Southern California Bight
2008 Regional Marine Monitoring Survey
(Bight'08)

Bioaccumulation Workplan

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Bight'08 Coastal Ecology Committee

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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INTRODUCTION

Regional marine monitoring has shown widespread contamination in fish of the Southern California Bight (SCB). This contamination includes both flatfishes (Schiff and Allen 2000) and pelagic fish (Jarvis et al. 2007). While the contamination was widespread, it has been limited to only a few contaminants types including total DDTs and, to a lesser extent, total PCBs. Other bioaccumulative contaminants not observed in fishes of the SCB included chlordanes, mercury and other trace metals.

The extent of fish contamination in the SCB has led to concerns about risk to wildlife consumers (Allen et al. 2004). Large portions of fish populations may contain levels of contaminants that exceed guidelines that represent risk to higher level predators. For example, over 97% of the region's most common benthic prey species (Pacific sanddabs) and pelagic prey species (Pacific sardines) predators exceeded wildlife risk guidelines (Schiff and Allen 2000; Jarvis et al, 2007). However, not all species carried this level of contaminant risk. For example, California Market squid, perhaps the pelagic species with the greatest biomass regionally, had virtually no exceedences of these wildlife risk thresholds.

At regional scales, the risk for human consumption is not well known. The State of California Office of Environmental Health and Hazard Assessment (OEHHA) is the agency responsible for advisories and closure of fisheries due to tissue contamination for human health concerns. There is currently a closure of the commercial fishery for one species (White Croaker) offshore of Palos Verdes and advisories to recreational anglers at isolated piers from Santa Monica to Long Beach. However, OEHHA does not conduct ongoing monitoring and is wholly dependent on others for data on which to create or revise advisories/closures. Information to support the current advisories date back to 1989.

There is focused monitoring of fish tissue contamination for human consumption in isolated locations throughout the SCB (Table 1). For example, there has been focused assessments of fish tissue contamination in the Los Angeles margin as a result of sediment contamination offshore Palos Verdes by the Montrose Settlement and Restoration Program (MSRP) (NOAA and US EPA 2007). This one time study was conducted in 2002-04. Ongoing annual to biennial monitoring of fish tissues is conducted by regulated discharge agencies under permits for the National Pollutant Discharge Elimination System (NPDES). While there are some similarities among the NPDES monitoring programs currently, not every agency monitors the same species, tissues, frequency, or chemical constituents. Even where similarities do exist, no one agency compiles all this information to make larger scale assessments of fish contamination regionally.

Table 1. Monitoring inventory for NPDES monitoring programs in the SCB circa 2007.

Facility	Freq	Season	Sites	Reps	Species	Fish/composite	Species	Mode	Tissue	Analyte
Terminal Island TP	1 per yr	Summer	2	1	2	10 individuals (no composites)	[Wt] Croaker, Queenfish	Rig	S/O Filet	As, Se, Hg, DDTs, PCBs % lipid
Hyperion	1 per 2 yr	Summer	2 zones	1	5	10	[Blk] Perch, Kelp Bass, Barred Sand Bass, [CA Scorpionfish] Rockfish, [Wt] Croaker	Rig	S/O Filet	As, Se, Hg, DDTs, PCBs % lipid
LACSD	1 per 2 yr	Summer	3 zones	1	5	10	[Blk] Perch, Kelp Bass, Barred Sand Bass, [CA Scorpionfish] Rockfish, [Wt] Croaker	Rig Trawl Trap Spear	S/O Filet	As, Hg, DDTs, PCBs % lipid
OCSD (no longer routine)	2 per yr	Summer/ Winter	2	1	2	10 individuals (no composite)	[CA Scorpionfish] Rockfish, [Wt] Croaker	Rig	S/O Filet, Liver	Histopathology, Hg, DDT, PCBs
San Diego South Bay	2 per year	Apr, Oct	2	3	1	3	Rockfish sp. (any combo)	Rig	S/O Filet	Lipids, PCB, CHCs, As, Cd, Cr, Cu, Pb, Hg, Se, Sb A, Sb, Fe, Mn, Ni, Ag
Pt Loma	1 per year	--	2	3	1	3	Rockfish sp. (any combo)	Rig	S/O Filet, Liver	Lipids, PCB, CHCs, As, Cd, Cr, Cu, Pb, Hg, Se, Sb

