Comprehensive Monitoring Program

for

Santa Monica Bay

Santa Monica Bay Restoration Commission

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Executive Summary

This report presents the Santa Monica Bay Restoration Commission's Comprehensive Monitoring Program (Program) for Santa Monica Bay. It builds on and completes efforts dating back to the mid 1990's to define a regional framework for monitoring environmental resources and conditions in the Bay. The Program focuses primarily on ecosystem resources rather than on anthropogenic pollution, thus filling an important knowledge gap about overall conditions in the Bay. The Program includes new monitoring efforts to fill key data gaps as well as acquiring data from other relevant sources in order to produce more comprehensive assessments of the status of the important habitats in the Bay.

The Program includes five major habitat or ecosystem types within the Bay:

- Pelagic ecosystem
- Soft bottom ecosystem
- Hard bottom ecosystem
- Rocky and sandy intertidal
- Wetlands

The chapters devoted to each habitat type identify a core motivating question and a number of related objectives. Specific monitoring approaches, indicators, and data products are then defined for each objective, providing the basis for monitoring designs that include detail on numbers and locations of stations, sampling frequency, and measurements to be collected. The monitoring designs for each habitat type include a combination of new and existing monitoring efforts. By identifying and incorporating data from other ongoing programs (e.g., compliance monitoring, resource agency monitoring, Bight Program monitoring), the Program ensures a cost-effective approach to assessing the condition of the Bay.

The Program includes a detailed implementation schedule, focused around three levels of assessment, including:

- Project level that annually summarizes basic findings for individual monitoring elements
- Habitat level, conducted every five years, that integrates and synthesizes data from all datatypes relevant to the five major habitats in the Bay (pelagic, hard bottom, soft bottom, intertidal, wetlands)
- Program level, including a summary biannual report and a more comprehensive assessment conducted every five years, that compiles findings from habitat assessments into a picture of the Bay as a whole

The Program's implementation plan defines three key management roles: program manager, data manager, and assessment manager. The program and assessment managers should be full-time SMBRC staff, while the data manager will be a Southern California Coastal Water Research Project (SCCWRP) staff member, reflecting the fact that SCCWRP will perform core database development and maintenance functions.

The total estimated cost for new monitoring elements that would be funded by the Comprehensive Monitoring Program range from a low of $1.5 million in 2009 and 2011 to a high of $2.1 million in 2008. Because of the assumptions required to represent costs on a common basis, these cost estimates are intended as an informed starting point for further planning, fund

raising, and contracting, not as firm or final costs. Additional costs are funded by existing compliance and resource monitoring programs that are conducted by other agencies and that have a secure funding base. While there are a number of potential sources of funding at the federal, state, and local levels, by far the largest of these is a set of relevant state bond initiatives, Propositions 12, 54, and possibly 84.

Introduction

The Comprehensive Monitoring Program (Program) for Santa Monica Bay described in this report represents the Santa Monica Bay Restoration Commission's plan for implementing coordinated monitoring to provide a regional, long-term picture of the status of the various ecosystems in Santa Monica Bay. It culminates efforts that began in the mid-1990's with the identification of key management questions and monitoring priorities.

The Program builds on the long history of monitoring of the marine environment in Santa Monica Bay. Monitoring has been the primary mechanism by which regulatory agencies, resource managers, and permitted dischargers have evaluated the condition of the Bay and the effectiveness of regulatory programs. However past monitoring's primary focus on major discharges left many acknowledged data gaps, and the lack of coordinated, baywide information has hindered efforts to restore and protect the health of the Bay's habitats and resources. The need for more comprehensive monitoring information has increased in recent years as a result of:

- Greater awareness of the regional nature of environmental stressors and impacts
- Increased interest in assessing and managing habitats and resources on a regional basis
- Greater knowledge of the interactions between localized sources of anthropogenic impact and larger-scale environmental processes (e.g., El Niño, Pacific Decadal Oscillation (PDO))
- Expanded interest in the role of terrestrial runoff and stormwater plumes on the nearshore coastal zone

These and other priorities have led the Santa Monica Bay Restoration Commission (SMBRC) to address many emerging water quality and habitat-related issues on the scale of the Bay as a whole. A necessary prerequisite for any such effort is the availability of monitoring information on a regional scale that focuses on key indicators and processes.

To ensure that monitoring in the Bay accomplishes this goal, and is conducted in a coordinated and efficient fashion, SMBRC – in the early 1990s – spearheaded the development of the Santa Monica Bay Comprehensive Bay Monitoring Program. The Bay Comprehensive Monitoring Program was developed in two phases. In Phase I, SMBRC developed a Regional Monitoring Comprehensive Framework (SMBRP1993) and detailed sampling designs for eight[1] of 16 monitoring components identified in the Framework. In Phase II, an in-depth analysis (SMBRP 2000) of the existing monitoring efforts in the Bay and the Bay watershed was conducted to identify duplication of effort and monitoring that had already accomplished its objectives. This analysis provided the basis for recommendations to eliminate some routine monitoring and reallocate savings in order to close critical monitoring gaps.

As a result of these two reports, new and revised sampling designs (for bacteriology, seafood tissue, and kelpbed overflights) have been implemented through National Pollution Discharge Elimination System (NPDES) permit revisions, as well as other inter-agency agreements. In addition, independent but complementary monitoring efforts, such as the periodic Southern California bightwide regional monitoring surveys, have helped to address status and trends questions on the regional scale. Despite the significant progress made (SMBRC 2005),

[1] These eight components are: shoreline bacteriology, seafood consumption, the soft bottom benthic system, the pelagic system, wetlands, kelp habitat, intertidal habitat, and pollutant sources and loadings.

monitoring gaps remain, along with the challenge of increasing the resources available for developing and implementing sampling designs to fill these gaps.[2]

Prompted by new requirements adopted in the NPDES permit for the City of Los Angeles' Hyperion Waste Water Treatment Plant and the Los Angeles County Sanitation Districts' Joint Water Pollution Control Plant, a new process to accelerate the implementation of the Comprehensive Bay Monitoring Program was initiated in April 2005 and continued through September 2006. This process included a review of implementation efforts to date and development of preliminary monitoring objectives.

This report presents the completion of that effort. It specifies detailed monitoring designs for broad ecosystem components, each of which integrates several narrower components in the original Framework. These designs coordinate both existing and new monitoring and explicitly link indicator selection, sampling design, and intended data products that focus on specific scientific and management questions. In addition, this report includes an implementation plan that includes a detailed schedule, cost estimates for individual Program elements, and recommendations on the Program's management structure, including its data management and assessment strategies.

[2] The gaps identified in 2000 included: rocky intertidal, pelagic fish, pelagic ecosystem, wetlands, hard bottom benthos, birds and mammals, commercial shellfish, and stormwater mass emission loading and plume tracking.

Overview of Bay Comprehensive Monitoring Program

The underlying goal of the Program is to address all elements of the Comprehensive Framework at a regional scale (i.e., the scale of the Bay) and in a coordinated manner that fosters data integration and regional interpretation and assessment. This document focuses primarily on those aspects of the Framework that had not been designed and/or implemented by previous SMBRC efforts, specifically:

- Pelagic ecosystem (Figure 1)
- Subtidal soft bottom benthos (Figure 2)
- Subtidal hard bottom benthos (Figure 3)
- Rocky and sandy intertidal (Figure 4)
- Wetlands (Figure 5)

These five Program elements incorporate individual components, such as demersal fish and shorebirds, that had previously been identified separately in the Framework. Each of these five major Program elements is described in a separate chapter that includes a brief background section, a description of monitoring objectives and data products, a summary explanation of needed monitoring, and a description of relevant special studies. Where possible, data needed to address monitoring objectives will be acquired through the integration of existing monitoring efforts. Data will be obtained from three categories of sources:

- Existing monitoring conducted by local, regional, and state or national entities, including permittees, research consortia, volunteer organizations, and resource management agencies
- Higher-level, derived data products that aid in the interpretation of monitoring data, such as upwelling and Pacific Decadal Oscillation (PDO) indices
- New monitoring needed to fill key data gaps, managed and funded by the SMBRC and/or other local or regional agencies

Specific details of existing monitoring efforts (e.g., sampling design, sample processing) are included by reference to relevant reports and websites in the Bibliography.

It is important to emphasize several key features of these monitoring designs in particular and of the Program as a whole:

- First, monitoring designs focus on the status of the overall Bay system, rather than on individual discharges and their associated impacts. Thus, the characteristic monitoring approach is to distribute monitoring sites throughout a habitat, using randomized or systematic designs, or a combination of both. The Program's designs are based on the implicit assumption that monitoring of site-specific impacts will continue to be addressed through compliance monitoring.
- Second, the Program does not include all possible monitoring, but focuses on the status of key resources at the scale of the Bay as a whole. There is much other monitoring that is occurring, or should occur, that simply does not fall within the Program's defined scope.
- Third, the Program defines "monitoring" broadly to include the acquisition and integration of data from a wide range of sources. An important aspect of the Program is its focus on taking maximum advantage of existing data gathering and anaylsis efforts being conducted by other parties.

- Fourth, while the Program's monitoring efforts extend only to the high-tide line along the shore, the Program is intended to also complement other efforts, such as TMDLs, that link the terrestrial and nearshore environments.
- Fifth, needs for new or improved monitoring and assessment methods, basic information about poorly known habitats, acquisition of key historical data, or preliminary investigations to explore potentially important questions are accommodated with targeted special studies. Special studies, with set ending dates and specific work products, provide useful flexibility without the necessity of prematurely including such efforts in the core of the long-term monitoring program itself.

