	4	4	96	15.9	ND	97	12.2	ND	ND	ND	ND	ND	1.06
6	Calif. killifish	OU	S-1	20	20	66	8.4	ND	84	ND	ND	ND	ND	ND	ND	1.43
7	Calif. killifish	IU	S-1	20	20	67	8.2	ND	102	ND	ND	ND	ND	ND	ND	1.44
8	Topsmelt*	OL	S-1	172	60	33	0.4	ND	160	ND	ND	ND	ND	ND	ND	1.70
9	Topsmelt*	IL	S-1	240	60	28	0.2	34	128	2.8	ND	ND	ND	ND	ND	1.77
10	Topsmelt*	IL	S-2	240	--	--	--	101	95	ND	ND	ND	ND	ND	ND	1.47
11	Topsmelt*	IL	S-3	245	--	--	--	10	50	4.0	ND	ND	ND	ND	ND	1.41
12	Topsmelt*	IU	S-1	230	60	27	0.2	ND	114	6.4	ND	ND	ND	ND	ND	1.48
13	P. S. sculpin	OL	S-1	36	36	77	9.2	ND	147	17.6	ND	ND	ND	ND	ND	1.20
14	P. S. sculpin	IL	S-1	36	35	67	6.3	ND	204	21.2	ND	ND	ND	ND	ND	1.65
15	P. S. sculpin	OU	S-1	36	36	64	5.5	ND	165	14.6	ND	ND	ND	ND	ND	1.68
16	Black perch	OL	S-1	8	8	80	16.8	ND	117	12.6	ND	ND	ND	ND	ND	1.14
17	Shiner perch	OL	S-1	22	22	52	3.4	ND	95	ND	ND	ND	ND	ND	ND	1.02
18	Arrow goby	IL	S-1	500	20	22	0.1	ND	56	ND	ND	ND	ND	ND	ND	0.87
19	Arrow goby	OU	S-1	280	20	25	0.2	ND	146	ND	ND	ND	ND	ND	ND	1.48
20	Arrow goby	IU	S-1	210	20	29	0.3	ND	262	22.2	ND	ND	ND	ND	ND	1.74
21	Chkspot goby	IL	S-1	266	20	24	0.2	53	195	11.0	ND	ND	ND	ND	ND	1.54
22	Calif. halibut	OL	S-1	4	4	122	31.8	136	87	ND	ND	ND	ND	ND	ND	0.96
23	Calif. halibut	IL	S-1	4	4	100	17.2	59	73	ND	ND	ND	ND	ND	ND	0.81
24	Dia. turbot	IL	S-1	6	6	77	14.1	ND	119	6.4	ND	ND	ND	ND	ND	0.84
	Avg. Spike Recovery							QC Limits: Percent Recovery (30 - 150%)								
	Lab Control	Lab	Sp, Du					44	84	85	70	98	31	85	82	
	Lab Control	Lab	2					79	79	83	67	99	125	83	83	
	Lab Control	Lab	3					34	112	108	109	102	38	109	131	
	Std. Ref. Mat.	Lab	1					108	83	97	NA	NA	NA	NA	NA	
	Std. Ref. Mat.	Lab	2					94								
	Carp 1 Ref.	Lab	1, 2, 3					94								
13SD	P. S. sculpin	OL	Sp, Du					65								
14SD	P. S. sculpin	IL	Sp, Du					47								
15SD	P. S. sculpin	OU	Sp, Du					58								

NFM = number of fish measured; SL = standard length; Wt. = weight

Comp No. = composite number. Total PCBs = sum of PCB numbers 18, 28, 52, 49, 44, 37, 74, 70, 66, 101, 99, 119, 87, 110, 81, 151, 77, 149, 123, 118, 114, 153, 168, 105, 138, 158, 187, 126, 128, 167, 177, 200, 156, 157, 180, 170, 201, 169, 189, 194, and 206. Total DDTs = sum of o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, and p,p'-DDE. Chlordane class = sum of Chlordene, oxichlordane, gamma-chlordane, alpha-Chlordane, trans-Chlordane, trans-Monachlor, and cis-Nonachlor. Quality control limits are expected ranges for spike sample recoveries. % R = percent recovery. Average recoveries could be multiple samples of the same tissue as indictaed in the Comp No. category. Sp, Du = spiked matrix sample and its duplicate.