STUDY DESIGN

A. Study Objectives

The goal of this study is to conduct a regionwide assessment of fish tissue contamination for impacts to human health. To address this goal, this project will answer two primary questions:

1) What percentage of popular fishing areas have low enough concentrations of contaminants that fish can be safely consumed?
2) What is the regional distribution of tissue contamination through the SCB?

The first question is spatial in design and attempts to determine extent of tissue contamination by identifying those locations where fish consumption is safe for anglers. The primary audience for this question is the public and OEHHA, who will hopefully use this information to inform future fish advisories. The second question, which includes magnitude in its design, will help determine where the locations of greatest concern are in the SCB. The primary audience is the regulatory community who are responsible for ensuring low levels of tissue contamination. A second important audience is the regulated community whose local NPDES monitoring results will benefit from comparisons to regional contaminant distributions.

B. General Approach

As defined in the study questions, this project has both spatial extent and magnitude components to its design. Since there are a multitude of potential approaches, the design committee followed five basic guiding principles:

- Make regionwide assessments
- Target fish species that people eat
- Sample locations where species are caught
- Measure tissues that are consumed
- Analyze constituents that represent potential risk to human consumers

These guiding principles were used to determine specific sample design and logistic requirements.

Guiding principles also defined the thresholds to be used for analysis. The State of California OEHHA has only recently provided guidelines for evaluation of data (Table 2). OEHHA uses two thresholds. The first threshold is the fish contaminant goal, below which fish are safe to eat. The second is the advisory tissue level, above which fish carry a quantifiable risk of consumption, particularly to nursing mothers and children. OEHHA only has thresholds for six constituents: Total PCB, Total DDT, methyl-Mercury, Toxaphene, Chlordane, and Dieldrin. The vast majority of fish advisories statewide are for total PCB and/or mercury.

Table 2. State of California Office of Environmental Health and Hazard Assessment Fish Contaminant Goal (FCG) and Advisory Tissue Level (ATL).

	Fish Contaminant Goal (ng/g wet)	Advisory Tissue Level (ng/g wet)**
Total PCB	3.6	21
Total DDT	21	520
methyl-Mercury*	-	70
Toxaphene	6.1	200
Chlordane	5.6	190
Dieldrin	0.46	15

* Can be measured as total Hg
** Based on 8 oz meal, 3 day/wk

C. Specific Approach

Specific guidance for this workplan will focus on four main areas: sampling locations, species selection, tissues to be analyzed, and contaminants to quantify.

C.1. Sampling locations

Sampling locations for this study will be comprised of fishing zones. The use of the zone concept is consistent with the direction that OEHHA will take in the future development of fish consumption guidelines for coastal areas because advisories issued on a pier-by-pier basis previously in Southern California were unsatisfactory. Fishing zones recognize that fish are mobile, which can result in variable contaminant exposure as well as a range of locations to be caught.

There are 24 fishing zones delimited from Point Conception to the US/Mexico International Border for this study (Appendix A, B). The offshore extent of fishing zones was confined to 200 m depth (approximate shelf break), but most frequently extended only as far as 60m depth since this is the limit of most recreational fishers. The longshore extent of fishing zones was selected using the following criteria:

1) Fishing pressure. Zones are smaller and more numerous in areas with more fishing pressure. Popular fishing locations were identified from Jones (2004) and discussions with stakeholders.
2) Homogeneity of contamination. Fishing zones were delineated based on known gradients of contamination to ensure as consistent exposure as possible to fish species. Contamination gradients were defined using previous regional monitoring data (Schiff 2000).
3) Stakeholder interest. Some intensification was provided where stakeholders had specific interest and resources.
4) Complete coverage. The entire SCB coastline must be sampled.

