Southern California Bight
2003 Regional Marine Monitoring Survey
(Bight'03)

Coastal Ecology Workplan

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I. INTRODUCTION

The Southern California Bight (SCB; Figure I-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.

Previous Regional Monitoring Studies

To begin addressing these concerns, there have been two previous regional monitoring efforts. 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. In both surveys, assessments were made of water quality, sediment contamination, the status of biological resources and species diversity, and the presence of marine debris in depths of 10 to 200m, with some special emphasis in areas of anthropogenic inputs such as large publicly owned treatment works (POTWs) or large river and creek mouths. However, Bight'98 extended what was done in 1994 by adding additional habitats such as offshore islands and inshore areas like bays/harbors, as well as additional areas of anthropogenic inputs such as marinas, ports, and small POTWs. Moreover, a regional evaluation of shoreline water quality was added in 1998 that provided our first evaluation of the swimmability of southern California beaches during dry and wet weather.

Benefits derived from both the SCBPP and Bight'98 also 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). Newer, cheaper microbiological methods were tested and evaluated alongside traditional microbial measurement methods and now have been accepted by both the state health agencies for routine shoreline monitoring (ref). Bight'98 also improved the comparability among the major laboratories in the SCB as a result of the quality assurance and quality control (QA/QC) laboratory intercalibration exercises for chemistry and microbiology. The project 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.

2003 Survey

The proposed Southern California Bight 2003 Regional Monitoring Project (Bight'03) is a continuation of the successful cooperative regional-scale monitoring begun in southern California during the 1990's. Bight'03 builds upon the previous successes and expands on the 1998 survey by including new participants, sampling more habitats, and measuring more parameters or using new methods. [Number] organizations, including international and volunteer organizations, have agreed to participate (Table I-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, ensures that an appropriate set of regional-scale questions will be addressed by the study. The additional resources brought by numerous participants also expands the number of habitats and indicators that will be sampled. Sampling for Bight'03 will include all of the areas sampled in 1998, plus a new focus on nearshore habitats (coastal lagoons) and offshore habitats (inner continental slopes and basins). Several new technologies will be brought to bear in Bight'03 including remote sensing from satellite, aerial, and land-based platforms, new microbial genetic and phenotypic source tracking techniques, and radiodating of sediments to determine age and accumulation of chemicals in sediments.

The Bight'03 Survey is organized into three technical components: 1) Coastal ecology, 2) Shoreline microbiology, and 3) Water quality. This work plan provides a summary of the project design for the coastal ecology component. 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 shoreline microbiology and water quality two components of the program.

Figure 1-1. Map of the Southern California Bight

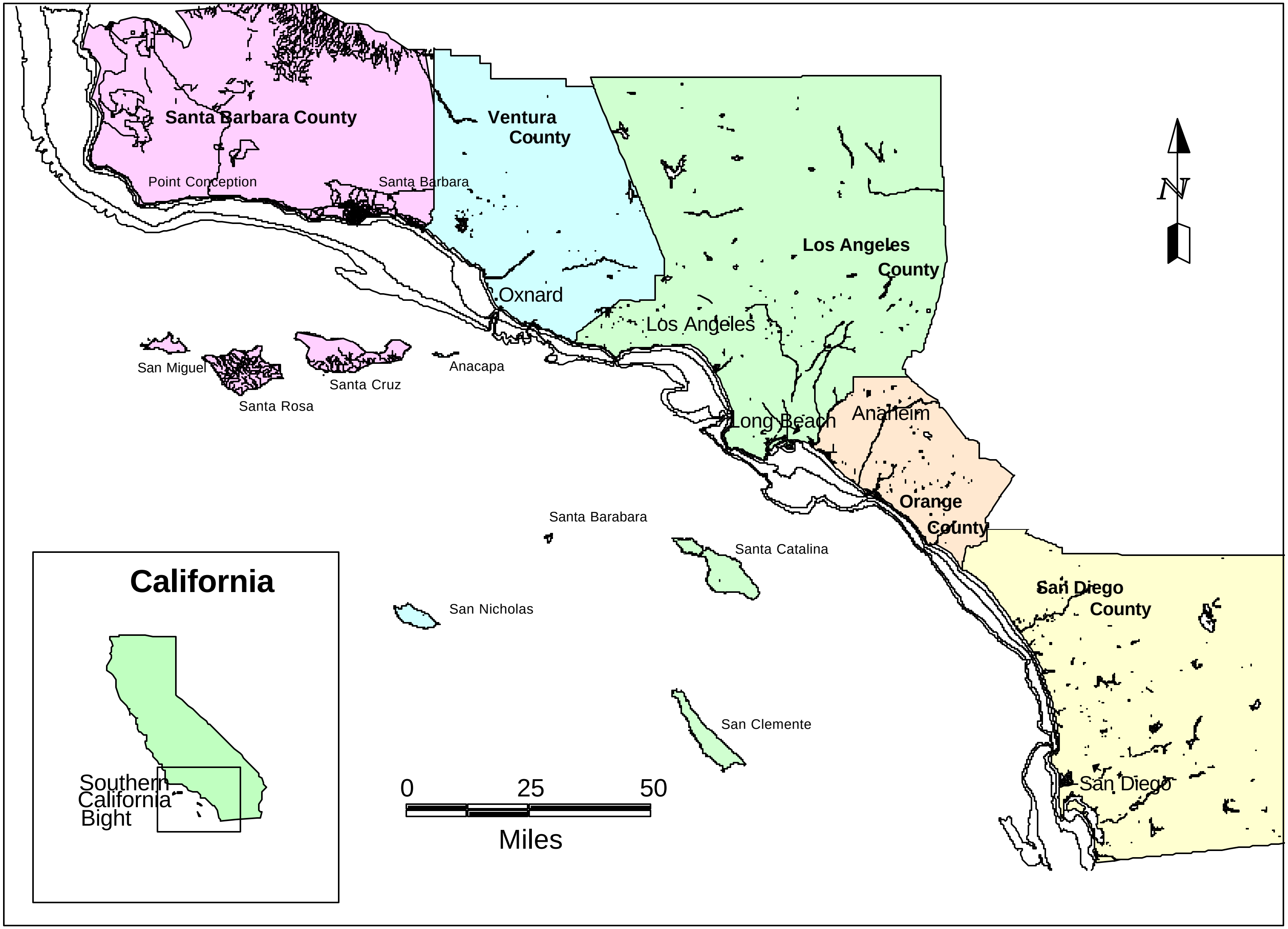


Table 1. Participants in the Bight'03 Regional Monitoring Program. Participants in the Coastal Ecology Component are asterisked.