Figure 1. Pelagic ecosystem monitoring design, showing both existing and new stations.

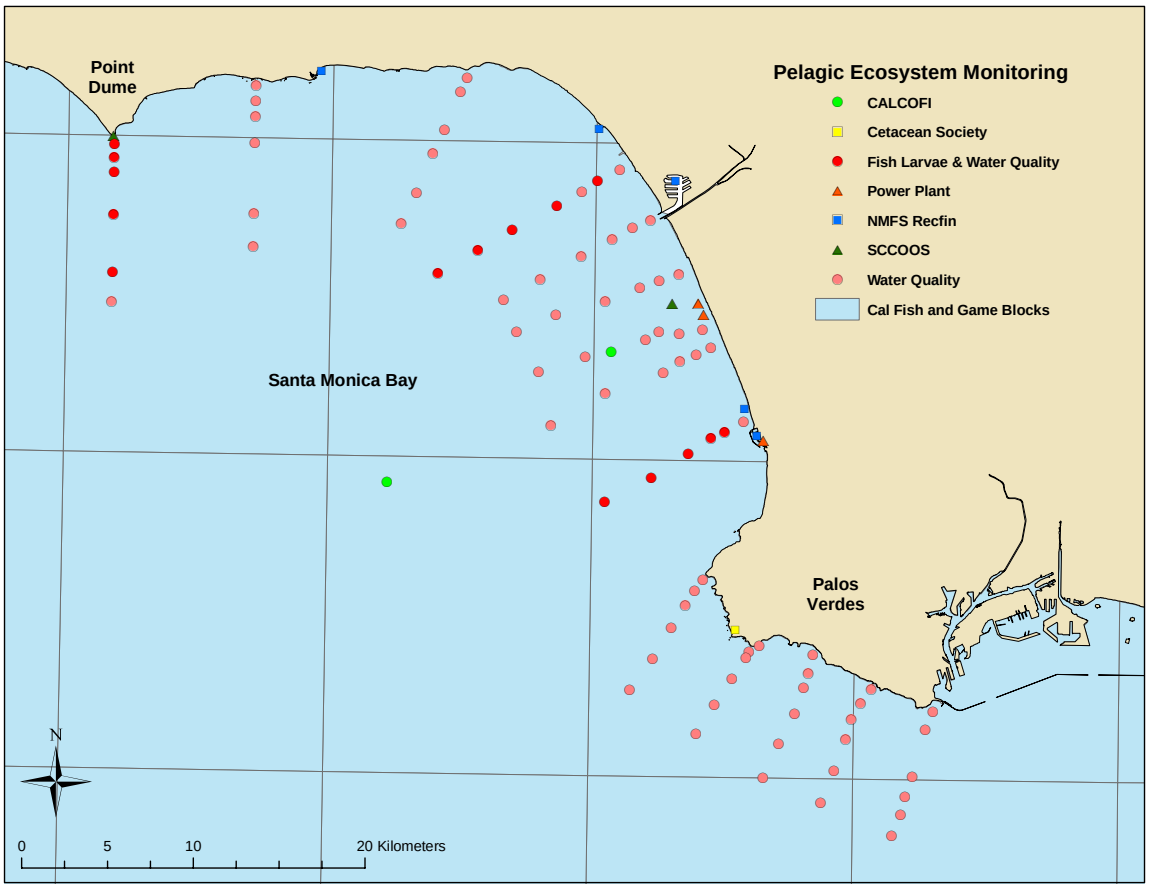


Figure 2. Soft bottom benthos monitoring design, showing both existing and new stations.

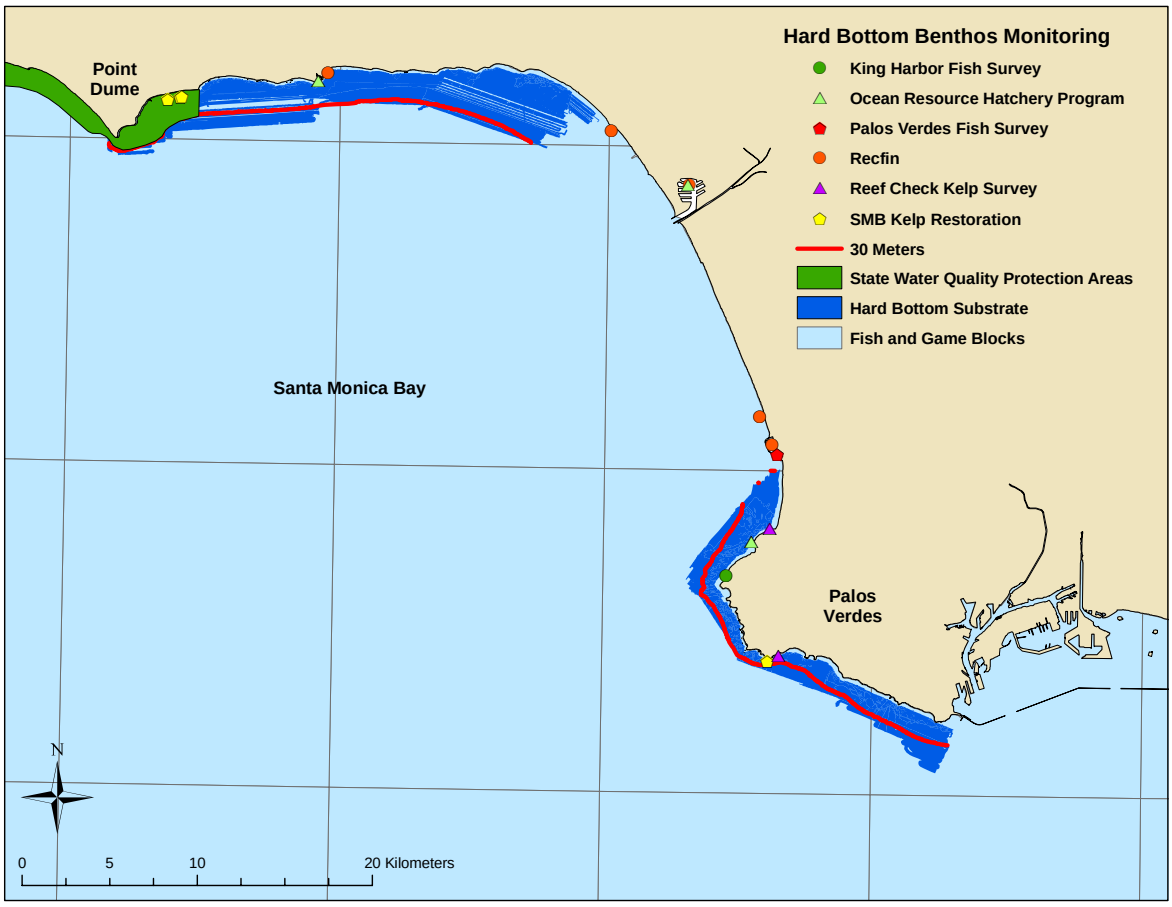


Figure 3. Subtidal hard bottom benthos monitoring design, showing both existing and new stations.

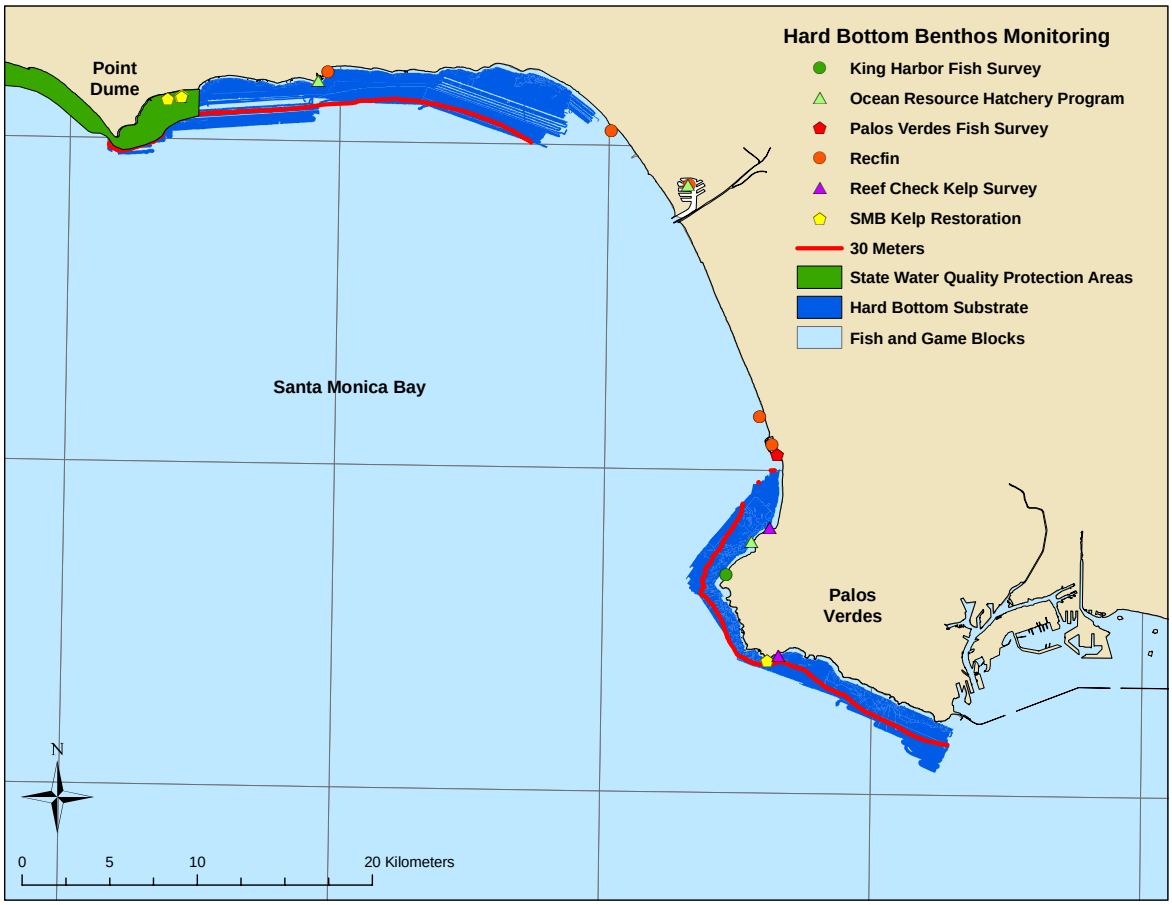


Figure 4. Rocky and sandy intertidal monitoring design, showing both existing and new stations.