Fishing will be conducted by the California Department of Fish and Game under the auspices of the SWRCB's Surface water ambient monitoring program (SWAMP). Fishing will occur between June and September, 2009 by a variety of gear including seines, trawls, hook and line, trap, and spear (BOG 2009).

C.2. Species

Selecting fish species to monitor is complicated due to the relatively high diversity of species, variation in habitat type and quality, variation in contamination, and the varying ecological attributes of potential indicator species. The following criteria were used to select target species:

1. Popular for consumption. These data were collated from the Recreational Fisheries Information Network (RecFIN), a product of the Pacific States Marine Fisheries Commission (PSMFC), which integrates state and federal marine recreational fishery sampling efforts (www.recfin.org/forms/est2004.html).
2. Widely distributed. Preferred species will extend the length of the SCB.
3. Representative of different exposure pathways. Both benthic and pelagic feeders should be included.
4. Continuity with previous monitoring efforts. This will increase the comparability with existing monitoring programs.

A total of three species were selected for analysis per fishing zone. Two species were selected as primary target species and one species will be selected from a list of secondary species (Table 3). Primary target species will be fished until sufficient numbers of specimens are caught. Secondary species will be kept as by-catch. The final selection of secondary species will be made at the end of the field effort. This will allow selection of the most widely distributed specie(s).

The primary target species are White croaker (*Genyonemus lineatus*) and kelp bass (*Paralabrax clathratus*). White croaker is predominantly an epibenthic feeder, often associated with soft-bottom sediments. Kelp bass is predominantly a water column feeder, often associated with rocky substrate. One or both of these species are also the most frequently measured in NPDES monitoring programs bightwide including the MSRP monitoring conducted in the Los Angeles margin.

The secondary species are Yellowfin croaker (*Umbrina roncador*), Barred sand bass (*Paralabrax nebulifer*), Spotted sand bass (*Paralabrax maculatofasciatus*), Olive rockfish (*Sebastes serranoides*), California Scorpionfish (*Scorpaena guttata*), and Pacific chub mackerel (*Scomber japonius*). The croaker, bass, and rockfish were selected because they serve as ecological replacements for primary species (i.e., same ecological niche or guild). The Scorpionfish and mackerel were selected because they were frequently caught in other monitoring programs.

Table 3. Primary and secondary target species.

Common Name	Scientific Name
Primary Target spp	
White Croaker	*Genyonemus lineatus*
Kelp Bass	*Paralabrax clathratus*
Secondary Target spp.	
Yellowfin Croaker	*Umbrina roncador*
Barred Sand Bass	*Paralabrax nebulifer*
Spotted Sand Bass	*Paralabrax maculatofasciatus*
Olive Rockfish	*Sebastes serranoides*
California Scorpionfish	*Scorpaena guttata*
Pacific Chub Mackerel	*Scomber japonius*

C.3. Tissue composite samples

Filet muscle tissue with the skin off will be used for analysis. Muscle filets are recommended by the USEPA (2000). Skin removal has been repeatedly used in past California monitoring including the Toxic Substances Monitoring Program, the Coastal Fish Contamination Program, and most southern California NPDES monitoring programs.

Upon collection each fish collected will be tagged with a unique identification number and measured for total length (longest length from tip of tail fin to tip of nose/mouth), fork length (longest length from fork to tip of nose/mouth), and weight. During dissection, each fish will be sexed and the weight of tissue filets recorded

Dissection and compositing of muscle tissue samples will be performed following USEPA guidance (USEPA 2000). There will be a total of three composite samples per species per zone. A total of five specimens will be collected per composite sample. All specimens should be legal size or larger. If more than five specimens are collected, then the middle 75% of the length distribution will be used for the composite. Specimens from this interquartile range will be selected at random for inclusion in each composite.