AMEC Incorporated
Aquatic Bioassay and Consulting Laboratories (ABCL)*
Channel Islands National Marine Sanctuary (CINMS)*
Chevron USA Products Company*
City of Long Beach*
City of Los Angeles Environmental Monitoring Division (CLAEMD)*
City of Oceanside*
City of Oxnard*
City of San Diego*
City of Santa Barbara
City of Ventura
CRG Marine Laboratories*
Encina Wastewater Authority*
Granite Canyon Marine Pollution Studies Lab*
Jet Propulsion Laboratory
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)*
Loyola Marymount University
Marine Biological Consultants
Marine Ecological Consultants
Minerals Management Service
NES Energy, Inc.*
NRG Energy, Inc.*
Orange County CoastKeeper
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 Baykeeper
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*
Santa Barbara Health Care Services
Santa Monica Baykeeper
South Orange County Water Authority (SOCWA)*
Southern California Coastal Water Research Project (SCCWRP)*
Southern California Marine Institute (SCMI)
State Water Resources Control Board (SWRCB)*
Surfrider Foundation
University of California, Los Angeles
University of California, Irvine
University of California, Riverside*
University of California, San Diego
University of California, Santa Barbara
US EPA Region IX*
US EPA Office of Research and Development*
US Geological Survey*
Vantuna Research Group*
Ventura County Environmental Health Division
Ventura County Watershed Protection Division*

II. STUDY DESIGN

A. Study Objectives

The overall goal of the coastal ecology component of Bight'03 is to assess the condition of the bottom environment and the health of the biological resources in the SCB. To accomplish this goal, Bight'03 will focus on two primary objectives:

1. Estimate the extent and magnitude of ecological change in the SCB,

2. 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, which 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 concentration of dissolved oxygen in the Bight is 6.7 ppm provides less useful information for environmental managers than does identifying what percentage of the area in the Bight fails to meet water quality standards. A second advantage of estimating areal extent concerns trend detection. 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.

There are two subobjectives within the areal extent and magnitude objective. The first subobjective 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'03 will compare condition among 11 geographic areas of interest (Table II-1). These subpopulations of our study area were selected to represent a range of natural and potentially affected habitats, and include all of the habitats sampled in 1998. There are three new habitats to be sampled in Bight'03. The first two are located offshore of previously sampled habitats; the upper continental slope (200-500m) and the lower slope and inner basin (500-1000m). The break in deep water strata is a reflection of an ecotone between upper slope and lower slope biological communities. The third habitat is inshore of previous sampled habitats and includes coastal lagoons. 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 subobjective 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 II-2) 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 will create a mass balance of contaminants in the SCB. This objective recognizes that local monitoring programs only address a portion of what is discharged to the SCB and that contaminant inputs to the SCB are cumulative both among sources and over time. Ultimately, both environmental managers and the public want to know what fraction of the contaminants that are discharged remain in the SCB and what fraction leaves the SCB. Therefore, Bight'03 will create an inventory of contaminants that reside in the SCB in sediment, water column, and biological compartments. The total mass of contaminants in these compartments will be compared to estimates of mass discharged from land based activities. Understanding how much mass is in the SCB will require some new measurements including measurements of not just sediment chemistry, but estimates of accumulation rates in sediments, as well as new measurements in the water column.

B. Sampling Design

The coastal ecology sampling design for Bight'03 will be divided into two components in order to efficiently address the areal extent and magnitude objective and the mass balance objective.

<u>Areal Extent and Magnitude</u>

The areal extent and magnitude component of Bight'03 will involve sampling of 360 sites in the SCB between July 14 and September 5, 2003. 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 II-1. 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 II-1). 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'03 is to maximize the coincidence of indicators, allowing us to relate biological response to chemical exposure and physical habitat condition. Measuring all parameters at all sites is not possible because the resources for Bight'03 are primarily in the form of in-kind services provided by participants, and not all participants measure all parameters. The number of sites sampled for each indicator group within each strata are presented in Table II-3. 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.

The number of sites on the maps in Appendix A exceeds the number of sites described in Table II-3 by about 10% in offshore areas and by about 20% in inshore areas. This difference between sample site selection and anticipated number of analytical results is in recognition that it may not be possible to sample all of the randomly-selected sites because of improper substrate type, depth restrictions, or dredging activities. To prevent an unacceptable loss of statistical power due to lost samples, the number of sites allocated was inflated by an expected site rejection rate, determined from historical sampling experience. Should the site rejection rate exceed this inflation factor by more than 10%, an additional set of random sites will be assigned during the survey.

<u>Mass Balance</u>

There are four sampling design elements necessary to address the mass balance objective. These elements include estimating the mass of contaminants in fish, water column, sediments, and discharges from land based activities. This question will focus on trace metals and the chlorinated hydrocarbons total DDT and total PCB (Table II-4). 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, they are conserved in some or all of the mass balance compartments and significant work by others, including SCBPP and Bight'98, can be used to help achieve the study objective. All of the field activities for this design will occur during the summer of 2003.

Contaminant mass in fish will be estimated for both flatfish and pelagic forage fish and squid. Contaminant mass of total DDT and total PCB in flatfish will be estimated using the results from Bight'98 that characterized concentrations and abundance bightwide. Contaminant mass of trace metals in flatfish will be estimated by measuring whole fish composites collected to address the extent and magnitude question for Bight'03. Contaminant mass of total DDT, total PCB, and trace metals in pelagic forage fish and squid will be estimated by randomly subsampling the commercial catch of the three most predominant (in terms of biomass) species. These include Pacific sardine, Northern anchovy, and California market squid whose bightwide commercial landings were 44,640, 7,569, and 70,942 mt in 2001, respectively.