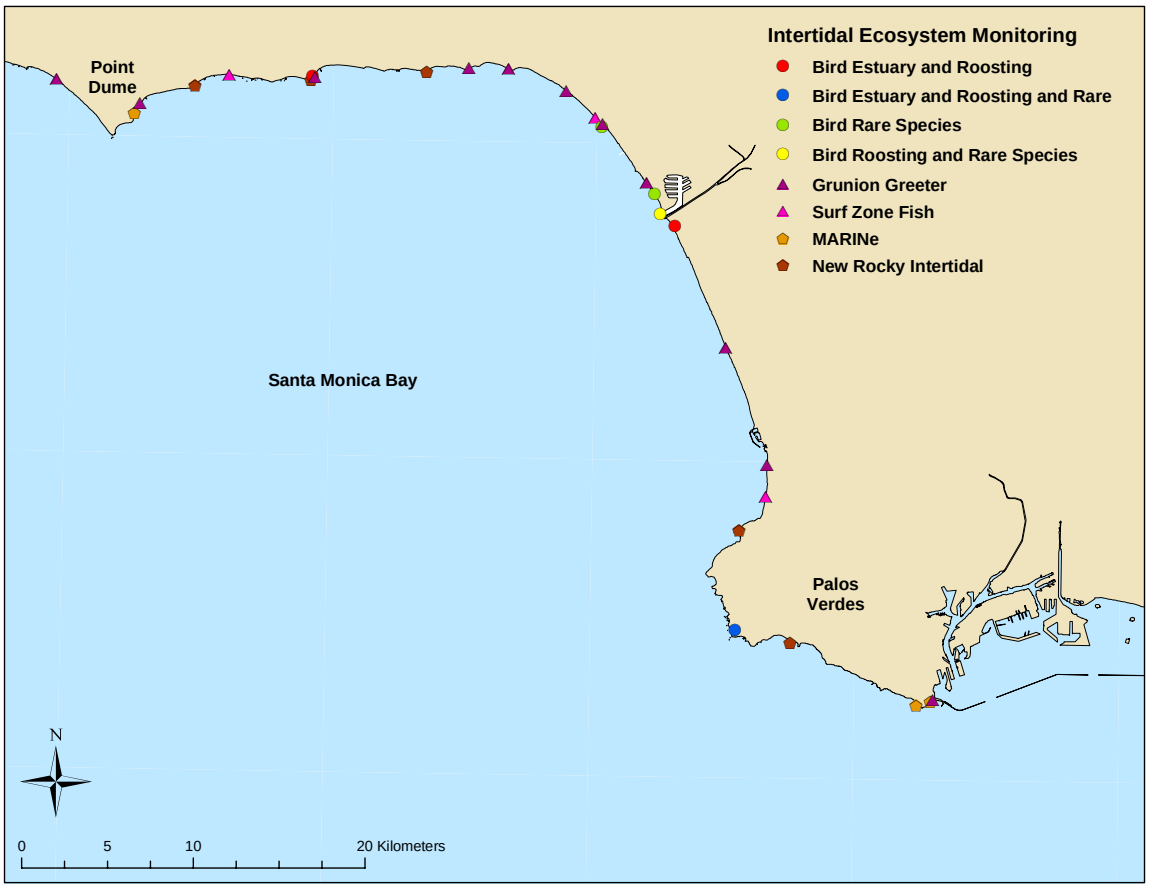
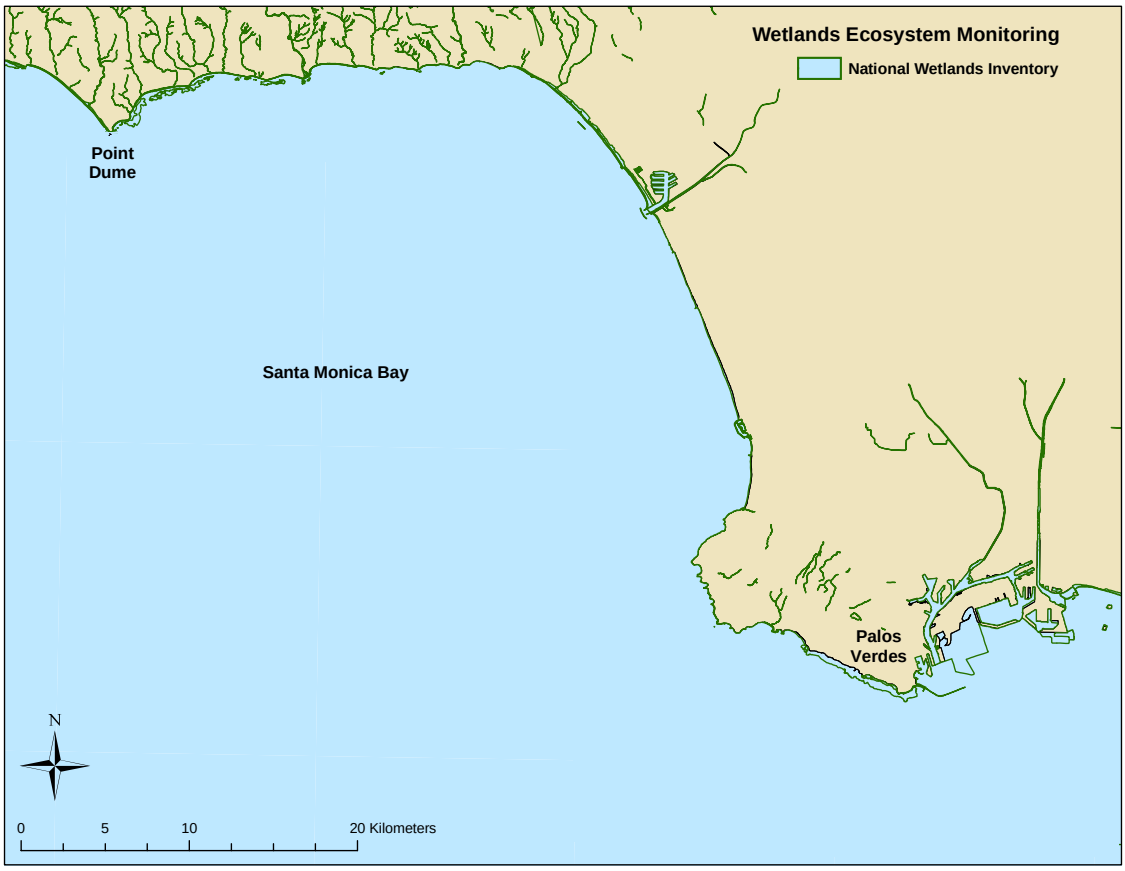


Figure 5. Wetlands in the Bay. Monitoring stations have not yet been identified.



Pelagic Ecosystem

The pelagic ecosystem is important because it includes the nutrients, phytoplankton, and zooplankton that are the base of the marine food chain and thus of sport and commercial fisheries, which are important resources in their own right. The pelagic ecosystem also includes marine mammals and certain species of sea birds that are primarily dependent on the ocean for their food and habitat.

Fundamental natural changes in the pelagic ecosystem can occur at the same time throughout the Southern California Bight, the California Current system, and even the entire north Pacific. Because such changes can alter the natural background against which many other monitoring data are routinely compared, having data available on the pelagic system can furnish a broader context for evaluating the results of other, more narrowly targeted components of the regional monitoring program. However, determining whether the natural background has in fact changed, or whether there are localized changes occurring only in Santa Monica Bay, involves comparing data on the pelagic ecosystem from within Santa Monica Bay to analogous data from both the California Current system and the entire North Pacific.

The basic question motivating this component of the Bay Comprehensive Monitoring Program is:

> Is the pelagic ecosystem in Santa Monica Bay healthy and protected from local anthropogenic disturbances that impact these resources?

Answering this question involves viewing the pelagic ecosystem from two different, but related, perspectives. The first is the status of the system as a whole, which primarily entails determining which of several alternative oceanographic states the system is in. This information provides the basic context for interpreting a wide range of monitoring data. The second perspective is related to the status of individual resources or resource categories that use the Bay as their habitat and that could, at least to some extent, be impacted by anthropogenic activities in the Bay. This program component is structured largely around the acquisition and integration of existing data, while initiating targeted new monitoring to fill specific data gaps.