ID = composite identification number; NF/C = number of fish per composite; P.S. = Pacific staghorn; Dia. = diamond; Calif. = California

Loc. = sampling locations: IU = inner upper bay; OU = outer upper bay; IL = inner lower bay; OL = outer lower bay.

Bold box enclose values above screening value for wildlife fish consumption: DDT = 14 ug/kg ww (Environment Canada 1997).

Contaminant concentrations are corrected (doubled) to compensate for 1:1 tissue to water dilution during homogenization.

Detection limit = 5 µg/kg; ND = nondetect; Sam. No. = sample number; * = number fish composited estimated by weight.

Appendix 13. Concentrations of PCB congeners found in whole fish tissue of forage fishes collected in Newport Bay, California in winter (March-April) 2002.

	Concentration (µg/kg)				
PCB	P. staghorn sculpin	arrow goby		California killifish	California halibut
Congener	Outer Lower	Inner Upper	Outer Upper	Inner Lower	Outer Lower
PCB 18	nd	nd	nd	nd	nd
PCB 28	nd	nd	nd	nd	nd
PCB 37	nd	nd	nd	nd	nd
PCB 44	nd	nd	nd	nd	nd
PCB 49	nd	nd	nd	nd	nd
PCB 52	nd	nd	nd	nd	nd
PCB 66	nd	nd	nd	8.7	nd
PCB 70	nd	nd	nd	nd	nd
PCB 74	nd	nd	nd	nd	nd
<u>PCB 77</u>	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 81</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 87	nd	nd	nd	nd	nd
PCB 99	nd	nd	nd	11.8	nd
PCB 101	nd	nd	nd	18.1	nd
<u>PCB 105</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 110	nd	nd	nd	12.2	nd
<u>PCB 114</u>	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 118</u>	**nd**	**nd**	**nd**	**16.0**	**nd**
PCB 119	nd	nd	nd	nd	nd
<u>PCB 123</u>	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 126</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 128	nd	nd	nd	nd	nd
PCB 138	nd	nd	nd	10.6	nd
PCB 149	nd	nd	nd	9.3	nd
PCB 151	nd	nd	nd	nd	nd
PCB 153/168	nd	nd	nd	10.9	nd
<u>PCB 156</u>	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 157</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 158	nd	nd	nd	nd	nd
<u>PCB 167</u>	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 169</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 170	nd	nd	nd	nd	nd
PCB 177	nd	nd	nd	nd	nd
PCB 180	nd	nd	nd	nd	nd
PCB 183	nd	nd	nd	nd	nd
PCB 187	nd	nd	nd	nd	nd
<u>PCB 189</u>	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 194	nd	nd	nd	nd	nd
PCB 200	nd	nd	nd	nd	nd
PCB 201	nd	nd	nd	nd	nd
PCB 206	nd	nd	nd	nd	nd
Total PCB	nd	nd	nd	97.6	nd

Detection limit = 5 µg/kg; nd = not detected; Congeners in bold and underlined are toxic to birds and mammals (see Van den Berg *et al.* (1998); P. = Pacific

Appendix 14. Concentrations of PCB congeners in whole fish tissue of forage fishes collected in Newport Bay, California in summer (August-September) 2002.