Contaminants in the water column will be sampled using a randomized design, similar to the design utilized for selecting areal extent and magnitude. Ninety sample sites will be used to sample three subpopulations: 1) the Los Angeles/Long Beach Harbor; 2) the Los Angeles margin, which is comprised of shelf, slope and basin habitats from Pt Dume to Newport Beach; and 3) the remainder of the SCB. Samples for trace metals will be collected at four depths using Niskin or VanDorn bottles. However, sampling for total DDT and total PCB is much more difficult due to the inherently low concentrations in seawater. Therefore, samples will be collected using a new *in situ* technology, solid phase microextraction (SPME). This technology utilizes a small fiber coated with extraction media to partition organic contaminants from water. At least four SPMEs, placed at multiple depths, may be deployed at each site for about three weeks.

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 use a nested design for acquiring both data types. The first approach, which estimates sediment mass at the large bightwide scales, will use the surficial sediment concentration data collected as part of the extent and magnitude objective along with published estimates of sediment accumulation.

The second approach, which is more intensive, will focus on deriving sediment concentration inventories and accumulation rates empirically at smaller spatial scales. This approach compliments the first because it provides a validation of the large bightwide scale design, while at the same time improving our confidence in an area of the SCB that received the greatest mass emissions of the indicators we are measuring. The more detailed study design consists of 30 to 40 box cores (20 x 30 x 60 cm) collected from 15–850 m water depth on the Los Angeles margin. 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; biological mixing rates will be determined using ^{234} Th techniques (DeMaste et al., 1985). Sediment chemistry will be conducted on four or more downcore sections from each box core that date back to at least 1900. Finally, the bias between the large scale approach and the more intensive localized approach will be compared by collecting the top 2 cm of sediment from each box core, similar to the large scale approach, above.

Estimates of emissions from most land based activities have already been characterized (i.e. Schiff et al 2001b). We will focus on emissions from large and small POTWs, stormwater runoff, and industrial facilities. However, some of this data is in various forms and sources and still needs to be compiled into a single data source. The point sources shall be the most straightforward of these estimates to compile and calculate; all of these discharges have some form of effluent self-monitoring program. Discharges from stormwater runoff is more complicated in that monitoring frequency, spatial and temporal distribution are less than the monitoring for point sources. Therefore, we will rely on three types of information to produce runoff loading estimates; self monitoring data by permittees, special studies by other agencies, and modeling. As will be evident in the loading estimates, pollutant emissions from land based activities has changed over time. Therefore, changes in sediment mass on the Los Angeles margin will be compared to changes in land based emissions over similar temporal scales.

C. Indicators

Bight'03 will measure multiple indicators (Table II-2) 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 discriminate between changes caused by anthropogenic and natural factors.

One design principle of Bight'03 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'03 indicators; more detailed descriptions of the methods can be found in the accompanying Field Methods and Logistics, and Quality Assurance Manuals for the project.

Contaminant Exposure

1. 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 of a Van Veen grab sample. The chemical analyte list includes both inorganic and organics (Table II-4) and was developed to include contaminants of local interest as well as those measured in the nationwide NOAA Status and Trends program. Measurement reporting limits have been adopted that will allow the data to be compared to NOAA sediment quality guidelines for anticipated biological effect (Long et al. 1995).

Organics

Organic compounds in sediments will be extracted with solvents and cleaned to remove interfering substances. PAHs will be analyzed by GC/MS or HPLC. Organochlorine pesticides and polychlorinated biphenyls will be analyzed by GC/ECD. 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.

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, ^{137}Cs, and ^{234}Th) will be determined by gamma spectrometry. The ^{210}Pb (half-life 22.3 y) method will be used to determine the accumulation rate of sediment on this margin segment. ^{137}Cs activities (half-life 30.0 y), an impulse tracer produced from atmospheric nuclear tests with a peak input in 1964, will be used to constrain the ^{210}Pb accumulation rates. ^{234}Th (half-life 24 days) will be used to determine rates of biological mixing of the sediment column.

2. 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 environment, 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:

3. 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.

4. 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 min at 0.8-1.0 m/s along depth isobaths (5 min in harbors). All fish and most invertebrates will be identified to species, counted, and weighed.

5. 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.

6. 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 sediment or in the water in the pores between sediment grains (interstitial water). Sediment samples will be collected from the top 2 cm of a Van Veen grab sample. The toxicity of bulk sediments will be assessed using an amphipod survival test conducted according to USEPA methods. Amphipods will be exposed to a 2 cm layer of test sediment for 10 days and then examined to determine the percent survival. The amphipod *Eohaustorius estuarius* was selected for this study because of its wide tolerance to variations in habitat characteristics and to provide comparability with recent toxicity information from other monitoring programs in California.

7. Fish Tissue Chemistry: The objective of the fish tissue chemistry measurements will be to estimate health risk to marine birds, mammals and wildlife from the consumption of prey tissue. This will be addressed by measuring the whole body concentration of the chlorinated organics compounds asterisked in Table II-4. In the SCBPP and in Bight'98, benthic fish species were selected that maximized exposure to sediment pathways and increased reliability that fish would be found over a large spatial area (i.e. fish guilds). In Bight'03, we will be focusing tissue chemistry on pelagic forage fish and squid. These species represent an alternate pathway to higher order predators and are predominate prey items to seabirds and some mammals. The primary target species (Table II-5) will be Pacific sardine, Northern anchovy, Pacific mackerel, and California market squid. These species will be collected using two techniques. The first technique will randomly subsample all three target species from commercial landings used for rendering. Landings will be grouped by CDFG fishing block into nearshore, offshore, and channel island strata. The second technique will randomly subsample Northern anchovy from the commercial live bait fishery. This sampling will target live bait barges at nine locations throughout the SCB.

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.

8. 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 LA900 which measures 74 size classes of particles between 0.05-1019 µm and 2) a Coulter LS230 that measures 116 size classes between 0.04-2000 µm.