C.4. Contaminants

Each composite sample will be analyzed for PCB congeners, DDT isomers and metabolites, and mercury (Table 4). Reporting levels shall be consistent with OEHHA thresholds for comparative purposes. Quality assurance activities shall focus on accuracy, precision, sensitivity, and comparability (Table 4).

Samples will be distributed among four laboratories (Table 5). There is an estimated 216 samples total for this element of the Bight'08 regional monitoring program (24 zones x 3 species x 3 replicates per species). The effort will be shared equally among organic and inorganic analytes.

Table 4. List of constituents and data quality objectives.

Analyte	Reporting Level (ng/wet g)	Accuracy	Precision	Frequency
Total PCB[a]	2	70-130% of certified 95% CI *or* 50-150% of uncertified reference values	Duplicate RPD ± 25%	5%
Total DDT[b]	10			
Toxaphene	5			
Chlordane[c]	5			
Dieldrin	5			
methyl-Mercury[d]	20	75-125% of certified 95% CI	Duplicate RPD ± 25%	5%

[a] Congeners 18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, 206 (optional 8, 27, 29, 31, 33, 56, 60, 64, 95, 97, 141, 146, 158, 174, 198/199, 200, 203, 209)

[b] o,p'- and p,p'- isomers of DDT, DDE, and DDD, plus p,p'-DDMU

[c] cis- and trans-chlordane, hepatachlor, heptachlor epoxide, cis and trans-nonachlor, and oxy chlordane

[d] Can be measured as total Hg

Table 5. Laboratory effort (number of samples).

Agency	Organics	Mercury
City of San Diego	90	90
City of Oxnard	45	45
San Diego Regional Harbor Monitoring Program	54	54
Los Angeles County Sanitation District	27	27
TOTAL	216	216

PRODUCTS AND TIMELINES

Two primary data products shall be produced for this study. The first data product will identify the extent of fish contaminant guideline exceedences (Fig 1). This graphic will quantify the number or proportion of fishing zones that exceed fish contaminant guidelines. If few zones exceed fish contaminant guidelines, then little or no action may occur. However, if a large fraction of fishing zones exceed fish contaminant guidelines then further action will be necessary including notifying OEHHA for fish advisory updates. Multiple graphics may be created for each species evaluated. The second data product will focus on spatial gradients in fish contamination (Fig 2). This will be used to assess if specific locations in the SCB should receive additional attention both in terms of fish advisories and potential follow up work to further refine fish contamination issues such as sources of pollutants.

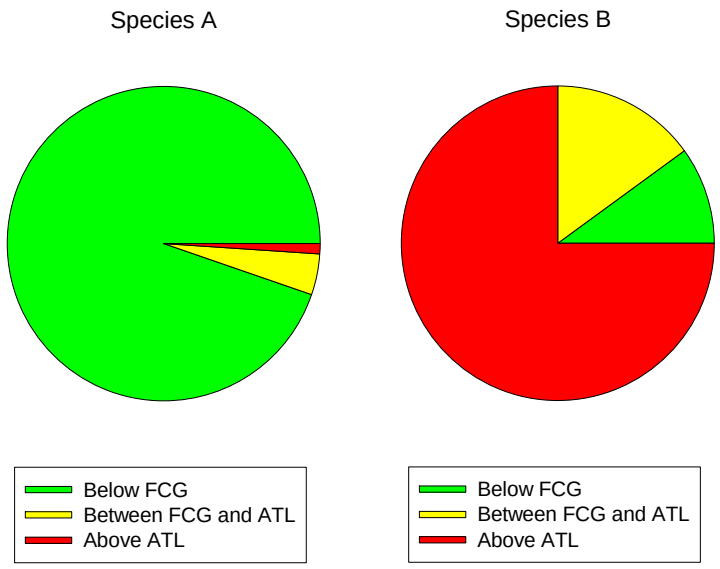

Figure 1. Example data for extent of fish contamination. FCG = Fish Contaminant Guideline. ATL = Advisory Tissue Level.

