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

Coastal Ecology Workplan

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I. INTRODUCTION

The Southern California Bight (SCB; Figure 1), an open embayment in the coast between Point Conception and Cape Colnett (south of Ensenada), Baja California, is an important and unique ecological resource. The SCB is a transitional area that is influenced by currents from cold, temperate ocean waters from the north and warm, tropical waters from the south. In addition, the SCB has a complex topography, with offshore islands, submarine canyons, ridges and basins, which provide a variety of habitats. The mixing of currents and the diverse habitats in the SCB allow for the coexistence of a broad spectrum of species, including more than 500 species of fish and several thousand species of invertebrates. The SCB is also a major migration route, with marine bird and mammal populations ranking among the most diverse in north temperate waters.

The coastal zone of the SCB is a substantial economic resource. Los Angeles/Long Beach Harbor is the largest commercial port in the United States, and San Diego Harbor is home to one of the largest US Naval facilities in the country. More than 100 million people visit southern California beaches and coastal areas annually, bringing an estimated $9B into the economy. Recreational activities include diving, swimming, surfing, and boating, with about 40,000 pleasure boats docked in 13 coastal marinas within the region (NRC 1990). Recreational fishing brings in more than $500M per year.

The SCB is one of the most densely populated coastal regions in the country, which creates stress upon its marine environment. Nearly 20 million people inhabit coastal Southern California, a number that is expected to increase another 20% by 2010 (NRC 1990). Population growth generally results in conversion of open land into non-permeable surfaces. More than 75% of southern Californian bays and estuaries have already been dredged and filled for conversion into harbors and marinas (Horn and Allen 1985). This "hardening of the coast" increases the rate of runoff and can impact water quality through addition of sediment, toxic chemicals, pathogens and nutrients to the ocean. Besides the impacts of land conversion, the SCB is already home to fifteen municipal wastewater treatment facilities, eight power generating stations, 10 industrial treatment facilities, and 18 oil platforms that discharge to the open coast.

Each year, local, state, and federal agencies spend in excess of $31M to monitor the environmental quality of natural resources in the SCB (Schiff *et al*. 2001). At least 75% of this monitoring is associated with National Pollutant Discharge Elimination System (NPDES) permits and is intended to assess compliance of waste discharge with the California Ocean Plan and the federal Clean Water Act, which set water quality standards for effluent and receiving waters. Some of this information has played a significant role in management decisions in the SCB.

While these monitoring programs have provided important information, they were designed to evaluate impacts near individual discharges. Today, resource managers are being encouraged to develop management strategies for the entire SCB. To accomplish this task, they need regionally-based information to assess cumulative impacts of contaminant inputs and to evaluate relative risk among different types of stresses. It is difficult to use existing data to evaluate regional issues because the monitoring was designed to be site-specific and is limited to specific geographic areas. The monitoring provides substantial data for some areas, but there is little or no data for the areas in between. Beyond the spatial limitations, data from these programs are not easily merged to examine relative risk. The parameters measured often differ among programs. Even when the same parameters are measured, the methodologies used to collect the data often differ and interlaboratory quality assurance (QA) exercises to assess data comparability are rare.

A. Previous Regional Monitoring Studies

There have been three previous regional monitoring efforts to begin addressing environmental concerns at larger spatial scales. The first regional monitoring survey in 1994, called the Southern California Bight Pilot Project (SCBPP), was a compilation of 12 agencies that cooperatively sampled 261 sites along the continental shelf between Point Conception and the United States/Mexico border. The second regional monitoring survey, called the Southern California Bight 1998 Regional Monitoring Project (Bight'98), was comprised of 64 agencies that cooperatively sampled 416 sites between Point Conception and Punta Banda, Mexico and included new habitats such as ports, bays, and marinas. The third regional monitoring survey, called the Southern California Bight 2003 Regional Monitoring Project (Bight'03), was comprised of 65 agencies that cooperatively sampled 391 sites between Point Conception and the United States/Mexico border, and expanded the number of habitats from Bight'03 to include estuaries and deep ocean basins. The increase in the number of sites and sampled habitats is a reflection of the value of this type of monitoring approach and positive interactions among organizations.