System-wide objectives

In this and subsequent chapters, the order of the monitoring objectives is not meant to reflect any inherent priority. Objectives may be grouped conceptually, in terms of common spatial scale, ecosystem process, or other functional aspect.

There are two primary monitoring objectives that address the system-wide aspect of the overall question motivating pelagic ecosystem monitoring:

1. Determine the state the overall California Current system with respect to large-scale oceanographic processes such as the Paciifc Decadal Oscillation (PDO), El Niño, and upwelling
2. Determine whether the state of the oceanographic system in Santa Monica Bay is synchronous with that in the California Current system as a whole

The first objective involves identifying which of several alternate states the California Current system is in. Derived indices for each major system feature (PDO, El Niño, and upwelling) are produced on a routine basis by the National Atmospheric and Atmospheric Administration (NOAA). In addition to the value of each particular quantitative index, NOAA prepares a

narrative assessment of each feature, describing, for example, which phase of the PDO is dominant. Values of these indices are associated with characteristic thresholds or ranges of values for key indicator values such as sea surface temperature, salinity, zooplankton biomass, and shoreline temperature. In addition to these in situ measurements, remote sensing data can provide synoptic pictures of some indicators such as sea surface temperature and chlorophyll a. The PDO index generally applies to the entire California Current (and portions of the North Pacific), the El Niño index to the California Current and its major subdividions (e.g., northern and southern), and the upwelling index to even smaller-scale subidvisions (e.g., norther and southern portions of the Southern California Bight). This objective would be evaluated seasonally.

The second objective involves comparing information from both NOAA and in-Bay monitoring efforts about system features within Santa Monica Bay, as well as the values of key oceanographic indicators, to those for the California Current system as a whole and its relevant subdivisions. Analyses of historical data have identified thresholds and/or typical ranges for values of biological and physical indicators that are indicative of alternative system states and that provide a basis for this comparison. This objective would be evaluated seasonally.

Resource-based objectives

There are seven primary monitoring objectives that address the resource-based aspect of the overall question motivating pelagic ecosystem monitoring. While these objectives would primarily be assessed at the scale of the Bay as a whole, a particular area of concern is the ASBS in the northern portion of the Bay.

1. Measure the change in relative abundance and frequency of occurrence of key resource species (e.g., marine mammals, pelagic fishes) in the Bay over time
2. Measure the change in the relative spatial distribution of key resource species in the Bay over time
3. Compare contaminant body burdens in bottlenose dolphins in the Bay to accepted wildlife health thresholds
4. Track changes in contaminant body burdens in bottlenose dolphins in the Bay over time
5. Measure indicator values of general ecosystem health (e.g., primary and secondary productivity, nutrients) for the Bay as a whole
6. Track indicator values of general ecosystem health over time
7. Determine the relative magnitude and frequency of adverse events (e.g., mammal strandings, harmful algal blooms)

The first and second objectives refer to bottlenose dolphins (which are resident in the Bay), grey whales, selected seabird species, fish larvae, and pelagic fishes, including those targeted by sport and commercial fisheries. The first objective specifies relative abundance and frequency of occurrence because estimating the absolute abundance for these species is extremely challenging and costly. Both relative abundance and spatial distribution, when combined with other information about the Bay, will provide a qualitative assessment of whether highly visible and valued resources are improving or declining. Data to meet these two objectives will be generated by a combination of new targeted monitoring (e.g., bottlenose dolphin survey) and existing programs (e.g., sport and commercial catch statistics, power plant impingement). For some indicators, comparison to data from outside the Bay could provide information about whether species in the Bay are exhibiting detrimental impacts. For example, regular assessments of some seabird and marine mammal species are conducted at spatial scales much larger than the Bay. These objectives would be evaluated annually but trends would only become apparent over multiyear to decadal timescales.

The third and fourth objectives are intended to determine the severity of an impact that is directly tied to human activity and to establish whether that impact is increasing or decreasing over time. While full wildlife health risk assessments are complex and costly, a straightforward comparison of tissue levels to commonly accepted thresholds or benchmarks can provide a measure of trends over time in the severity of this impact. Bottlenose dolphins were selected as an indicator because of their position high on the foodchain, their relative longevity, their presence in the Bay, and the high level of public interest in their status. Trends in their body burdens of contaminants would only be apparent on a decadal timescale.

The fifth and sixth objectives focus on measures of basic ecosystem processes (e.g., primary and secondary productivity) and on constituents (e.g., nutrients) that could affect these processes. This objective also focuses on qualitative measures of highly visible indicators such as sharks, which, over time, can provide a measure of the success of management actions such as fishing restrictions. While there are no thresholds or benchmarks that provide definitive indications of human impacts, an examination of spatial patterns within the Bay (e.g., onshore-offshore differences), comparisons with data from the California Current system as a whole, and trends over time can all provide evidence of localized human impacts within the Bay. Data to meet these two objectives will be generated by existing programs (e.g., CalCOFI, Central Bight Water Quality Monitoring Program, power plant impingement of large pelagic organisms, NMFS shark survey data). These objectives would be evaluated annually but trends would only become apparent over multiyear to decadal timescales.

The seventh objective is intended to provide information on highly visible events that generate a large degree of public interest and that, over a multiyear or decadal timescale, could provide evidence of trends in the degree of human impact on the Bay. Data to meet this objective would be obtained from other agencies (e.g.. NMFS) that routinely monitor and/or collect such information.

Monitoring and data acquisition

Each objective can be matched with one or more monitoring strategies, benchmarks or reference conditions that provide a basis for evaluation, data products, and management actions. Summarized in Table 1, this provides a conceptual summary of this element of the overall Comprehensive Program. Table 2 then describes the specific combination of monitoring and data acquisition activities that will be used to accomplish these objectives, including a summary of monitored indicators, while Figure 1 displays the distribution of monitoring sites in the Bay. Table 2 is followed by descriptions of the individual indicators.

Table 1. Core objectives and monitoring program design elements for the pelagic ecosystem component of the regional program.

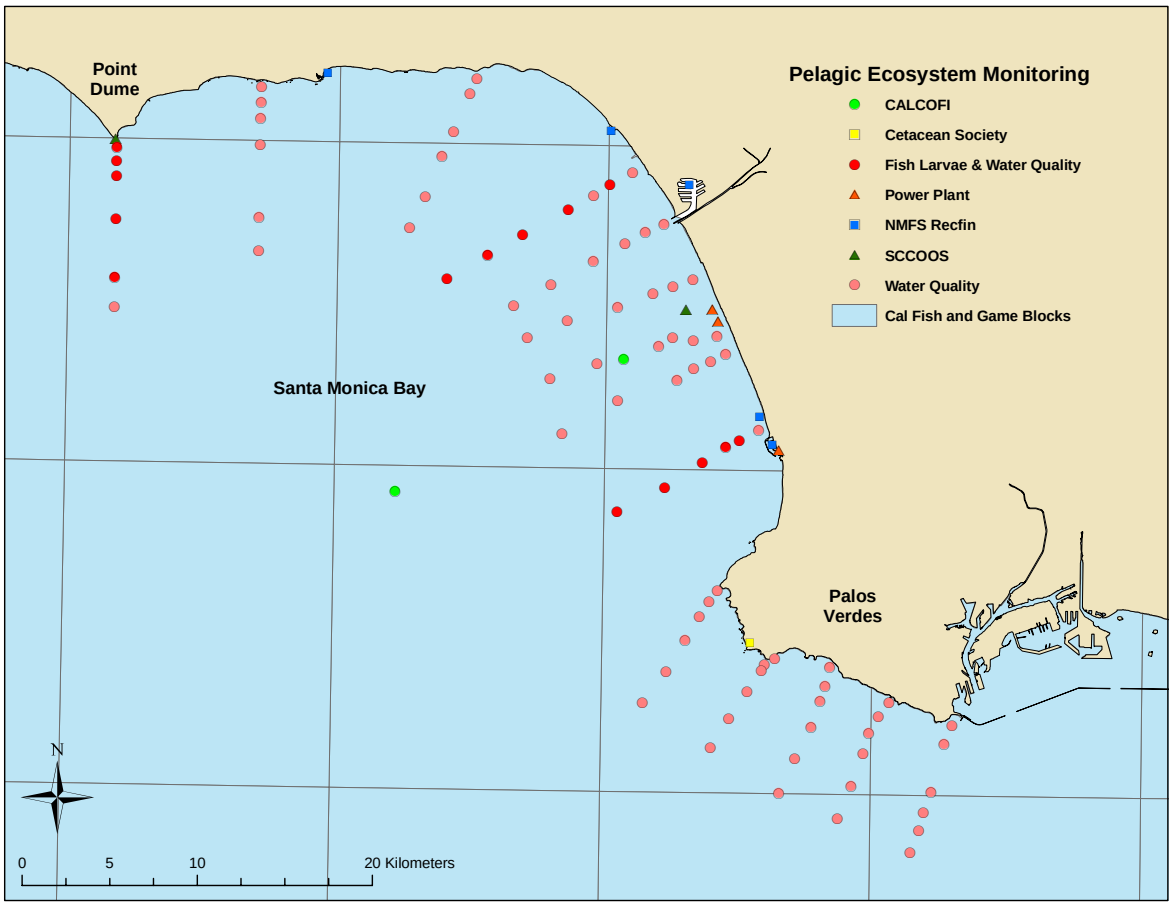
Objective	Strategy	Reference condition	Data products
System			
Determine overall system state	Focus on overall system Target established indicators	El Niño index PDO index Upwelling indices north of, in, and south of Bay Average and regional measures of biological / physical indicators	Maps, trend lines of major indices Contour maps, trend lines for biological / physical indicators
Determine state of Bay	Compare Bay to larger system Target established indicators	Overall system state Thresholds / typical values for different system states	Contour maps, trend lines for biological / physical indicators Comparisons of indicators to thresholds / typical values
Resource			
Measure changes in relative abundance and frequency of occurrence of key species	Focus on individual resources Baywide sampling Track trends over time	Historical data from the Bay, Southern California Bight, Pacific coast	Trend lines of relative abundance, frequency of occurrence
Measure changes in distribution of key species	Focus on individual resources Baywide and gradient sampling Track trends over time	Historical data from the Bay, Southern California Bight, Pacific coast	Contour maps, trend lines of spatial distribution patterns
Compare dolphin body burdens to thresholds	Focus on key sentinel species	Established wildlife health thresholds Data from S. CA Bight Offshore populations	Tables, graphs of body burdens vs. thresholds Statistical comparisons
Track dolphin body burdens over time	Focus on key sentinel species Track trends over time	Historical data from the Bay Data from S. CA Bight Offshore populations	Trend lines of body burdens
Measure ecosystem health	Focus on basic indicators of condition / process Baywide and gradient sampling	Overall system state Historical data from Bay	Contour maps of indicator values Comparisons of indicators to thresholds / typical values
Track ecosystem health over time	Track trends over time	Historical data from Bay	Trend lines of indicator values
Track adverse events	Focus on notable events	Historical data from Bay	Narrative descriptions Trend lines Maps