9. Total Organic Carbon (TOC): TOC will be measured with a Carlo Erba 1108 Elemental Analyzer equipped with an AS/23 Autosampler.

FIGURE II-1. 90% Confidence Intervals about an estimate of percent of area changed as a function of sample size.

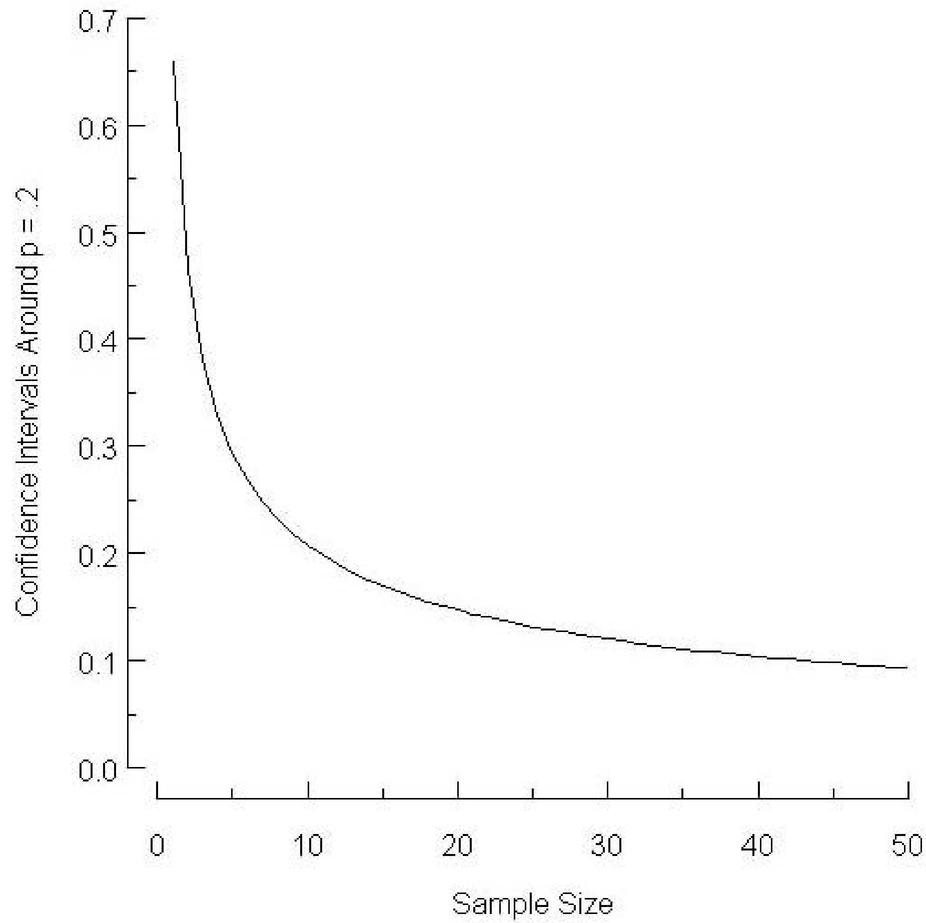


TABLE II-1. Subpopulations of interest in Bight'03.

<u>Input Areas</u>

a. Large POTW Outfalls
b. Small POTW Outfalls

<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 (5 – 200 m)

<u>Inshore Areas</u>

a. Ports/Bays/Harbors
b. Estuaries
c. LA Co. estuaries
d. Marinas

TABLE II-2. Indicators to be measured in Bight'03.

<u>Contaminant exposure</u>
- Sediment chemistry
- Water column chemistry
- Debris

<u>Biological response</u>
- Benthic infauna
- Fish assemblage
- Fish pathology
- Macroinvertebrate assemblage
- Fish tissue chemistry
- Sediment Toxicity

<u>Habitat</u>
- Grain size
- Sediment organic carbon

TABLE II-3. Sample sizes in the subpopulations for Bight'03.

	Sediments	Infauna	Trawl	Sed Tox
Offshore Strata				
5 to 30 m	X	X	X	|
30 to 120 m	X	X	X	X
120 to 200 m	X	X	X	|
200 to 500 m	X	X	X	X
500 to 1000 m	X			
Input Strata				
Large POTW	X	X	X	
Small POTW	X	X	X	
Inshore Strata				
Marinas	X	X	X	X
Ports/Bays/Harbors	X	X	|	X
Estuaries	X	X		X
LA Co. estuaries	X	X		X
Island Strata	X	X	X	X
Target Sample Size	360	330	240	210

TABLE II-4. Constituents that will be measured in sediment and tissues in Bight'03.

	Sediment	Fish		Sediment	Fish
Aluminum	Yes	No	Acenaphthene	Yes	No
Antimony	Yes	Yes	Acenaphthylene	Yes	No
Arsenic	Yes	Yes	Anthracene	Yes	No
Barium	Yes	Yes	Benz[a]anthracene	Yes	No
Beryllium	Yes	Yes	Benzo[a]pyrene	Yes	No
Cadmium	Yes	Yes	Benzo[b]fluoranthene	Yes	No
Chromium	Yes	Yes	Benzo[e]pyrene	Yes	No
Copper	Yes	Yes	Benzo[g,h,i]perylene	Yes	No
Iron	Yes	No	Benzo[k]fluoranthene	Yes	No
Lead	Yes	Yes	Biphenyl	Yes	No
Mercury	Yes	Yes	Chrysene	Yes	No
Nickel	Yes	Yes	Dibenz[a,h]anthracene	Yes	No
Selenium	Yes	Yes	Fluoranthene	Yes	No
Silver	Yes	Yes	Fluorene	Yes	No
Zinc	Yes	Yes	Indeno(1,2,3-c,d)pyrene	Yes	No
chlordane	yes	Yes	Naphthalene	Yes	No
PCB Congeners[a]	Yes	Yes	Perylene	Yes	No
4,4'-DDT	Yes	Yes	Phenanthrene	Yes	No
2,4'-DDT	Yes	Yes	Pyrene	Yes	No
4,4'-DDD	Yes	Yes	2,6-Dimethylnaphthalene	Yes	No
2,4'-DDD	Yes	Yes	1-Methylnapthalene	Yes	No
4,4'-DDE	Yes	Yes	2-Methylnapthalene	Yes	No
2,4'-DDE	Yes	Yes	1-Methylphenanthrene	Yes	No
Total organic carbon	Yes	No	1,6,7-Trimethylnaphthalene	Yes	No
Lipid	No	Yes			

[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, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, 206.