Benefits derived from the previous surveys included the development of new useful technical tools that could only be developed with regional data sets and participation by multiple organizations. For example, the project produced iron-normalization curves for the SCB, allowing distinction between natural and anthropogenic contributions of metals in sediments (Schiff and Weisberg 1998). A Benthic Response Index was developed that integrates complex benthic infaunal data into an easily interpreted form that describes the degree of perturbation at a site (Bergen *et al.* 1998). These types of tools have culminated in management tools such as the State of California's sediment quality objectives (ref). The Bight Regional Surveys have also improved the comparability among the monitoring organizations in the SCB. The quality assurance and quality control (QA/QC) significantly improved following laboratory intercalibration exercises for chemistry, group training for field crews, and taxonomic resolution for biologists. The Regional Monitoring Program has also produced a series of manuals containing standardized field, laboratory and data management activities that increased continuity of data and data reporting among participants, even after the regional monitoring surveys were completed. Many of these manuals are now mandated in NPDES monitoring and reporting programs regionwide.

B. 2008 Survey

The proposed Southern California Bight 2008 Regional Monitoring Project (Bight'08) is a continuation of the successful cooperative regional-scale monitoring begun in southern California. Bight'08 builds upon the previous successes and expands on the 2003 survey by including new participants, answering additional questions, and measuring more parameters or using novel methods. Sixty organizations, including international and volunteer organizations, have agreed to participate (Table 1). The inclusion of multiple participants, many of them new to regional monitoring, provides several benefits. Cooperative interactions among many organizations with different perspectives and interests, including a combination of regulators and dischargers, ensure that an appropriate set of regional-scale questions will be addressed by the study.

The Bight'08 Survey is organized into six technical components: 1) Coastal Ecology, 2) Shoreline Microbiology, 3) Water Quality, 4) Hard Bottom, 5) Areas of Special Biological Significance, and 6) Nutrient Overenrichment in Wetlands. Coastal ecology focuses on sediment contaminants and associated impacts on benthic infauna and demersal fish. This work plan provides a summary of the project design. The work plan is supported by three companion documents detailing Field Methods and Logistics, Quality Assurance (QA), and Information Management. Separate work plans are also available for the other elements of Bight'08.

Figure 1. The Southern California Bight.

Table 1. Participants in the Bight'08 Regional Monitoring Program. Asterisk indicates participants in the coastal ecology component.

AES Corporation*
Aquatic Bioassay and Consulting Laboratories (ABCL)*
California State University at Channel Islands
California State University at Long Beach*
Channel Islands National Marine Sanctuary (CINMS)*
Chevron USA Products Company*
City of Los Angeles Environmental Monitoring Division (CLAEMD)*
City of Oceanside*
City of Oxnard*
City of San Diego*
City of Ventura
Copper Development Association*
Encina Wastewater Authority*
Houston Industries, Inc.*
Jet Propulsion Laboratory
City of Los Angeles, Department of Water and Power (LADWP)*
Los Angeles County Dept. of Beaches & Harbors*
Los Angeles County Dept. of Health Services
Los Angeles County Dept. of Public Works
Los Angeles Regional Water Quality Control Board*
Los Angeles County Sanitation Districts (LACSD)*
Marine Biological Consultants
Marine Corps Base - Camp Pendleton
Minerals Management Service
National Oceanic and atmospheric Administration (NOAA)*
National Park Service*
Nautilus Environmental, Inc.*
NES Energy, Inc.*
NRG Energy, Inc.*
Occidental College*
Orange County Environmental Health Division
Orange County Public Facilities and Resources (OCPFRD)
Orange County Sanitation District (OCSD)*
Port of Long Beach*
Port of Los Angeles*
Port of San Diego*
Reliant Corporation*
San Diego County Dept. of Environmental Health*
San Diego Regional Water Quality Control Board (SDRWQCB)*
San Elijo Joint Powers Authority*
Santa Ana Regional Water Quality Control Board*
State Water Resources Control Board*
Santa Monica Bay Restoration Commission
Southern California Wetland Recovery Project
Tijuana Estuary National Estuarine Research Reserve
University of California at Santa Barbara
University of California at Los Angeles
University of Southern California*
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey*
Weston Solutions, Inc.*