	Concentration (µg/kg)								
	topsmelt								
PCB		Inner Lower				SPerch	Pacific staghorn sculpin		
Congener	IU	1	2	3	OL	OL	OU	IL	OL
PCB 18	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 28	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 37	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 44	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 49	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 52	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 66	nd	nd	8.8	nd	nd	nd	nd	nd	nd
PCB 70	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 74	nd	nd	nd	nd	nd	nd	nd	nd	nd
<u>PCB 77</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 81</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 87	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 99	nd	10.1	14.5	nd	nd	nd	nd	nd	nd
PCB 101	nd	14.7	20.6	10.1	nd	nd	nd	nd	nd
<u>PCB 105</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 110	nd	nd	10.3	nd	nd	nd	nd	nd	nd
<u>PCB 114</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 118</u>	**nd**	**nd**	**13.3**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 119	nd	nd	nd	nd	nd	nd	nd	nd	nd
<u>PCB 123</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 126</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 128	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 138	nd	nd	9.6	nd	nd	nd	nd	nd	nd
PCB 149	nd	nd	11.0	nd	nd	nd	nd	nd	nd
PCB 151	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 153/168	nd	8.9	13.0	nd	nd	nd	nd	nd	nd
<u>PCB 156</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 157</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 158	nd	nd	nd	nd	nd	nd	nd	nd	nd
<u>PCB 167</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
<u>PCB 169</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 170	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 177	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 180	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 183	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 187	nd	nd	nd	nd	nd	nd	nd	nd	nd
<u>PCB 189</u>	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 194	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 200	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 201	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 206	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCB	nd	33.7	101.1	10.1	nd	nd	nd	nd	nd

SPerch = shiner perch; IU = inner upper; OU = outer upper; IL = inner lower; OL = outer lower.

Detection limit = 5 µg/kg; nd = not detected; Congeners in bold and underlined are toxic to birds and mammals (see Van den Berg *et al*. 1998)

Appendix 14 (continued).

PCB Congener	Concentration (µg/kg) DTurbot IL	arrow goby IU	arrow goby OU	arrow goby IL	CGoby IL	California killifish IU	California killifish OU	BPerch OL	California halibut IL	California halibut OL
PCB 18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 37	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 66	nd	nd	nd	nd	7.0	nd	nd	nd	nd	nd
PCB 70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 77	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 81	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 87	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 99	nd	nd	nd	nd	9.2	nd	nd	nd	10.6	16.3
PCB 101	nd	nd	nd	nd	11.7	nd	nd	nd	15.7	24.9
PCB 105	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 110	nd	nd	nd	nd	nd	nd	nd	nd	nd	10.9
PCB 114	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 118	**nd**	**nd**	**nd**	**nd**	**9.5**	**nd**	**nd**	**nd**	**7.8**	**22.2**
PCB 119	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 123	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 126	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 138	nd	nd	nd	nd	7.6	nd	nd	nd	8.5	28.5
PCB 149	nd	nd	nd	nd	nd	nd	nd	nd	nd	9.9
PCB 151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 153/168	nd	nd	nd	nd	8.4	nd	nd	nd	9.8	22.9
PCB 156	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 157	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 158	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 167	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 169	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 170	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 180	nd	nd	nd	nd	nd	nd	nd	nd	7.1	nd
PCB 183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 187	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 189	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**	**nd**
PCB 194	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCB	nd	nd	nd	nd	53.4	nd	nd	nd	59.4	135.7

BPerch = black perch; CGoby = cheekspot goby; DTurbot = diamond turbot
IL = inner lower bay; IU = inner upper bay; OL = outer lower bay; OU = outer upper bay
Detection limit = 5 µg/kg; nd = not detected; Congeners underlined and bold are toxic to birds and mammals (see Van den Berg et al. 1998).

Appendix 15. Historical concentrations of total DDT in muscle or whole body tissue of Newport Bay, California fishes from 1978 to 2002.