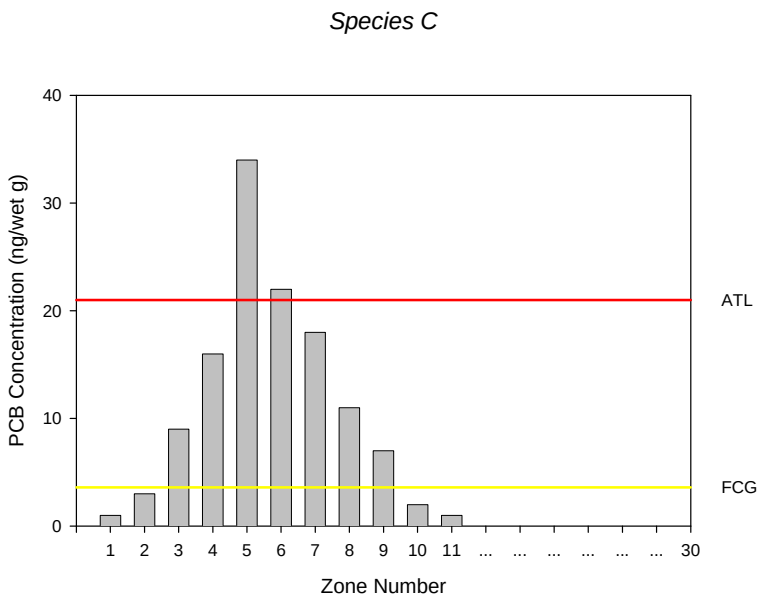

Figure 2. Example data showing the spatial gradient in fish contamination. FCG = Fish Contaminant Guideline. ATL = Advisory Tissue Level.