II. STUDY DESIGN

A. Study Objectives

The overall goal of the coastal ecology component of Bight'08 is to assess the condition of the benthic environment and the health of the biological resources in the SCB. To accomplish this goal, Bight'08 will focus on three primary objectives:

1) Estimate the extent and magnitude of ecological change in the SCB,
2) Determine the trends in extent and magnitude of ecological change in the SCB, and
3) Determine the mass balance of pollutants that currently reside within the SCB.

The first objective, estimating the amount of area (i.e., number of acres) in the SCB that ecological conditions differ from reference conditions, is a departure from traditional approaches to environmental monitoring that generally focus on estimating average condition. Estimating the areal extent of ecological change offers several advantages. First, it provides a more direct assessment of status. For instance, identifying that the average Shannon-Weiner (H') benthic diversity in the SCB is 3.12 provides less useful information for environmental managers than does identifying what percentage of the area in the SCB has impaired biological communities. A corollary to this concept is the assessment of regional reference condition. Since most monitoring programs in the SCB are site specific, assessment of regional reference condition allows managers to determine how similar (or different) are their individual sites to the breadth and depth of natural variation in the SCB.

There are two sub-objectives within the areal extent and magnitude objective. The first sub-objective is to determine if the areal extent and magnitude vary among geographic regions. If we answer this question, then managers can determine if specific areas are in worse condition than others, such as areas near anthropogenic inputs versus those areas distant from inputs. Therefore, Bight'08 will compare condition among 10 geographic areas of interest (Table 2). These subpopulations of our study area were selected to represent a range of natural and potentially affected habitats, and are inclusive of all the habitats sampled in 2003. There are two habitats subsumed within coastal shelf strata from Bight'03; large and small POTWs. Managers felt that sufficient information was already being collected at POTW outfall sites as part of their routine monitoring programs that the additional strata were unnecessary. In contrast, there are two strata in Bight'08 split from a single stratum in Bight'03; ports and bays. The break in these two embayment areas is a reflection of the desire to assess potential spatial differences due to industrial activities. Comparison of the relative condition among strata not only provides information about the geographic distribution of impacts, it also allows comparison of relative risk from a variety of point and non-point source discharges. Comparison of conditions may be conducted by comparing the extent of area exceeding a threshold of concern or by comparison of mean condition.

The second sub-objective within the areal extent and magnitude objective is assessing the relationship between biological responses and contaminant exposure. Such associations provide the information necessary for risk assessment, and for developing efficient regional strategies for protecting the environment by identifying the predominant types of stress in the SCB ecosystem. Therefore, this subobjective will be accomplished by simultaneously collecting numerous measures of biological response, contaminant exposure and habitat condition (Table 3) to better identify when exposure has reached a level of concern. Measuring multiple indicators also permits us to identify the most likely type of exposure leading to biological response.

The second primary objective is to assess trends in estimates of areal extent. If conditions in the Bight change over time such that some areas improve and others worsen, the average condition might not change. By estimating the areal extent of alteration, we will be better able to describe these changes. Because of the desire to understand these changes, the Bight'08 program has made trends detection one of its primary goals. While an assessment of trends in areal extent has been attempted following previous surveys, these attempts were hindered largely because we lacked estimates of inter-survey variability. In order to accommodate the need for modeling this component of variability, we have modified the design in Bight'08 to incorporate revisiting randomly selected sites from previous surveys in 1998 and 2003.