Common Name	Scientific Name	Year	No. Samples	Tissue	Concentration (µg/kg ww) Mean	Min.	Max.	Source
topsmelt	*Atherinops affinis*	1978	3	M	**140**	**125**	**151**	Mearns et al. (1991)
topsmelt	*Atherinops affinis*	1980	10	M	**748**	**99**	**1,830**	Mearns et al. (1991)
topsmelt	*Atherinops affinis*	2002	5	WB	**109**	**50**	**160**	Present study
jacksmelt	*Atherinopsis californiensis*	2001	3	M	139	52	232	Present study
California killifish	*Fundulus parvipinnis*	2002	3	WB	100	84	116	Present study
California scorpionfish	*Scorpaena guttata*	1999	1	M	9	--	--	CFCP (Year 1)
Pacfic staghorn sculpin	*Leptocottus armatus*	2002	4	WB	143	57	204	Present study
striped bass	*Morone saxatilis*	1978	3	M	690	485	823	Mearns et al. (1991)
kelp bass	*Paralabrax clathratus*	2001	1	M	19	--	--	Present study
spotted sand bass	*Paralabrax maculatofasciatus*	1978	3	M	**680**	**199**	**1,370**	Mearns et al. (1991)
spotted sand bass	*Paralabrax maculatofasciatus*	2000/2001	5	M	**68**	**15**	**108**	Present study
barred sand bass	*Paralabrax nebulifer*	2000/2001	2	M	56	45	66	Present study
California corbina	*Menticirrhus undulatus*	2001	3	M	361	259	490	Present study
spotfin croaker	*Roncador stearnsii*	2001	2	M	68	38	98	Present study
yellowfin croaker	*Umbrina roncador*	1978	3	M	**200**	**174**	**222**	Mearns et al. (1991)
yellowfin croaker	*Umbrina roncador*	1980	10	M	**310**	**148**	**815**	Mearns et al. (1991)
yellowfin croaker	*Umbrina roncador*	1999	1	M	**47**	--	--	CFCP (Year 2)
yellowfin croaker	*Umbrina roncador*	2001	5	M	**102**	**47**	**132**	Present study
striped mullet	*Mugil cephalus* (adult)	1978	3	M	4,210	2,470	5,760	Mearns et al. (1991)
striped mullet	*Mugil cephalus* (juvenile)	1978	3	M	1,440	527	2,780	Mearns et al. (1991)
striped mullet	*Mugil cephalus*	1980	10	M	2,070	582	4,178	Mearns et al. (1991)
shiner perch	*Cymatogaster aggregata*	1999	3	M	**198**	**126**	**272**	CFCP (Years 1&2)
shiner perch	*Cymatogaster aggregata*	2000/2001	1	M	**40**	--	--	Present study
shiner perch	*Cymatogaster aggregata*	2002	1	WB	**95**	--	--	Present study
black perch	*Embiotoca jacksoni*	1999	1	M	**28**	--	--	CFCP (Year 2)
black perch	*Embiotoca jacksoni*	2000/2001	7	M	**40**	**29**	**61**	Present study
black perch	*Embiotoca jacksoni*	2002	1	WB	**117**	--	--	Present study
arrow goby	*Clevelandia ios*	2002	5	WB	141	56	262	Present study
longjaw mudsucker	*Gillichthys mirabilis*	1979/1980	8	M	258	40	981	Mearns et al. (1991)
cheekspot goby	*Ilypnus gilberti*	2002	1	WB	195	--	--	Present study
California halibut	*Paralichthys californicus*	1980	10	M	**628**	**168**	**1,170**	Mearns et al. (1991)
California halibut	*Paralichthys californicus*	2000/2001	6	M	**69**	**41**	**104**	Present study
California halibut	*Paralichthys californicus*	2002	3	WB	**86**	**73**	**97**	Present study
fantail sole	*Xystreurys liolepis*	2000/2001	1	M	36	--	--	Present study
diamond turbot	*Hypsopsetta guttulata*	1999	1	M	**18**	--	--	CFCP (Year 1)
diamond turbot	*Hypsopsetta guttulata*	2000/2001	8	M	**36**	**22**	**61**	Present study
diamond turbot	*Hypsopsetta guttulata*	2002	1	WB	**119**	--	--	Present study
C-O sole	*Pleuronichthys coenosus*	2000/2001	2	M	34	30	38	Present study
spotted turbot	*Pleuronichthys ritteri*	1999	1	M	**30**	**13**	**53**	CFCP (Years 1&2)
spotted turbot	*Pleuronichthys ritteri*	2000/2001	4	M	**40**	**23**	**57**	Present study