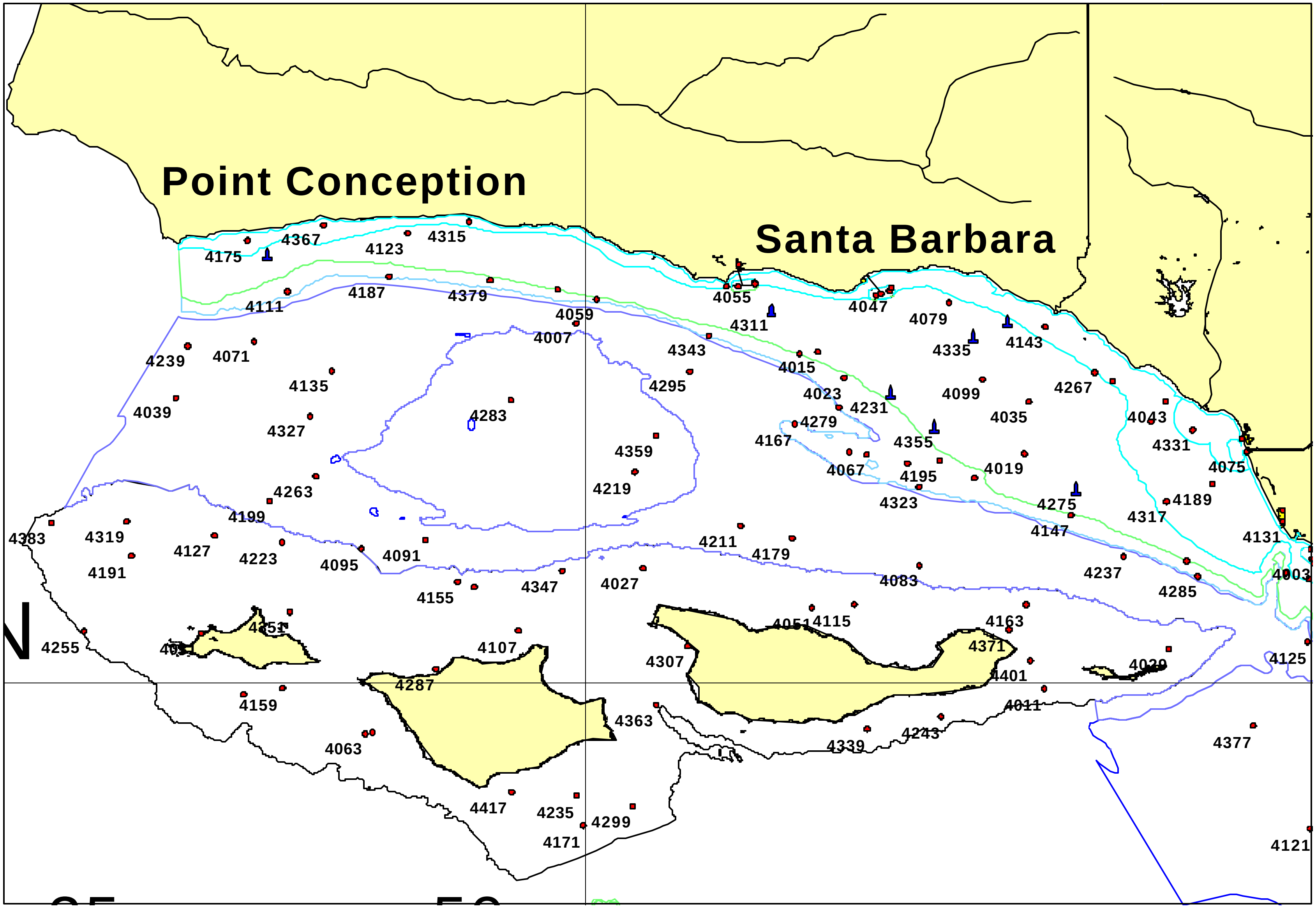
TABLE II-5. Target species for tissue chemistry analysis.

Common Name	Scientific Name
Northern anchovy	*Engraulis mordax*
Pacific sardine	*Sardinops sagax*
California market squid	*Loligo opalescens*
Chub mackeral	*Scomber japonicus*