The third primary objective is to create a mass balance of contaminants in the SCB. This objective recognizes that local monitoring programs only measure a portion of what is discharged and that only a small portion of the SCB is sampled to assess where these discharges finally deposit. Ultimately, contaminant inputs to the SCB are cumulative both among sources and over time and both environmental managers and the public want to know what fraction of the contaminants that are discharged remain in the SCB and where they are accumulating. In Bight'03, this objective was addressed by quantifying the mass of contaminants in sediment, water column, and biological compartments. The vast majority of these contaminants were found in sediments and over half of the sediment contaminant mass was found in the deep ocean basins (>200 m) where no monitoring occurs. The goal of Bight'08 is to further this mass balance assessment by enhancing measurements in the deep ocean basins to provide confidence in our assessment of contaminant mass.

B. Sampling Design

The coastal ecology sampling design for Bight'08 will be divided into two components. These include: 1) areal extent, magnitude, and trends; and 2) mass balance.

Areal Extent, Magnitude, and Trends

The areal extent, magnitude, and trends component of Bight'08 will involve sampling 360 sites for sediments in the SCB between July 1 and September 30, 2008. The summer period was chosen for the study because it represents a period of steady weather during which the indicators we measure are expected to remain stable.

Maps of the sampling sites are provided in Appendix A. Sites were selected using a stratified random approach, with the strata corresponding to the subpopulations of interest in Table 2. Stratification ensures that an appropriate number of samples are allocated to characterize each population of interest with adequate precision. We aimed to allocate thirty sites to each strata because this yields a 90% confidence interval of about ± 10% around estimates of areal extent (assuming a binomial probability distribution and p = 0.2; Figure 2). This level of desired precision was selected because differences in response of less than 10% among subpopulations are unlikely to yield different management decisions.

Sites were selected randomly within strata, rather than by investigator pre-selection, to ensure that they are representative and can be extrapolated to the response of the entire strata. Although sites were selected randomly, a systematic component was added to the selection process to minimize clustering of sample sites. The systematic element was accomplished by using an extension of the sampling design used in the SCBPP and in EPA's Environmental Monitoring and Assessment Program (EMAP; Stevens 1997). A hexagonal grid was randomly placed over a map of the sampling area, a subsample of hexagons chosen from this population, and one sample was obtained at a randomly selected site within each grid cell. The hexagonal grid structure ensures systematic separation of the sampling, while the random selection of sites within grid cells ensures an unbiased estimate of ecological condition. Further details about this site selection process are provided in Appendix B.

One of the design attributes of Bight'08 is to maximize the coincidence of indicators, allowing us to relate biological response to chemical exposure and physical habitat condition. The number of sites sampled for each indicator group within each strata are presented in Table 4. To maximize overlap of indicators, sites that receive fewer indicator measurements were randomly chosen (with a systematic element) as a subset of the sites at which all indicators are measured.

Approximately half of the sites in each of seven strata are revisits of previously sampled sites in order to help assess trends. These strata include the 5 - 30 m, 30 - 120 m, and 120 - 200 m depth zones on the coastal shelf as well as marinas, ports, bays and estuaries. One quarter of the sites will be from Bight'98, one quarter will be from Bight'03, and the remaining one half will be new sites for Bight'08. All of these sites will be randomly selected and spatially unbiased so estimates of spatial extent are still valid.

Mass Balance

The focus of the mass balance study is on contaminants in sediments of the deep ocean basins. The contaminants of interest include trace metals and chlorinated hydrocarbons (total DDT and total PCB; Table 5). These constituents were selected because they are representative of two major classes of contaminants that have been, or continue to be, released into the environment.

The focus on the deep ocean basins is a reflection of work previously done that indicated this habitat has some of the greatest mass for most of the contaminants of interest. Fifty percent, or more, of the contaminant mass in the SCB may be found in deep basin sediments. Therefore, three basins will be targeted including Santa Monica Basin, San Pedro Basin, and the San Diego Trough (Figure 1). Targeting these areas will help us to refine our mass estimates for these habitats.

In order to estimate the mass of contaminants in sediments, the sampling design requires not only sediment concentrations, but estimates of sediment accumulation rates. We will focus on deriving sediment concentration inventories and accumulation rates empirically. This approach mimics and compliments the previous work done in Bight'03, enabling us to integrate the two data sets. The Bight'08 study design consists of 40 box cores (20 x 30 x 60 cm) collected between 200 to 1000 m water depth from Los Angeles to San Diego. Subcores will be taken from each box core for sediment chemistry and radiochemical analysis. Sediment accumulation rates will be measured using ^{210}Pb geochronological techniques. Sediment chemistry will be conducted on four or more downcore sections from each box core that date back to at least 1900.