No. Samples = number of composites for present study; may be a mix of individual fish or composites in Mearns et al. (1991).
M = muscle tissue; WB = whole body tissue
Species and data in bold can be compared between 1978-1980 and 2000-2002.
CFCP = Coastal Fish Contamination Project, State Water Resources Control Board. Years 1 and 2 (May and October 1999).
Note: Mearns and Young (1980) in Mearns et al. (1991) should be MBC and SCCWRP (1980)

Appendix 16. Historical concentrations of total PCB in muscle or whole body tissue of Newport Bay, California fishes from 1978 to 2002.

Common Name	Scientific Name	Year	No. Samples	Tissue	Concentration (µg/kg ww) Mean	Min.	Max.	Source
topsmelt	*Atherinops affinis*	1978	3	M	52	29	74	Mearns et al. (1991)
topsmelt	*Atherinops affinis*	1980	10	M	32	2	89	Mearns et al. (1991)
topsmelt	*Atherinops affinis*	2002	5	WB	29	0	101	Present study
jacksmelt	*Atherinopsis californiensis*	2001	3	M	3	0	10	Present study
California killifish	*Fundulus parvipinnis*	2002	3	WB	33	0	98	Present study
California scorpionfish	*Scorpaena guttata*	1999	1	M	ND	-	-	CFCP (Year 1)
Pacfic staghorn sculpin	*Leptocottus armatus*	2002	4	WB	ND	-	-	Present study
striped bass	*Morone saxatilis*	1978	3	M	25	120	324	Mearns et al. (1991)
kelp bass	*Paralabrax clathratus*	2001	1	M	ND	-	-	Present study
spotted sand bass	*Paralabrax maculatofasciatus*	1978	3	M	242	64	465	Mearns et al. (1991)
spotted sand bass	*Paralabrax maculatofasciatus*	2000/2001	5	M	7	0	24	Present study
barred sand bass	*Paralabrax nebulifer*	2000/2001	2	M	ND	-	-	Present study
California corbina	*Menticirrhus undulatus*	2001	3	M	21	0	58	Present study
spotfin croaker	*Roncador stearnsii*	2001	2	M	ND	-	-	Present study
yellowfin croaker	*Umbrina roncador*	1978	3	M	54	42	69	Mearns et al. (1991)
yellowfin croaker	*Umbrina roncador*	1980	10	M	20	2	42	Mearns et al. (1991)
yellowfin croaker	*Umbrina roncador*	1999	1	M	30	-	-	CFCP (Year 2)
yellowfin croaker	*Umbrina roncador*	2001	5	M	12	0	41	Present study
striped mullet	*Mugil cephalus* (adult)	1978	3	M	821	425	1,320	Mearns et al. (1991)
striped mullet	*Mugil cephalus* (juvenile)	1978	3	M	265	32	642	Mearns et al. (1991)
striped mullet	*Mugil cephalus*	1980	10	M	89	8	268	Mearns et al. (1991)
shiner perch	*Cymatogaster aggregata*	1999	3	M	60	39	94	CFCP (Years 1&2)
shiner perch	*Cymatogaster aggregata*	2000/2001	1	M	ND	-	-	Present study
shiner perch	*Cymatogaster aggregata*	2002	1	WB	ND	-	-	Present study
black perch	*Embiotoca jacksoni*	1999	1	M	14	-	-	CFCP (Year 2)
black perch	*Embiotoca jacksoni*	2000/2001	7	M	ND	-	-	Present study
black perch	*Embiotoca jacksoni*	2002	1	WB	ND	-	-	Present study
arrow goby	*Clevelandia ios*	2002	5	WB	ND	-	-	Present study
longjaw mudsucker	*Gillichthys mirabilis*	1979/1980	8	M?	19	4	49	Mearns et al. (1991)
cheekspot goby	*Ilypnus gilberti*	2002	1	WB	53	-	-	Present study
California halibut	*Paralichthys californicus*	1980	10	M	32	8	?	Mearns et al. (1991)
California halibut	*Paralichthys californicus*	2000/2001	6	M	ND	-	-	Present study
California halibut	*Paralichthys californicus*	2002	3	WB	65	0	136	Present study
fantail sole	*Xystreurys liolepis*	2000/2001	1	M	ND	-	-	Present study
diamond turbot	*Hypsopsetta guttulata*	1999	1	M	ND	-	-	CFCP (Year 1)
diamond turbot	*Hypsopsetta guttulata*	2000/2001	8	M	ND	-	-	Present study
diamond turbot	*Hypsopsetta guttulata*	2002	1	WB	ND	-	-	Present study
C-O sole	*Pleuronichthys coenosus*	2000/2001	2	M	ND	-	-	Present study
spotted turbot	*Pleuronichthys ritteri*	1999	3	M	8	ND	14	CFCP (Years 1&2)
spotted turbot	*Pleuronichthys ritteri*	2000/2001	4	M	ND	-	-	Present study