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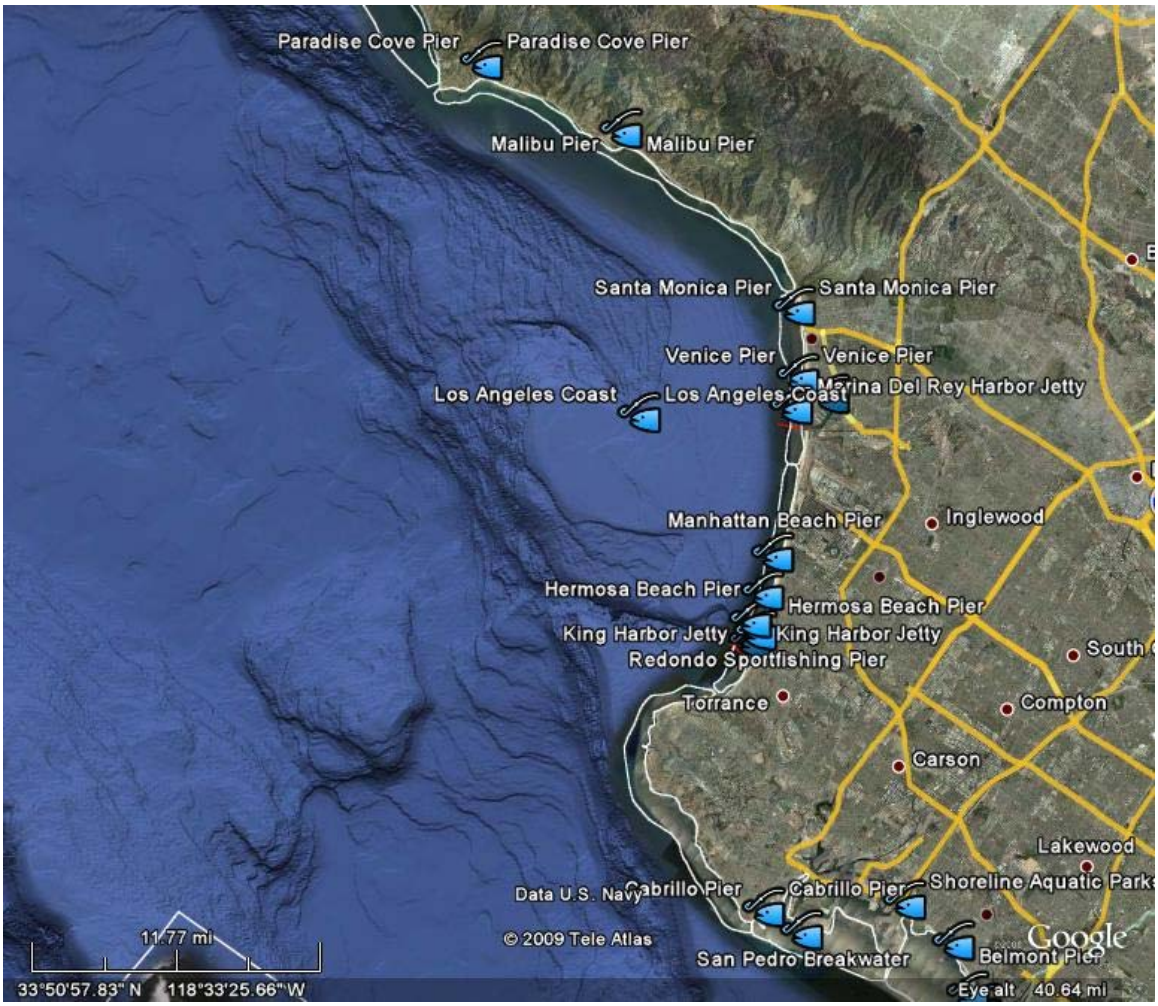