C. Indicators

Bight'08 will measure multiple indicators (Table 3) at each site in order to relate contaminant exposure, biological response, and habitat condition. Collecting measures of contaminant exposure with measurements of biological response at common sites allows investigators to identify and statistically model associations between altered ecological conditions and particular environmental stresses. Habitat indicators help to discriminate between changes caused by anthropogenic and natural factors.

One design principle of Bight'08 is that these indicators will be measured using uniform sampling methods throughout the Bight. The probability-based sampling design provides a framework for integrating data into a comprehensive regional assessment, but the validity of such an assessment depends on ensuring that all the data that contribute to it are comparable. Below, we present a short description of the methods used to measure the Bight'08 indicators; more detailed descriptions of the methods can be found in the accompanying Field Methods and Quality Assurance Manuals for the project.

Contaminant Exposure

Sediment Chemistry: Chemical analysis of sediment samples provides an assessment of contaminant exposure for bottom dwelling animals. Sediment samples will be collected from the top 2 cm (coastal sites) or top 5 cm (embayments) of a Van Veen grab sample. The chemical analyte list includes both inorganic and organics (Table 5) and was developed to include comparisons to local programs and to national monitoring datasets such as NOAA's Status and Trends program. The constituent list and associated reporting limits was specifically developed for comparison to sediment quality guidelines such as the State of California's sediment quality objectives (SWRCB 2008) or NOAA sediment quality guidelines for anticipated biological effect (Long *et al*. 1995). All chemistry measurements will follow performance-based quality assurance guidelines described in the Bight'08 Quality Assurance Plan.

Organics: Organic compounds in sediments will be extracted with solvents and cleaned to remove interfering substances. PAHs will be analyzed by GC/MS. Organochlorine pesticides and polychlorinated biphenyls will be analyzed by Gc/ECD, GC/MS, or GC/MS/MS. The accuracy of PCB measurements will be enhanced by measuring 41 individual congeners in all samples with elevated concentrations. The PCB congener list was selected to include compounds that are abundant in the environment and compounds with a high potential for toxicity. New to the Bight'08 survey will be measurements of pyrethroid pesticides.

Inorganics: Metals in sediments will be analyzed by ICP, ICPMS, or atomic absorption spectrophotometry after strong acid digestion. Mercury will be analyzed by cold vapor technique. In addition to trace metals, the reference elements iron and aluminum will also be measured in each sample. Normalization of the trace metal data to reference element concentrations will enable anthropogenic contamination to be distinguished from natural variations in background concentrations.

Radiochemistry: Radiochemical analyses will be conducted on sediment recovered by box corers as part of the Mass Balance study. Sediment samples will be prepared following techniques described by Alexander *et al*. (1993) and radiochemical activities (^{210}Pb) will be determined by gamma spectrometry.

Marine Debris: The amount of plastic, metal and other anthropogenic debris on the bottom is a measure of human influence on the bottom. Debris captured in trawls will be classified by type (e.g., plant material, plastic, and cans) and scored according to relative abundance.

Biological Response

While indicators of contaminant exposure provide an important measure of the influence of anthropogenic materials on the marine and estuarine environments, it is the effect of this exposure upon biological processes that determines the significance of the contaminants. The effect of contaminant exposure will be examined through a variety of indicators:

Benthic Infauna: Benthic infauna (animals that live in the sediment) are an important part of the ocean food web. Because infauna generally reside in one location for most of their lives and are chronically exposed to sediment contaminants, they are an excellent indicator of environmental quality. Samples for infaunal analysis will be taken with a 0.1 m^2 modified Van Veen grab. Samples will be washed through a 1.0 mm stainless steel screen and preserved for identification to the lowest practical taxonomic unit.