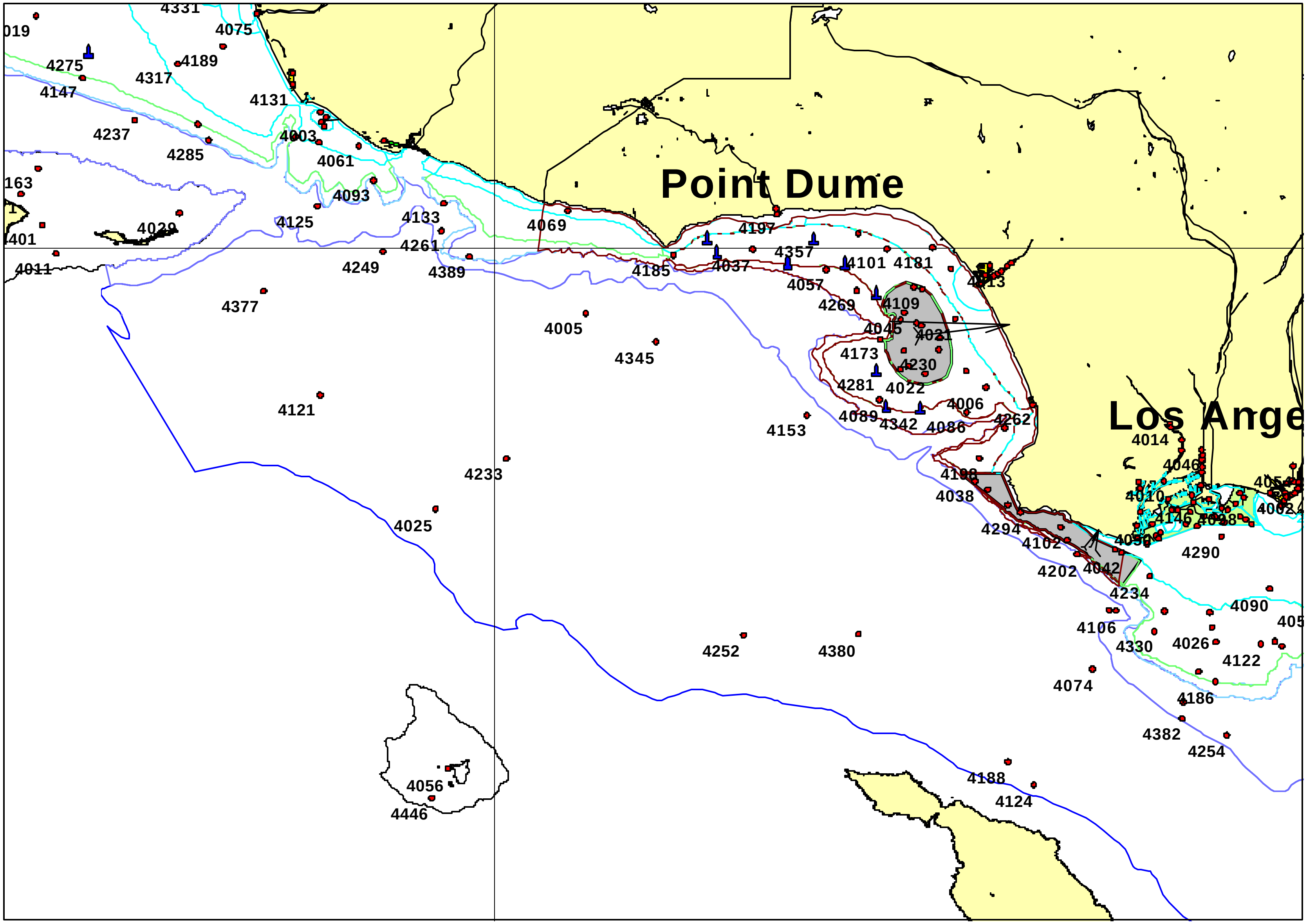
APPENDIX 1

BIGHT'03 STATION LOCATION CHARTS

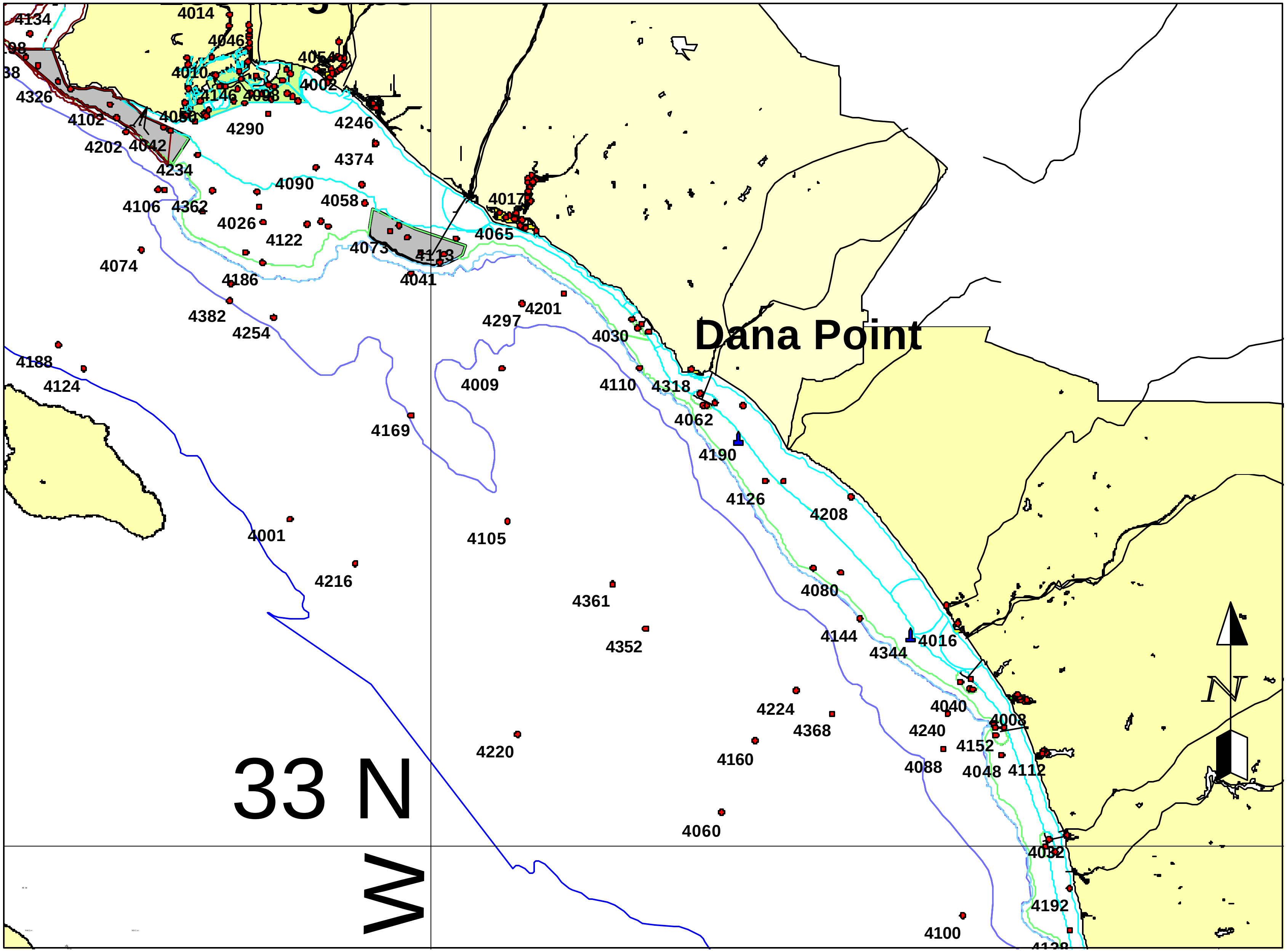
Bight' 03 Sampling Stations