Table 2. Design overview for the pelagic ecosystem component of the regional program. Entries in *italics* in the Description column indicate monitoring components that already exist as part of an ongoing program.

Design approach	Description	Stations, frequency	Indicators / raw data
Sampling grids	*CalCOFI grid*	101 stations in 11 on-offshore lines in southern California; 1 station in Santa Monica Bay; 4 / year	Chlorophyll, zooplankton biovolume, sea surface temperature, salinity, thermocline depth, dissolved oxygen, silicate, nutrients, primary productivity
	Central Bight Water Quality Monitoring Program	84 stations, 4 / year	Chlorophyll, sea surface temperature, salinity, dissolved oxygen, transmissivity, pH, dissolved organic matter, thermocline depth ADD: Nutrients (nitrates, phosphates, ammonia) at 15 stations in 3 on-offshore transects
	Fish larvae transects	5 stations in each of 3 on-offshore grids; 2 / year	Species identification and abundance, zooplankton biomass
	Shoreline temperature network	~ 30 stations situated along Pacific coastline of US; monitored at least daily	Temperature
	California Fish & Game blocks	10 blocks in Santa Monica Bay; compiled monthly	Recreational catch estimates, by region
	NMFS Recfin sampling sites	5 stations (Hermosa, Malibu, Marina del Rey, Redondo, Santa Monica); daily reporting summarized 1 / year	Number of recreational fishing trips and participants, weight and number of fish caught and/or released, by region
	Bottlenose dolphin & seabird surveys	Inshore & offshore surveys in Bay; 72 days / year	Oceanographic conditions, relative abundance, location, timing, behavior, tissue contaminant levels on 30 inshore and 30 offshore bottlenose dolphins
	DHS Marine Biotoxin Monitoring Program	Statewide network, multiple stations in Santa Monica Bay	Toxin levels in shellfish, incidence of toxic blooms, incidence of toxic plankton
Single sites	*Power plant impingement & entrainment*	1 station each at Scattergood, El Segundo, and Redondo Beach generating stations; reported 1 / year	Numbers of fish and other large pelagic organisms, by species, impinged in cooling water
	American Cetacean Society Gray Whale Census & Behavior Project	1 station on Palos Verdes Peninsula, daily during migration season	Daily counts of migrating gray whales, calves, behavior observations
	SCCOOS oceanography buoys	2 buoys (Santa Monica Pier, Pt. Dume), continuous measurements	Temperature, salinity, chlorophyll, dissolved oxygen

Design approach	Description	Stations, frequency	Indicators / raw data
Synoptic survey	*NOAA oceanographic indices*	Seasonal, annual	Local / regional upwelling indices, El Niño and PDO indices
	NOAA satellite remote sensing	3 systems (AVHRR, MODIS, OCM; continuous measurements	Baywide (and larger) estimates of sea surface temperature (AVHRR), chlorophyll (MODIS), ocean color (OCM)
	SCCOOS surface currents	Synoptic radar mapping	Current speed, direction, transport estimates of suspended, dissolved components
	NMFS marine mammal stranding network	Baywide, as reported	Number, timing, location, type of mammals stranded
	NMFS thresher shark survey	Bightwide survey; 1 station in Bay; 1 / year	Longline and gillnet sets for adults and juveniles; size, condition, number
Surveys	*USFWS seabird conservation*	Variety of monitoring and assessment studies	Abundance, population status, threats

Figure 1. Pelagic ecosystem monitoring design, showing both existing and new stations.



The recommended monitoring indicators in Table 2 are described briefly below.

System-wide monitoring

The core of the pelagic ecosystem component is the assessment of the oceanographic variables that, together, indicate whether the overall state of the system has changed and whether such a change has occurred in or out of phase with changes in the California Current and the larger North Pacific. The key measurements and derived variables used in this assessment are as follows.

Sea surface temperature provides information about the source and distribution of water masses in the region and, in combination with salinity, can furnish a distinctive signature for different water masses. Changes in sea surface temperature in turn are associated with important shifts in biological resources such as zooplankton and fish. Measurements of sea surface temperature and salinity are routinely available from CalCOFI and Central Bight Water Quality Monitoring Program cruises, satellite data (AVHRR), and the two SCCOOS moored buoys.

Shoreline temperature measurements are routinely collected from a network of stations along the western coast of the US. Changes in shoreline temperatures are typically well correlated with temperature changes in the California Current and can provide a measure of anomalous patterns in the nearshore zone. These data are available on the SCCOOS website.

Surface currents will be mapped beginning in 2007 by the SCCOOS radar network for surface current mapping. These data will provide a tool for evaluating transport and time scales for suspended or dissolved components in the upper layer of the water column.

Sea level is measured by the NOAA network of tide gauge stations along the California coast. These data are available from NOAA and are used by basic oceanographic researchers to derive changes in sea level over time. Such changes can be indicative of changes in system state such as El Niños.

Thermocline depth reflects seasonal factors as well as longer-term and larger-scale dynamics in the climate and current systems themselves. Persistent changes in thermocline depth can affect phytoplankton populations and higher trophic levels by affecting the relative availability to the pelagic ecosystem of the pool of nutrients in deeper water. Measurements of thermocline depth are routinely available from CalCOFI and Central Bight Water Quality Monitoring Program cruises.

Chlorophyll a is a summary measure of phytoplankton biomass and a crude indicator of productivity. Changes in chlorophyll a reflect shifts in nutrient levels due to upwelling and larger-scale displacements of water masses due to El Niños and other events. Measurements of chlorophyll a in key regions of the California Current are routinely available from CalCOFI and Central Bight Water Quality Monitoring Program cruises.

Ocean color measurements are collected by a NOAA satellite and have a resolution of 30 meters, which makes these data useful for tracking stormwater plumes. These data are most easily accessed through the SCCOS website.

Zooplankton biomass responds directly to the availability of the phytoplankton they feed on and is therefore a useful indicator of the overall productivity of the pelagic ecosystem. Zooplankton biomass exhibits characteristic changes during El Niños, dropping significantly when California

Current water is replaced by warmer and less nutrient rich water from the south. Zooplankton biomass is routinely measured by the CalCOFI program and will be measured as part of the new fish larvae monitoring element.

Derived indices integrate multiple indicators to determine the overall state of various aspects of the oceanographic system. Upwelling indices measure the relative intensity of upwelling at key locations along the coast. Upwelling operates at seasonal and annual timescales. The El Niño index indicates whether the California Current is under the influence of an El Niño, as well as the event's relative intensity. El Niños operate at the timescale of several years. Like the El Niño index, the PDO index specifies which state the oceanographic system is in. However, it reflects influences from the North Pacific, driven by changes in an atmospheric system called the Aleutian Low, that affect the relative temperature, nutrient content, and strength of the California Current. The PDO operates at the timescale of several decades. These derived indices are routinely available from NOAA.

Nutrient distributions strongly influence the location, timing, and intensity of phytoplankton blooms, as well as phytoplankton community structure. Nutrients are added to Bay through POTW discharges, stormwater runoff, and aerial deposition. Correlations of nutrient patterns with chlorophyll a measurements can provide insight into whether the Bay's foodchain is being affected by anthropogenic nutrients. In addition, nutrient patterns are related to the timing and intensity of harmful algal blooms Nutrients are routinely monitored by the CalCOFI program, but monitoring of onshore – offshore transects within the Bay would be a new monitoring effort, most likely added to the Central Bight Water Quality Monitoring Program sampling grid. This would involve some realignment of the water sampling stations, which are currently concentrated in the center of the Bay. The suite of nutrient analysis should mimic those conducted by the CalCOFI Program.

Resource-based monitoring

This aspect of the pelagic ecosystem component focuses on a number of distinct resource categories that are ecologically important, that provide commercial and recreational opportunities, and/or are of particular interest because of their charismatic nature. The key measurements and derived variables used in this assessment are as follows.