Demersal Fish and Megabenthic Invertebrate Assemblages: Demersal fish and megabenthic invertebrates are more mobile than the benthic infauna, but are still closely associated with the bottom and chronically exposed to sediment contaminants. Demersal fish and megabenthic invertebrates will be collected with a semiballoon otter trawl with 7.6-m headrope length and a 1.3 cm cod-end mesh. Trawls will be towed for 10 minutes at 0.8 to 1.0 m/s along depth isobaths (5 minutes in harbors). All fish and most invertebrates will be identified to species, counted, and weighed.

Gross Fish Pathology: The presence and extent of external diseases (e.g., fin rot and tumors) and anomalies (e.g., skeletal deformities or abnormal coloration) will be recorded from fish collected in the trawls for assemblage analysis. Specimens with unusual or unidentified conditions will be returned to the laboratory for detailed examination.

Sediment Toxicity: Toxicity tests provide a direct measure of the effect of contamination on benthic organisms. These tests complement sediment chemistry measurements by providing a measure of the combined toxic effect of the complex mixture of contaminants present in surficial sediments or in the water in the pores between sediment grains (interstitial water). The toxicity of bulk sediments will be assessed by measuring survival of the amphipod, *Eohaustorius estuarius,* after exposure for 10 days. In addition, the normal development of the bivalve, *Mytilus galloprovincialis,* will be measured using the sediment:seawater interface test. Both tests support the application of California's sediment quality objectives.

Habitat Condition

The distribution of biota is also affected by natural habitat factors, such as grain size and the amount of organic matter present. Habitat indicators will be measured to help distinguish the relative effects of natural and anthropogenic factors on biotic distribution.

Sediment grain size: Grain size will be measured with a laser diffraction technique, a method that provides greater resolution between particle size classes with less variability than conventional pipette techniques. Two instruments will be used: 1) A Horiba LA920 which measures 89 size classes of particles between 0.05 to 2,000 μm and 2) a Coulter LS230 that measures 116 size classes between 0.04 to 2000 μm.

Sediment Total Organic Carbon (TOC), Total Nitrogen (TN) and Total Phosphorus (TP): TOC and TN will be measured with a Carlo Erba 1108 Elemental Analyzer equipped with an AS/23 Autosampler. Sediment TP will be measured by digestion and measurement of extracts on an autoanalyzer.

Special Studies

The Bight program represents an excellent opportunity to add on special studies and research not routinely conducted for ongoing monitoring programs. Researchers are always looking to test new technology, evaluate new indicators, apply new methods, or explore unanswered questions in new locations. The Bight program comprises an enormous platform of core measurements with indicators typically measured on a routine basis. The merging of the Bight program with researchers provides a positive interaction for both parties. Researchers view the Bight program as a cost efficient vehicle to move their research forward. Bight participants get the added value of their research for essentially no cost. Incorporating new measurements and methods into the Bight program benefits regulated participants in the Bight program because it is not part of a permit requirement and can help determine if a perceived issue is actually a widespread environmental problem. Incorporating their special studies into the Bight program benefits researchers because it allows their work direct access to the important environmental decision makers in the SCB.

There are 10 special studies planned for Bight'08 (Table 6; Appendix D). The studies range across all 10 indicators being measured in Bight'08 incorporating contaminant exposure, biological response, and habitat condition. Nearly all of the special studies supplement existing indicators already being measured as part of the Bight program. For example, the study of new chemical indicators like PBDEs supplement existing chemical measurements or the use of sediment toxicity identification evaluations supplements the standard toxicity assays being conducted with the same species. Several of the special studies also provide integration among one another. For example, the study on pharmaceuticals and personal care products (PPCPs) provides insight into the fish endocrine disruption study because PPCPs can be hormone mimickers, or the AVS/SEM study integrates well with the copper free ion measurements because both are attempting to assess the bioavailable fraction of copper.

Figure 2. Ninety-percent confidence intervals around an estimate of percent of area changed as a function of sample size.