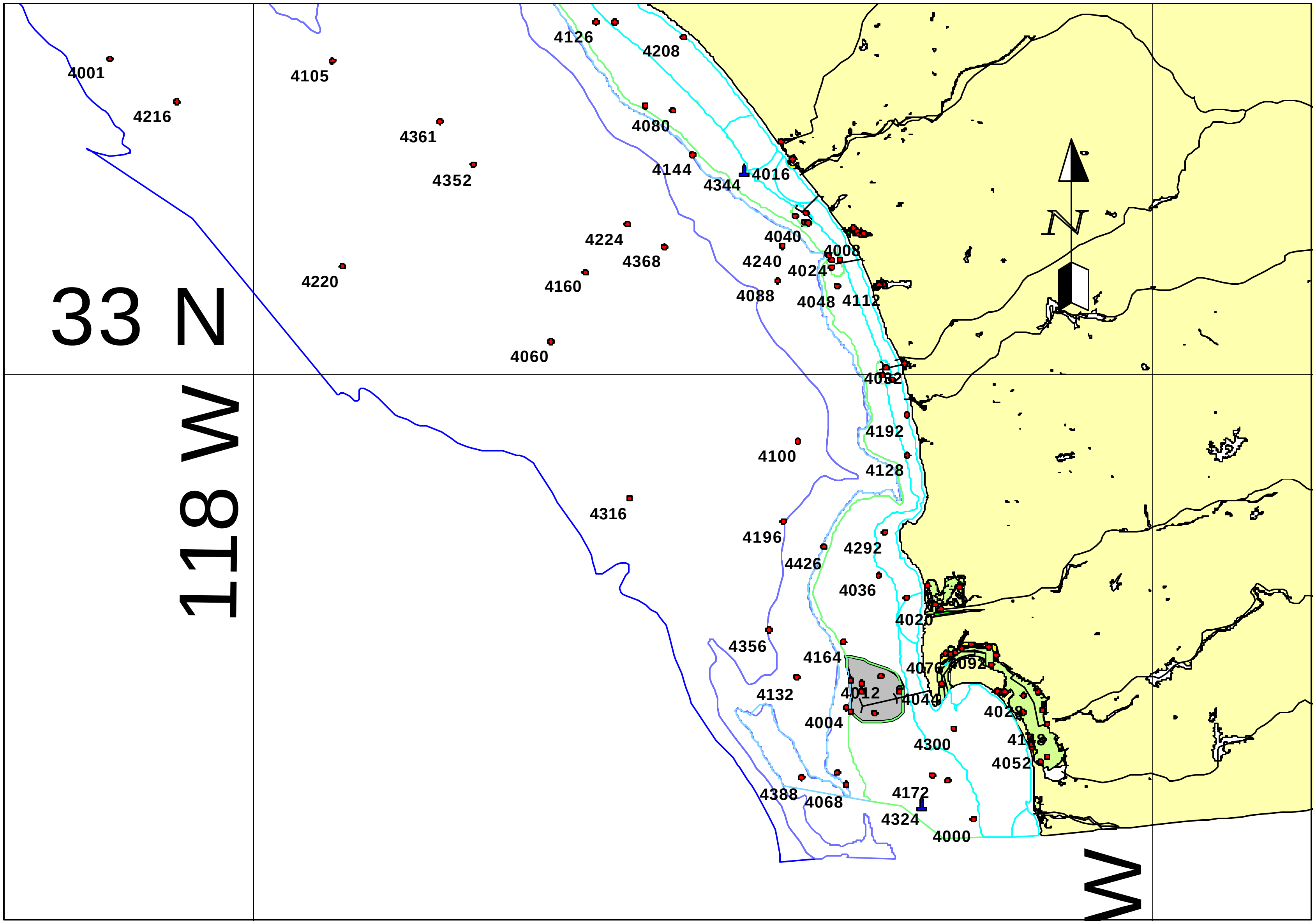
Bight' 03 Sampling Stations



Bight' 03 Sampling Stations



Bight' 03 Sampling Stations



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