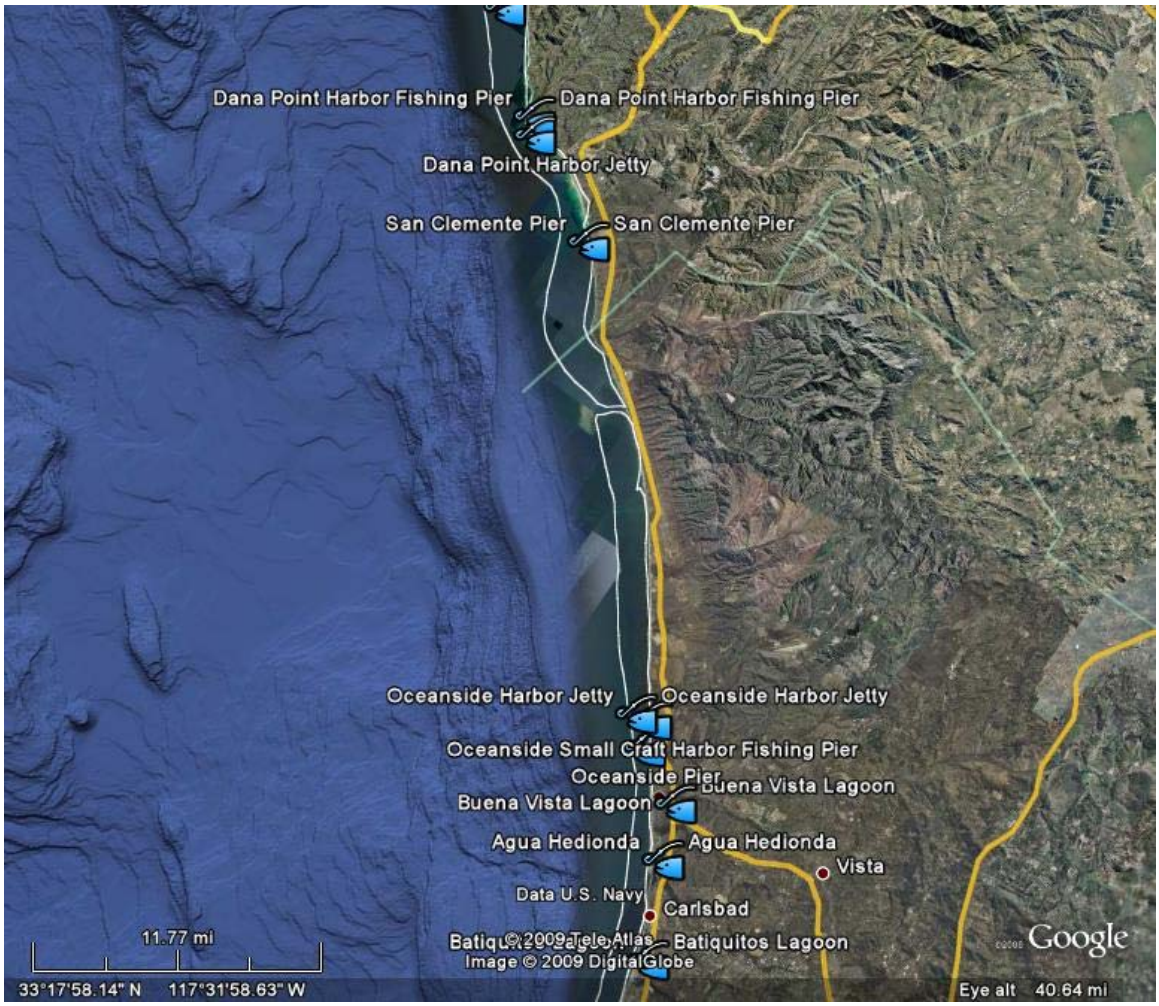
APPENDIX A: MAPS OF FISHING ZONES