Fish larvae are indicators of the status of both the overall pelagic ecosystem as well as of individual species of particular interest. The species composition, relative abundance, and distribution of the fish larvae community all can shift in response to changes in major oceanographic features such as temperature, salinity, and zooplankton biomass. In addition, fish larvae can respond to more localized conditions that reflect combinations of natural and anthropogenic influences. Fish larvae are routinely sampled by the CalCOFI program and will also be sampled by a new monitoring effort in Santa Monica Bay that uses methods comparable to those used in the CalCOFI Program. All larvae, and most fish eggs, will be identified and the goal of this effort will be to characterize fish larvae at the scale of the entire Bay, without attempting to identify patterns or trends related to any specific discharge or other potential source of impact. In addition, coastal power plants may soon be required to sample fish eggs and larvae as part of their impingement compliance monitoring programs.

Commercial and recreational catch statistics can indicate broad trends in the relative abundance and distribution of key fish species. However, catch statistics are can also be influenced by shifts in market conditions, weather and access to different habitats, popularity, and runs of individual species (which shift effort away from other species). Both commercial and

recreational catch records are subject to coverage gaps and potential biases that limit their utility for assessing fine scale (both temporal and spatial) trends. In addition, commercial catch data on finer spatial scales may not be readily available because of confidentiality requirements. Commercial catch records are systematically collected by both federal (NMFS) and state (CDF&G) management agencies. CDF&G reports commercial catch on the basis of reported landings from each 10 nautical square mile (i.e., 10 miles on a side) "block". Recreational catch for the commercial sport boat fishery is estimated by NMFS based on reported catches from five landings in the Bay. However, these results are available from the Recfin database only as part of an aggregated dataset at the scale of the entire Southern California Bight. These bightwide data could be useful in providing a larger background context for for evaluating other data (e.g., impingement records). In addition, it may be possible to extract the data from the Bay from the larger Recfin database.

Power plant impingement and entrainment data are regularly collected by all coastal electricity generating stations in the Southern California Bight. The plants have been shown to be useful samplers of nearshore fish populations and thus provide a picture of broad trends over time and patterns of spatial distribution. In addition, the impingement data include records of any large pelagic organisms impinged (e.g., sharks, turtles). These data will likely continue to be collected through compliance monitoring with the pending state policy on once-through cooling. As mentioned above (Fish larvae) fish eggs and larvae may be added to the required entrainment monitoring.

Bottlenose dolphins frequent Santa Monica Bay and tend to spend more time within the Bay and nearby areas of the coast than do migratory marine mammals, which range more widely. Because of their position high on the food chain, these dolphins are thus potentially useful indicators of conditions in the Bay. A monitoring program has been proposed that would estimate dolphins' relative abundance, frequency of ocurrence, and distribution, and collect tissue samples to estimate pollutant body burdens and genetic differences between inshore and offshore populations.

Gray whale migrations are a notable semiannual event in the Bay that attract a high level of public interest. While they are not likely to be directly affected by conditions in the Bay (because they are a transient rather than resident species), information on the timing and route of migrations, as well as on the number of whales migrating, are of wide interest. Such data are also useful to marine mammal biologists and managers responsible for assessing the status of the population over its entire range (Alaska to Baja California). Whale migrations in the Bay are routinely monitored by the American Cetacean Society's Gray Whale Census and Behavior Project, which provides summary data and trends over time on their website. However, because most gray whales use offshore routes, these shore-based data provide information only on the use of the nearshore migratory route, not on the size of the entire population. Migration monitoring conducted by the Point Reyes Bird Observatory in northern California can provide a point of comparison for data collected within the Bay by shore-based observations.

Information on **marine mammal strandings** in the Bay can provide a warning of unusual conditions, data on potential linkages between harmful algal blooms and marine mammal mortalities, as well as information on human activities that increase the risk of injury or mortality to marine mammals. Stranding data is collected by NMFS's Marine Mammal Health and Stranding Response Program and coordinated locally through the NMFS regional office in Long Beach. While this is not a regular, systematic survey, a high percentage of strandings in the Bay are probably reported because of the heavy human use of the coastline. Pinnipeds are simply counted and, where possible, identified to species. Additional data (e.g., size, external

characteristics) are collected on cetaceans, by Los Angeles County Museum of Natural History staff, but necropsies to determine cause of death are only occasionally performed.

Harmful algal blooms can pose health risks to humans and marine organisms, although human illness has to date been very rare in southern California. Harmful algal blooms are also indicators of shifts in oceanographic conditions. Trends over time in the frequency, size, severity, and distribution of such blooms can thus provide insight into changes in nearshore ocean conditions. Data on harmful algal blooms is collected by the California Department of Health Services Marine Biotoxic Monitoring Program and the data are available from their website.

Seabirds are widely known to be sensitive indicators of ocean conditions. This is because they are strongly dependent on prey items that are themselves influenced by ocean condition. Thus, the status of seabird populations can provide important information about the presence, severity, and implications of shifts in the overall state of the pelagic ecosystem. In addition, seabirds are a highly visible and valued aspect of the pelagic ecosystem. Seabirds in the Bay will be observed as part of the bottlenose dolphin survey, but there is no systematic monitoring of seabird populations in the Bay. The status of seabird communities outside the Bay is also measured by a number of state and federal agencies and nonprofit research organizations. In particular, the US Fish and Wildlife Service's Regional Seabird Conservation Plan for the Pacific Region summarizes current monitoring and assessment efforts. These data can provide a point of comparison for data collected within the Bay.

Special studies

Harmful algal blooms

While the current California Department of Health Services monitoring program tracks the distribution and abundance of toxic algal species, there is as yet no validated modeling tool that could reliably predict harmful algal blooms based on oceanographic conditions. In addition, there is a time lag with current methods stemming from the need to visually identify and count algal samples in the laboratory. Dr. Burton Jones (University of Southern California) has been funded by NOAA's MERHAB program (http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-merhab.html) to develop improved methods for algal identification, detection, modeling, and prediction. This project is focused on San Pedro Bay, but there is potential for SMBRC participation, either in developing new methods or evaluating their applicability to Santa Monica Bay.

Soft Bottom Benthos

The soft bottom benthos is important because it is the sink for a portion of the particle-bound contaminants that enter the Bay through discharges, runoff, and aerial deposition. It is a key part of the food chain for demersal invertebrates and fish. Because sediment conditions change more slowly than do pelagic conditions, the soft bottom benthos is a useful means of identifying and tracking an important category of anthropogenic impacts on the Bay.

The basic question motivating this component of the Bay Comprehensive Monitoring Program is:

> Are soft bottom marine benthic ecosystems in Santa Monica Bay healthy and protected from local anthropogenic disturbances that impact these resources?

Answering this question involves viewing the soft bottom benthos from two different, but related, perspectives. The first is measurement of the magnitude and spatial extent of impacts due to anthropogenic activities such as discharges. This information will provide feedback about the overall effectiveness of management actions to reduce contaminant loads to the Bay. The second perspective is related to the status of individual resources or resource categories that use the soft bottom benthos as their habitat and that could, at least to some extent, be impacted by anthropogenic activities in the Bay. This program component is largely structured around the Bight Program's periodic monitoring effort and the core monitoring programs associated with POTW NPDES permits.

Monitoring objectives

As mentioned above, the order of the monitoring objectives is not meant to reflect any inherent priority. Objectives may be grouped conceptually, in terms of common spatial scale, ecosystem process, or other functional aspect.

There are nine primary monitoring objectives that address the status of the soft bottom ecosystem. While these objectives would primarily be assessed at the scale of the Bay as a whole, a particular area of concern is the ASBS in the northern portion of the Bay.

1. Determine levels throughout the Bay of toxicity and of contaminants in sediments
2. Track changes over time in sediment toxicity and contaminant levels
3. Determine the status throughout the Bay of infaunal and demersal fish/macroinvertebrate communities
4. Track changes over time in the status of infaunal and demersal fish/macroinvertebrate communities
5. Determine levels of fish tissue contamination throughout the Bay
6. Track changes over time in levels of fish tissue contamination
7. Determine the proportion of the Bay exceeding accepted thresholds and benchmarks for toxicity, sediment contamination, community status, and fish tissue contamination, and the degree to which these proportions change over time
8. Estimate the potential magnitude of fishing impacts by tracking the location and intensity of commercial fishing with bottom gear
9. Estimate changes in relative abundance of key commercial and recreational demersal fishes

The first six objectives focus on a set of widely accepted indicators of benthic contamination and community condition. Of these, derived indices have been developed for both the benthic infaunal and the demersal fish / macroinvertebrate communities. These indices permit

conclusions to be drawn about the overall degree of anthropogenic impact to these communities. The objectives will be addressed primarily with data from the Bight Program's randomized sampling grid, although this may be supplemented with data from the two major POTW outfall monitoring programs in the Bay, at Hyperion and White Point. The randomized Bight Program design permits assessments to be made (at the "population" level) about the overall status of soft bottom habitat, in contrast to the conclusions about specific locations that a fixed-site monitoring design supports. The Bight Program design also enables long-term trend analysis of condition, but only with respect to baywide status (e.g., sediment toxicity in the Bay has declined/increased by X%). The data to address these six objectives is readily available from ongoing programs. The objectives would be addressed on the timescale of the Bight Program, which monitors approximately every five years.