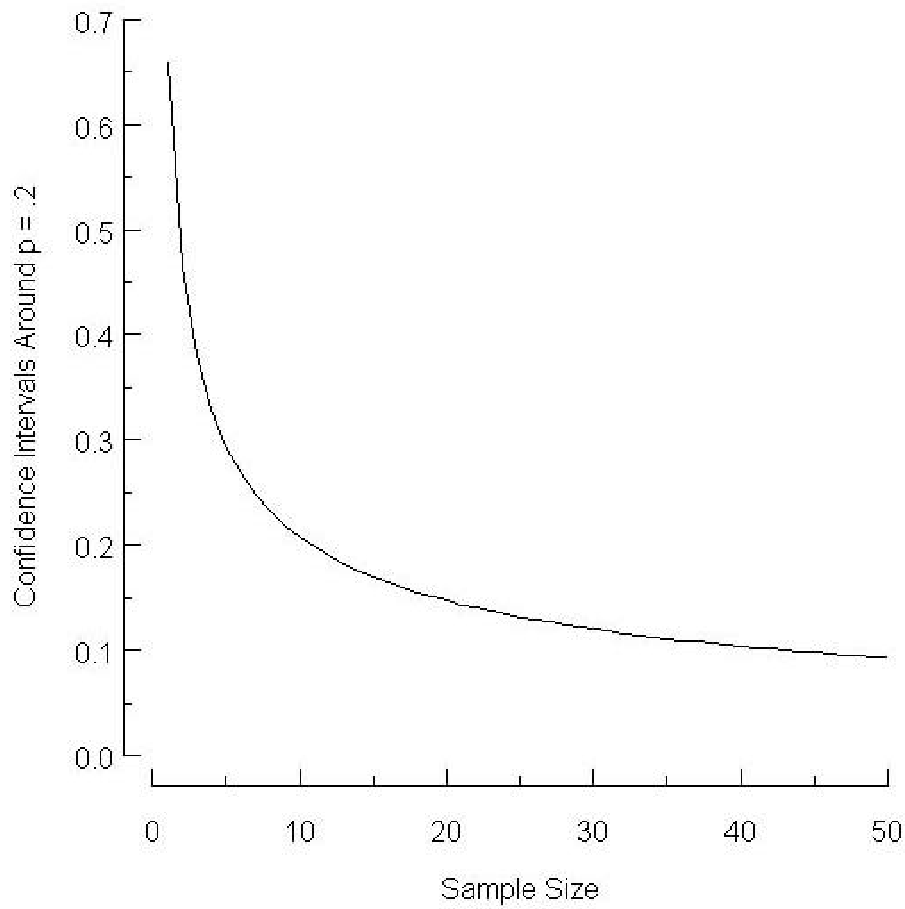

Table 2. Subpopulations of interest in the areal extent and magnitude, trends and mass balance objectives of the Bight'08 Coastal Ecology study.

<u>Offshore Areas</u>

a. Inner shelf (5-30 m)
b. Mid-shelf (30-120 m)
c. Outer shelf (120-200 m)
d. Upper slope (200-500 m)
e. Lower slope and basin (500 – 1,000 m)
f. Channel Islands (30 – 120 m)

<u>Embayment Areas</u>

a. Estuaries
b. Ports
c. Bays
d. Marinas

Table 3. Indicators to be measured in Bight'08.

Contaminant exposure
- Sediment chemistry
- Water column chemistry
- Debris

Biological response
- Benthic infauna
- Fish assemblage
- Fish pathology
- Macroinvertebrate assemblage
- Sediment toxicity

Habitat
- Grain size
- Sediment organic carbon

Table 4. Sample sizes in the subpopulations for Bight'08.

Strata	Sediment Chemistry	Infauna	Trawl	Sed Tox
Offshore Strata				
5 to 30 m	30	30	30	10
30 to 120 m	30	30	30	10
120 to 200 m	30	30	30	10
200 to 500 m	30	30	30	
500 to 1000 m	30	30		
Embayment Strata				
Marinas	30*	30*		30*
Ports	30*	30*		30*
Bays/Harbors	60*	60*	30	60*
Estuaries/Lagoon	60*	60*		60*
Island Strata	30	30		
Target Sample Size	360	360	150	210

* Local enhancements in the San Diego Region.