Total PCBs in the 1970s and 1980s was based on the sum of major Aroclors but in 2000-2002 was based on the sum of PCB congeners.
No. Samples = number of composites for present study; may be a mix of individual fish or composites in Mearns et al. (1991).
M = muscle tissue; WB = whole body tissue
Species and data in bold can be compared between 1978-1980 and 2000-2002.
CFCP = Coastal Fish Contamination Project, State Water Resources Control Board. Years 1 and 2 (May and October 1999).
Note: Mearns and Young (1980) in Mearns et al. (1991) should be MBC and SCCWRP (1980)

Appendix 17. Historical concentrations of total selenium in muscle or whole body tissue of Newport Bay, California fishes from 1978 to 2002.

Common Name	Scientific Name	Year	No. Samples	Tissue	Concentration (mg/kg ww) Mean	Min.	Max.	Source
topsmelt	*Atherinops affinis*	1978	3	M	**0.91**	**0.54**	**1.30**	Mearns et al. (1991)
topsmelt	*Atherinops affinis*	2002	5	WB	**0.53**	**0.22**	**1.66**	Present study
jacksmelt	*Atherinopsis californiensis*	2001	3	M	0.17	0.15	0.18	Present study
California killifish	*Fundulus parvipinnis*	2002	3	WB	0.95	0.38	1.92	Present study
California scorpionfish	*Scorpaena guttata*	1999	1	M	0.11	-	-	CFCP data (Year 1)
Pacfic staghorn sculpin	*Leptocottus armatus*	2002	4	WB	0.39	0.34	0.45	Present study
striped bass	*Morone saxatilis*	<1982	3	M	1.13	0.61	1.42	Mearns et al. (1991)
kelp bass	*Paralabrax clathratus*	2001	1	M	0.16	-	-	Present study
spotted sand bass	*Paralabrax maculatofasciatus*	<1982	3	M	**1.34**	**1.22**	**1.42**	Mearns et al. (1991)
spotted sand bass	*Paralabrax maculatofasciatus*	2000/2001	5	M	**0.24**	**0.21**	**0.30**	Present study
barred sand bass	*Paralabrax nebulifer*	2000/2001	2	M	0.18	0.17	0.18	Present study
California corbina	*Menticirrhus undulatus*	2001	3	M	0.14	0.12	0.14	Present study
spotfin croaker	*Roncador stearnsii*	2001	2	M	0.30	0.23	0.36	Present study
yellowfin croaker	*Umbrina roncador*	1978	3	M	**0.78**	**0.78**	**0.79**	Mearns et al. (1991)
yellowfin croaker	*Umbrina roncador*	1999	1	M	**0.44**	-	-	CFCP data (Year 2)
yellowfin croaker	*Umbrina roncador*	2001	5	M	**0.19**	**0.14**	**0.24**	Present study
striped mullet	*Mugil cephalus* (adult)	1978	3	M	0.65	0.38	0.80	Mearns et al. (1991)
striped mullet	*Mugil cephalus* (juvenile)	1978	3	M	0.67	0.38	0.88	Mearns et al. (1991)