Fishing zones from the Gaviota Pier to the Port Hueneme Harbor Jetty, including San Miguel, Santa Rosa, Santa Cruz, and Anacapa Islands.

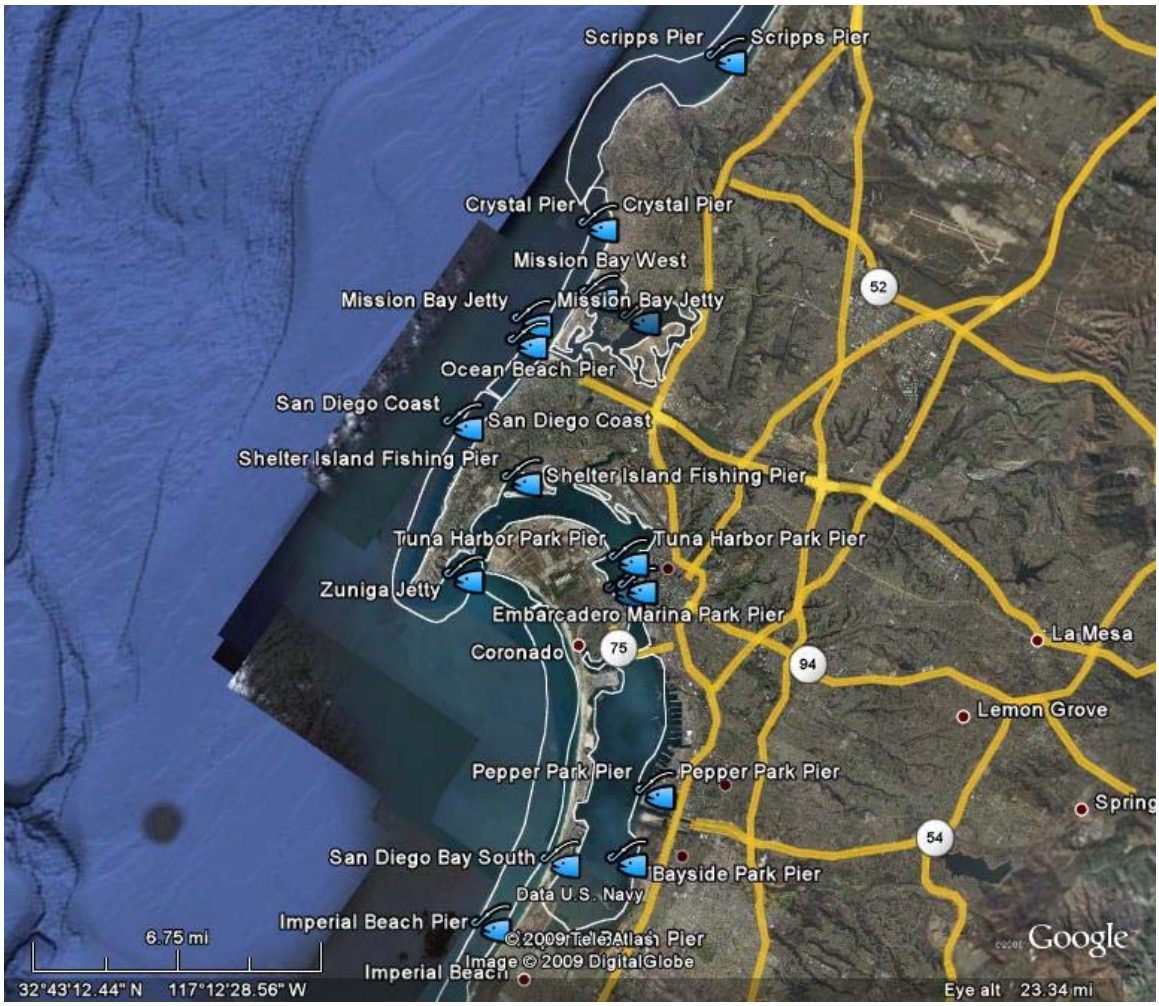


Fishing zones from the Paradise Cove Pier to the Belmont Pier.

Fishing zones from the San Pedro Breakwater to the Dana Point Harbor Fishing Pier.



Fishing zones from the Dana Point Harbor Fishing Pier to Batiquitos Lagoon.



Fishing zones from the Scripps Pier to Imperial Beach.

APPENDIX B: LAB LOADING

Zone Number	Zone Description	Organics (3 replicates per species)			Inorganics (3 replicates per species)		
		Spp 1	Spp 2	Spp 3	Spp 1	Spp 2	Spp 3
1	Tijuana River to North Island	CSD	CSD	CSD	CSD	CSD	CSD
2	San Diego South Bay	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP
3	San Diego North Bay	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP
4	Point Loma	CSD	CSD	CSD	CSD	CSD	CSD
5	Mission Bay	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP
6	Pt Loma to La Jolla	CSD	CSD	CSD	CSD	CSD	CSD
7	La Jolla to San Onofre	CSD	CSD	CSD	CSD	CSD	CSD
8	San Onofre to Crystal Cove	CSD	CSD	CSD	CSD	CSD	CSD
9	Crystal Cove to Santa Ana River	CSD	CSD	CSD	CSD	CSD	CSD
10	Newport Bay	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP
11	Santa Ana River to Seal Beach	CSD	CSD	CSD	CSD	CSD	CSD
12	Long Beach to San Pedro	LACSD	LACSD	LACSD	LACSD	LACSD	LACSD
13	Palos Verdes	LACSD	LACSD	LACSD	LACSD	LACSD	LACSD
14	South Santa Monica Bay	LACSD	LACSD	LACSD	LACSD	LACSD	LACSD
15	Middle Santa Monica Bay	OXN	OXN	OXN	OXN	OXN	OXN
16	North Santa Monica Bay	OXN	OXN	OXN	OXN	OXN	OXN
17	Pt Dume to Oxnard	OXN	OXN	OXN	OXN	OXN	OXN
18	Ventura to Rincon	OXN	OXN	OXN	OXN	OXN	OXN
19	Rincon to Goleta (plus oil platforms)	OXN	OXN	OXN	OXN	OXN	OXN
20	Goleta to Pt Conception	CSD	CSD	CSD	CSD	CSD	CSD
21	Northern Channel Islands	CSD	CSD	CSD	CSD	CSD	CSD
22	Catalina Island	CSD	CSD	CSD	CSD	CSD	CSD
23	Oceanside Hbr	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP
24	Dana Pt Hbr	RHMP	RHMP	RHMP	RHMP	RHMP	RHMP