Table 5. Constituents that will be measured in sediment during Bight'08.

Trace Metals

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Copper
Iron
Lead
Mercury
Nickel
Selenium
Silver
Zinc

Other Constituents
Total Organic Carbon
Total Nitrogen
Total Phosphorus
Grain Size

PCB Congeners

PCB 18
PCB 28
PCB 37
PCB 44
PCB 49
PCB 52
PCB 66
PCB 70
PCB 74
PCB 77
PCB 81
PCB 87
PCB 99
PCB 101
PCB 105
PCB 110
PCB 114
PCB 118
PCB 119
PCB 123
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PCB 187
PCB 189
PCB 194
PCB 201
PCB 206

Chlorinated Hydrocarbons

cis-chlordane
trans-chlordane
o.p'-DDT
p,p'-DDT
o.p'-DDD
p,p'-DDD
o.p'-DDE
p.p'-DDE
p,p'-DDMU
Dieldrin

Polycyclic Aromatic Hydrocarbons

Acenaphthene
Acenaphthylene
Anthracene
Benz[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[e]pyrene
Benzo[g,h,i]perylene
Benzo[k]fluoranthene
Biphenyl
Chrysene
Dibenz[a,h]anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
Naphthalene
Perylene
Phenanthrene
Pyrene
2,6-Dimethylnaphthalene
1-Methylnapthalene
2-Methylnapthalene
1-Methylphenanthrene
1,6,7-Trimethylnaphthalene

Pyrethroid Pesticides

Bifenthrin
Cyfluthrin
lambda-Cyhalothrin
Cypermethrin
Deltamethrin
Esfenvalerate
Fenpropathrin
cis-Permethrin
trans-Permethrin

PolyBrominated Diphenyl Ethers

BDE 17 (2,2',4-TriBDE)
BDE 28 (2,4,4'-TriBDE)
BDE 47 (2,2',4,4'-TetraBDE)
BDE 47 (2,2',4,4'-TetraBDE)
BDE 47 (2,2',4,4'-TetraBDE)
BDE 99 (2,2',4,4',5-PentaBDE)
BDE 100 (2,2',4,4',6-PentaBDE)
BDE 138 (2,2',3,4,4',5'-HexaBDE)
BDE 153 (2,2',4,4',5,5'-HexaBDE)
BDE 154 (2,2',4,4',5,6'-HexaBDE)
BDE 183 (2,2',3,4,4',5',6-HeptaBDE)
BDE 190 (2,3,3',4,4',5,6-HeptaBDE)
BDE 209 (decabromodiphenylether)

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Table 6. Integration of special studies with existing indicators. X = where there is overlap or correlation among measurements.

Special Study	Sediment Chemistry	Marine debris	Infauna	Demersal Fish	Sediment Toxicity	Sediment Grain Size	TOC
Sediment profile camera		X	X			X	X
PBDEs in sediment	X		X		X	X	X
Pharmaceuticals in sediment	X		X	X		X	X
Variability in sampling	X		X		X	X	X
Sediment TIES	X		X		X	X	X
AVS-SEM	X		X		X	X	
Copper free ion measurements	X		X		X	X	X
EDC in flatfish				X			
Forams	X		X		X	X	X
Irgarol in Marinas	X		X		X	X	X

APPENDIX A: SAMPLE SITE MAPS

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/BightPlanningDocuments/Bight08/Bight08_FieldManual_AppendixA.pdf

APPENDIX B: SAMPLE SITE ASSIGNMENTS

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/BightPlanningDocuments/Bight08/Bight08_FieldManual_AppendixB.pdf

APPENDIX C: SAMPLE LABORATORY ASSIGNMENTS

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/BightPlanningDocuments/Bight08/Bight08_FieldManual_AppendixC.pdf

APPENDIX D: SPECIAL STUDIES

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/BightPlanningDocuments/Bight08/Bight08_FieldManual_AppendixD.pdf