The seventh objective addresses the degree to which the Bay's soft bottom habitat exceeds thresholds or benchmarks for the suite of monitored indicators and will be evaluated with data from the Bight Program and the seafood safety and fish tissue contamination trends monitoring in local POTW NPDES permits. Because of the randomized nature of the Bight Program's design, it is possible to derive population-level estimates about, for example, the proportion of the Bay's soft bottom benthic habitat that exceeds each of several ranges of impact established for the benthic infaunal community index. Changes in these proportions over time can also be tracked, as indicators in themselves, and compared to results from throughout the Southern California Bight. To complement this regional perspective, the local NPDES bioaccumulation trends monitoring assesses whether fish tissue contamination in the vicinity of the local ocean outfalls is changing over time. More specifically, this monitoring provides information on whether tissue concentrations of contaminants continue to exceed the Advisory Tissue Concentration (ATC) where consumption advisories have been implemented, and on tissue contaminant trends relative to the ATC in other species not currently subject to local consumption advisories.

The eighth and ninth objectives focus on different aspects of the condition of highly visible commercial and recreational fishery resources. Both furnish indirect, rather than direct, measures of the status of these resources. However, such indirect measures can be valuable given the difficulty of directly measuring the population size of demersal fish species on the scale of the Bay. Catch statistics for demersal fish are available from the Department of Fish and Game, while data on bottom fishing gear would come from new monitoring efforts. These objectives would be evaluated on an annual basis.

Monitoring and data acquisition

Each objective can be matched with one or more monitoring strategies, benchmarks or reference conditions that provide a basis for evaluation, data products, and management actions. Summarized in Table 3, this provides a conceptual summary of this element of the overall Comprehensive Program. Table 4 then describes the specific combination of monitoring and data acquisition activities that will be used to accomplish these objectives, including a summary of monitored indicators, while Figure 2 displays the distribution of monitoring sites in the Bay. Table 4 is followed by descriptions of the individual indicators.

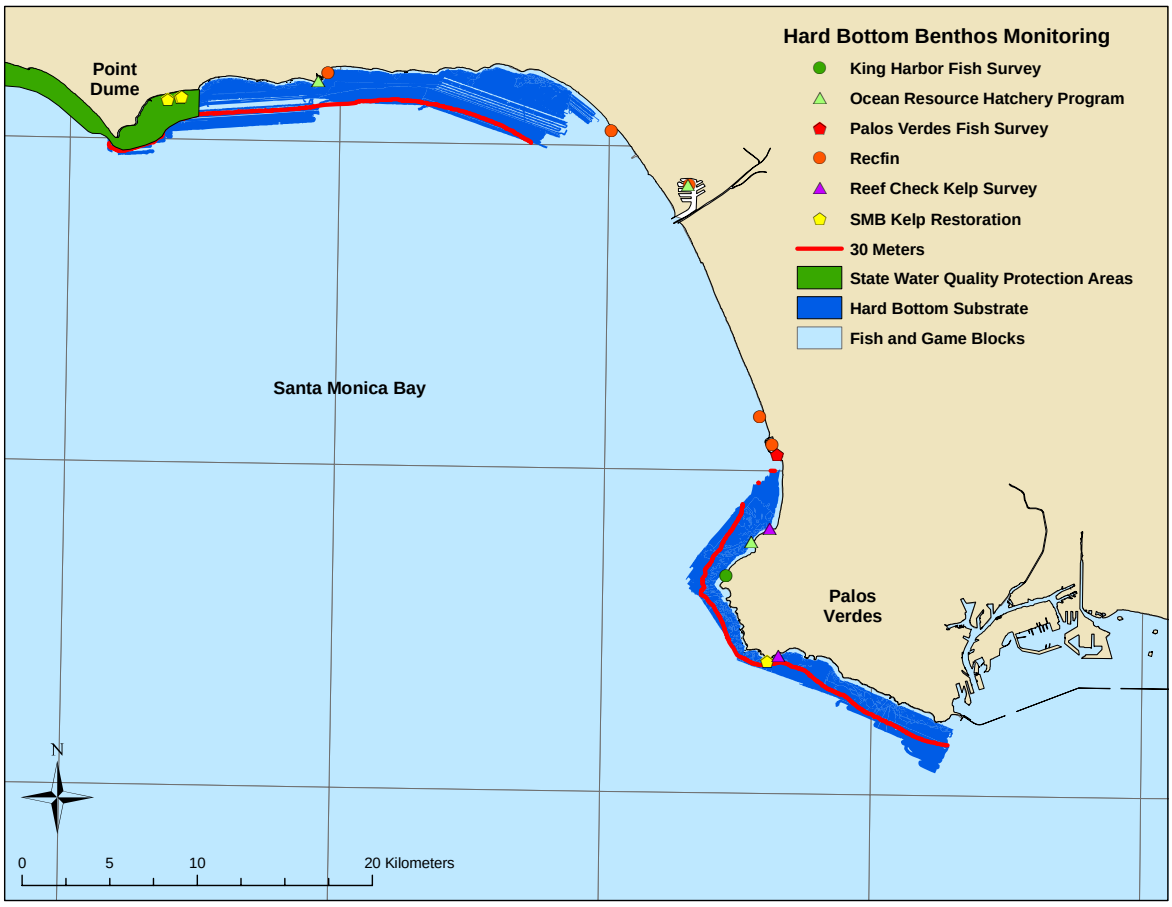
Table 3. Core objectives and monitoring program design elements for the soft bottom ecosystem component of the regional program.

Objective	Strategy	Reference condition	Data products
Determine toxicity, contaminants in sediments	POTW NPDES grid Randomized baywide grid Target established indicators	Bightwide reference from Bight program Historical data from Bay	Tables, contour maps of toxicity and contaminant values Percent area over thresholds
Track toxicity, contaminants over time	Track trends over time in above indicators	Bightwide reference from Bight program Historical data from Bay	Trend lines of toxicity and contaminant values Trend in percent area over thresholds
Determine status of infaunal, demersal communities	POTW NPDES grid Randomized baywide grid Target established indicators	Bightwide reference from Bight program Historical data from Bay	Tables, contour maps of infaunal, demersal community indices Percent area over thresholds
Track infaunal, demersal communities over time	Track trends over time in above indicators	Bightwide reference from Bight program Historical data from Bay	Trend lines of infaunal, demersal community indices Trend in percent area over thresholds
Determine fish tissue contamination	POTW NPDES Local Trends sampling POTW NPDES Local Seafood Safety sampling Randomized baywide grid Target established indicators	Bightwide reference from Bight program Historical data from Bay	Tables, contour maps of tissue levels
Track fish tissue contamination over time	Track trends over time in above indicators	Bightwide reference from Bight program Historical data from Bay	Trend lines of fish tissue levels
Compare fish tissue to thresholds, benchmarks	Population-based assessments	Bightwide reference from Bight program Fish tissue contamination guidelines Historical data from Bay	Percent population over thresholds Trend in percent population over thresholds
Identify bottom fishing activities	Survey fishermen Review permits	Historical data from Bay	Map of location, intensity of bottom fishing
Estimate abundance of commercial, recreational species	Focus on individual resources Indirect estimates	Historical data from Bay Data from Bight and from Cal Current system as a whole	Tables and trend lines in catch statistics Statistical comparisons of catch levels to Bight and Cal Current system
Determine use of habitat by juvenile halibut	Focus on individual resources	Historical data from Bay	Abundance, timing, distribution of juvenile halibut habitat

Table 4. Design overview for the soft bottom benthos component of the regional program. Entries in *italics* in the Description column indicate monitoring components that already exist as part of an ongoing program.

Design approach	Description	Stations, frequency	Indicators / raw data
Sampling grids	*Bight Program grid*	~35 stations in stratified random grid; 1 / 5 years	Infauna, demersal fish and macrofauna, fish tissue contamination, sediment chemistry, grain size, toxicity
	POTW benthic infauna grid	88 stations in fixed grid; 1 / year	Infauna, sediment chemistry, grain size
	POTW demersal fish & invertebrate gird	24 fixed stations; 2 / year	Demersal fish and macroinvertebrates
	POTW sediment chemistry grid	108 stations; at least 1 / 5 years	Grain size, total organic carbon, dissolved sulfides, selected priority pollutants, 303(d) listed compounds for the Bay
	POTW fish tissue zones	6 zones; 1 / year for trends 5 zones; 1 / 2 years for human health risk assessment	Fish tissue DDT and PCB contamination trend monitoring in hornyhead turbot; seafood safety monitoring for DDT, PCB, As, and Hg in various sportfish
	Fish & Game blocks	10 blocks in Santa Monica Bay; compiled monthly	Recreational and commercial catch estimates, by region block, port
	NMFS Recfin sampling sites	5 stations(Hermosa, Malibu, Marina del Rey, Redondo, Santa Monica); daily reporting summarized 1 / year	Number of recreational fishing trips and participants, weight and number of fish caught and/or released, by region
Descriptive data	Commercial bottom fishing	NA	Location, intensity, frequency of commercial fishing with on-bottom gear
Targeted area	ASBS, northern Bay	Portion of the Bight Program random grid; every 5 years (need for 30 sites in ASBS to be assessed in context of Bightwide ASBS stratum)	Infauna, demersal fish and macrofauna, fish tissue contamination, sediment chemistry, grain size, toxicity
Derived variables	*Thresholds and benchmarks (Bight Program, NOAA, NAS)*	NA	Infauna and fish index thresholds, sediment contamination and toxicity thresholds, tissue contamination thresholds

Figure 2. Soft bottom benthos monitoring design, showing both existing and new stations.



The recommended monitoring indicators in Table 4 are described briefly below.