shiner perch	*Cymatogaster aggregata*	1999	3	M	**0.36**	**0.25**	**0.50**	CFCP data (Y1&2)
shiner perch	*Cymatogaster aggregata*	2000/2001	1	M	**0.13**	-	-	Present study
shiner perch	*Cymatogaster aggregata*	2002	1	WB	**0.22**	-	-	Present study
black perch	*Embiotoca jacksoni*	1999	1	M	**0.33**	-	-	CFCP data (Year 2)
black perch	*Embiotoca jacksoni*	2000/2001	7	M	**0.11**	**0.08**	**0.17**	Present study
black perch	*Embiotoca jacksoni*	2002	1	WB	**0.23**	-	-	Present study
arrow goby	*Clevelandia ios*	2002	5	WB	0.59	0.22	1.42	Present study
cheekspot goby	*Ilypnus gilberti*	2002	1	WB	0.24	-	-	Present study
California halibut	*Paralichthys californicus*	2000/2001	6	M	0.23	0.02	0.38	Present study
California halibut	*Paralichthys californicus*	2002	3	WB	0.23	0.22	0.26	Present study
fantail sole	*Xystreurys liolepis*	2000/2001	1	M	0.14	-	-	Present study
diamond turbot	*Hypsopsetta guttulata*	1999	1	M	**0.93**	-	-	CFCP data (Year 1)
diamond turbot	*Hypsopsetta guttulata*	2000/2001	8	M	**0.39**	**0.18**	**0.64**	Present study
diamond turbot	*Hypsopsetta guttulata*	2002	1	WB	**0.24**	-	-	Present study
C-O sole	*Pleuronichthys coenosus*	2000/2001	2	M	0.12	0.11	0.12	Present study
spotted turbot	*Pleuronichthys ritteri*	1999	3	M	**0.48**	**0.25**	**0.86**	CFCP data (Y1&2)
spotted turbot	*Pleuronichthys ritteri*	2000/2001	4	M	**0.18**	**0.13**	**0.25**	Present study

No. Samples = number of composites for present study; may be a mix of individual fish or composites in Mearns et al. (1991).
M = muscle tissue; WB = whole body tissue
Species and data in bold can be compared between 1978-1981 and/or 1999, and 2000-2002.
CFCP = Coastal Fish Contamination Project, State Water Resources Control Board. Years 1 and 2 (May and October 1999).
Note: Mearns and Young (1980) in Mearns et al. (1991) should be MBC and SCCWRP (1980)

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From: Craig J. Wilson
To: Melenee Emanuel; Tim Stevens
Date: 5/24/04 2:09PM
Subject: Fwd: data docs for NBay and SDCreek

Please enter these documents into our record. CJW

>>> Pavlova Vitale Monday, May 24, 2004 >>>
Craig, here is additional information we got for the upcoming water quality assessment that Peter Kozelka sent to me. So I am passing it along to you guys.

Pavlova N. Vitale
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CC: 'Amy King'; kozelka.peter@epamail.epa.gov