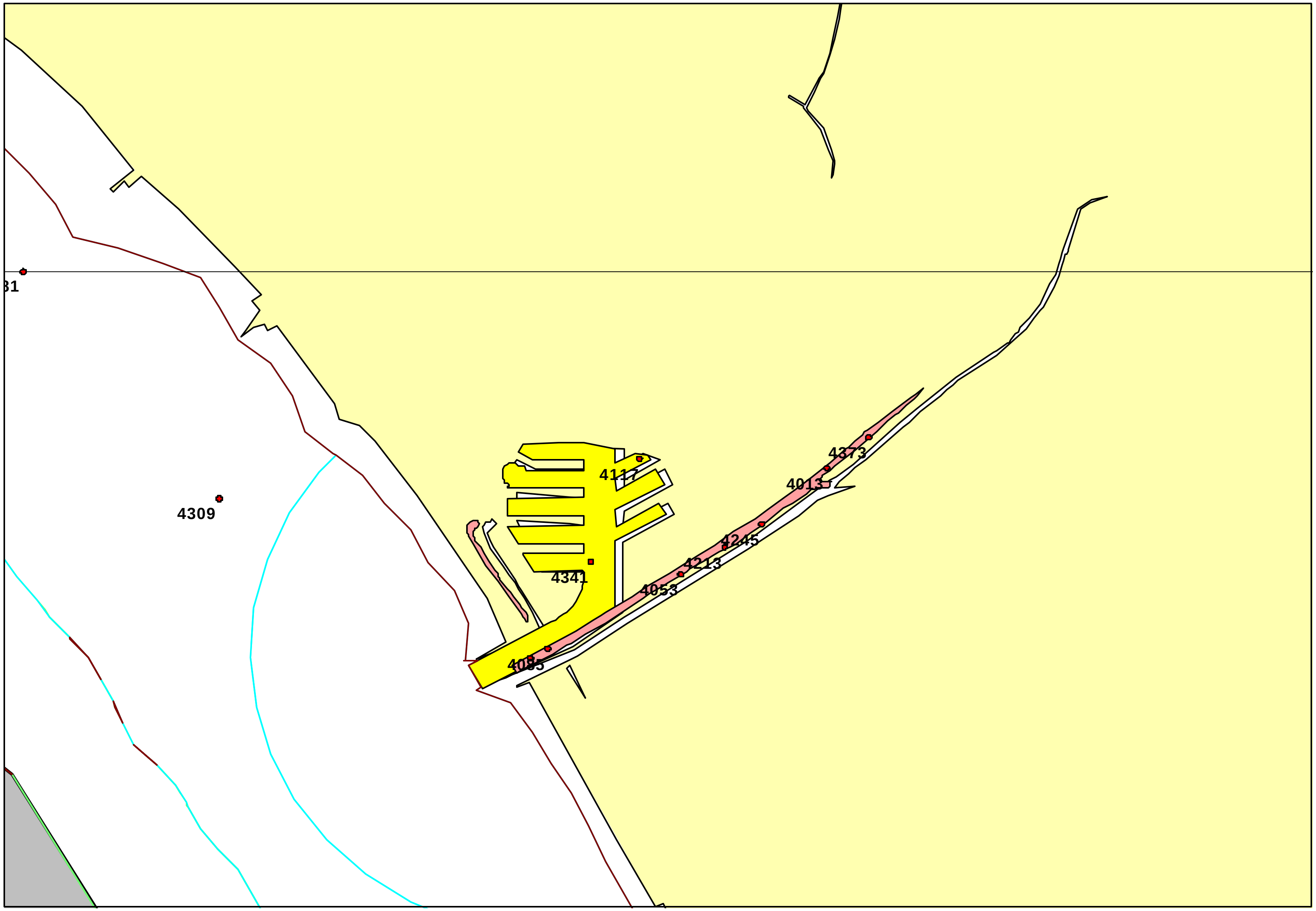
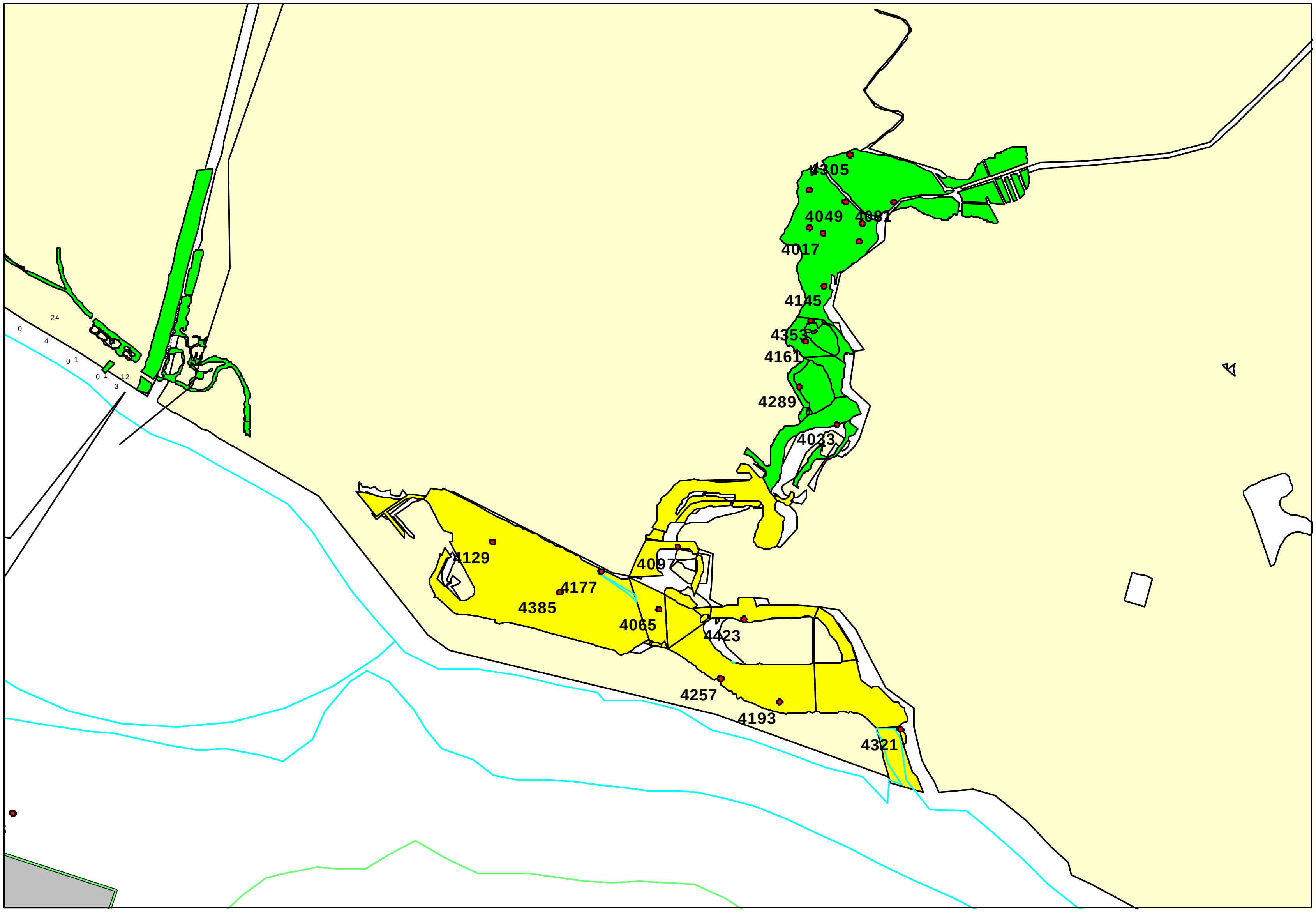


Bight' 03 Sampling Stations

Bight' 03 Sampling Stations



Bight' 03 Sampling Stations