Sediment contamination provides a picture of the movement of key contaminants through the benthic system. It is thus a measure of potential impact, as well as of the long-term effectiveness of management actions to control contaminant loads to the Bay. Sediment contamination for a range of constituents is routinely sampled by both the periodic Bight Program and POTW compliance monitoring programs focused around outfalls.

Sediment toxicity provides a direct measure of the potential for contaminant impacts. Toxicity tests are a routine part of the periodic Bight Program.

Benthic infaunal community indices provide a direct measure of the condition of the infaunal community and thus of the level of impact from anthropogenic pollution. In combination with information on sediment contamination and toxicity it furnishes a comprehensive picture of sediment conditions. The benthic infauna is sampled routinely as a part of the periodic Bight Program and annually as part of the core monitoring program in NPDES permits of local POTWs.

Benthic fish and invertebrates contribute a different perspective on soft bottom benthic conditions. Though they are affected by many of the same environmental conditions that affect the infauna, they are also more mobile and occupy a different place in the foodchain. Benthic fish and invertebrates are routinely sampled as a part of the periodic Bight Program, as well as by the trawl component of POTW compliance monitoring programs.

Fish tissue contaminant levels provide a measure of the potential for foodchain and human health impacts, as well as a direct measure of the effectiveness of management actions on upper trophic levels. Fish tissue is sampled routinely as a part of the periodic Bight Program and POTW compliance monitoring programs.

Commercial fishing that uses on-bottom gear can directly impact the soft bottom benthos through physical disturbance. While the Comprehensive Monitoring Program does not include in situ monitoring to measure such impacts, describing the amount, intensity, and frequency of such fishing activities can help to understand the overall level of disturbance to the soft bottom system. By doing so, it can then help to inform management decisions about managing such disturbance. Anecdotal information suggests that there is a small amount of lobster fishing along the Palos Verdes Peninsula and in upper Malibu, and that squid fishing is not uncommon near Point Dume. Commercial catch records are also available from the California Department of Fish and Game for each reporting block. However, because these are 10 nautical miles on a side, the spatial resolution of these data is poor.

Commercial and recreational catch (see description in Pelagic Ecosystem chapter).

The ASBS in the northern part of the Bay will be sampled as a part of the periodic Bight Program (see also the hard bottom and intertidal program components) for the usual suite of Bight Program soft bottom indicators. The need for additional samples, in addition to those allocated by the Bight Program's randomized design, will not be clear until after the Bight Program's design for the 2008 survey has been developed. The Bight Program may address ASBS's throughout the Bight as a distinct stratum (or combination of strata), which would affect the number of stations required for the Bay.

Special studies

Investigate inshore halibut nursery grounds

A 1989 study documented the presence of small juvenile halibut at Hermosa Beach in the southern portion of the Bay. At the time, this was considered an anomalous finding because small (1 – 10 cm) juvenile halibut were thought to prefer estuarine back-bay habitats where they feed on small fish and are presumably relatively sheltered from predation. This portion of the Bay's open coastline might provide suitable habitat for such small halibut because it is sheltered from southerly swells by the Palos Verdes Peninsula. However, this supposition is based on the single survey from 1989 and it is not clear whether other habitat characteristics along this portion of the coastline, primarily food and refuge from predators, are suited to this small size class. The 1989 finding should be confirmed with additional data before any routine monitoring is considered. If the earlier findings were to be confirmed, this would expand the known nursery areas for juvenile halibut and have implications for the management of this inshore habitat.

Hard Bottom Benthos

The hard bottom benthos in Santa Monica Bay encompasses several distinct habitat types, including nearshore rocky reefs (some with persistent kelp beds), artificial reefs (including breakwaters and jetties), and deep rocky substrate (e.g., Short Bank and the canyon walls). These habitats support significant economic and ecological resources within the bay. Human uses include commercial and recreational fishing, scuba diving, and tourism.

The basic question motivating this component of the Bay Comprehensive Monitoring Program is:

Are hard bottom benthic ecosystems in Santa Monica Bay protected and healthy?

While some reefs that maintain kelp beds have been relatively well studied, much of the rocky substrate in the Bay is not well characterized and there is a need for a more balanced and representative picture of the overall condition of this habitat. This will include a focus on the status of individual resources or resource categories that use the hard bottom benthos as their habitat and that could, at least to some extent, be impacted by anthropogenic activities in the Bay. This program component is structured around a combination of existing monitoring at targeted sites and a new randomized survey that will accomplish a broad assessment of this habitat as a whole.

Monitoring objectives

As mentioned above, the order of the monitoring objectives is not meant to reflect any inherent priority. Objectives may be grouped conceptually, in terms of common spatial scale, ecosystem process, or other functional aspect.

There are six primary monitoring objectives that address the status of the hard bottom ecosystem. While these objectives would primarily be assessed at the scale of the Bay as a whole, a particular area of concern is the ASBS in the northern portion of the Bay.

1. Determine the status of algal, invertebrate, and fish communities throughout the Bay within the shallow water (< 90 feet) portion of the habitat
2. Track changes over time in the status of algal, invertebrate, and fish communities throughout the Bay within shallow water (< 90 feet) high relief and low relief habitat types
3. Conduct reconnaissance of conditions in deep-water (> 90 feet) habitat, including banks, canyons, and rocky outcrops along the shelf edge
4. Track changes over time at a set of fixed reefs in shallow water
5. Estimate changes in abundance of key commercial and recreational rocky subtidal fishes
6. Assess the effectiveness of the current ASBS and any future marine protected areas at protecting and/or restoring algal, invertebrate, and fish communities

The first and second objectives focus on assessing the overall status of reef communities, using a combination of data on macroalgal, large invertebrate, and fish communities, collected using the CRANE indicators. Rocky substrate will be divided into three strata: natural substrate in the north Bay, natural substrate in the south Bay, and artificial substrate including breakwaters and jetties. Natural patches of hard bottom substrate were included in the sampling population if they were at least 200 m^2 in total area, at least 30 m along one axis (the length of the standard transect line), and no narrower than 5 m (the width of the standard transect line). An attempt was made to define additional strata on the basis of vertical relief but the mapping data was not adequate for this purpose. The potential effect of vertical relief will therefore be assessed during data analysis,

based on additional data on habitat characteristics collected by divers. These analysis results may lead to further stratification in future surveys. The three initial strata will be sampled with a design analogous to the Bight Program design, with 30 transects randomly allocated to the artificial stubstrate stratum and 120 stations divided among the north and south Bay strata. Unlike for the soft bottom ecosystem, however, derived indices of community status, and descriptions of reference conditions, have not yet been developed. Thus, comparisons across strata and over time will necessarily be based on descriptive data. Data to meet these objectives will come from a new monitoring element and the objectives would be evaluated every two years. In addition, the kelpbed aspect of shallow reef communities will continue to be assessed with the quarterly Central Region Kelp Survey Consortium (CRKSC) overflights.

The third objective addresses conditions at hard bottom habitats that are beyond diving depth (greater than 90 feet). These include banks such as Short Bank, that can be popular recreational fishing locations, the walls of the Dume, Redondo, and Santa Monica Submarine Canyons, and the rocky outcrops that are abundant along the edge of the continental shelf. There is little existing information about these habitats and monitoring should therefore begin with reconnaissance surveys. These will necessarily be conducted by remotely operated vehicle (ROV) or manned submersible and the data will be primarily photographic and/or observational. The reconnaissance surveys could provide the basis for the design of a periodic monitoring program for these areas. Given the relative costliness of such surveys and the likelihood that these deeper environments do not change quickly, this objective would be evaluated on a decadal time scale.

The fourth objective focuses on a set of fixed monitoring sites in shallow water that have been consistently monitored for several years. Because they will continue to be monitored with the full CRANE protocol of multiple transects per site, they provide the ability to describe long-term trends at the site-specific level. Data to meet this objective is available from existing monitoring studies and the objective would be evaluated every two years.

The fifth objective focuses on the condition of highly visible commercial and recreational fishery resources. Achieving reliable quantitative estimates of abundance of reef fishes would be extremely difficult, requiring intensive amounts of sampling effort. However, estimates of relative abundance and of changes in abundance over time can be derived from Department of Fish and Game catch statistics, power plant impingement of rocky reef species, and from the random and fixed site monitoring data. This objective would be evaluated every two years.

The sixth objective focuses on systematically evaluating the degree to which the ASBS and any future marine protected areas sited within the Bay meet their objectives. The existing ASBS in the Bay will be evaluated with the randomized grid and perhaps as through the Bight Program. However, because the formal site selection process for marine protected areas under the Marine Life Protection Act (MLPA) for southern California has not yet begun, specific sites and boundaries have yet to be determined. Once such sites are designated, a monitoring program would be established that includes at a minimum replicated sites inside and outside the reserve boundary. Monitoring would if possible include multiple sampling events before the reserve is formally established. Such a BACI (Before After Control Impact) type of design provides checks against common types of both spatial and temporal bias and could be integrated with the randomized grids described above.

Monitoring and data acquisition

Each objective can be matched with one or more monitoring strategies, benchmarks or reference conditions that provide a basis for evaluation, data products, and management actions.

Summarized in Table 5, this provides a conceptual summary of this element of the overall Comprehensive Program. Table 6 then describes the specific combination of monitoring and data acquisition activities that will be used to accomplish these objectives, including a summary of monitored indicators, while Figure 3 displays the distribution of monitoring sites in the Bay. Table 6 is followed by descriptions of the individual indicators.

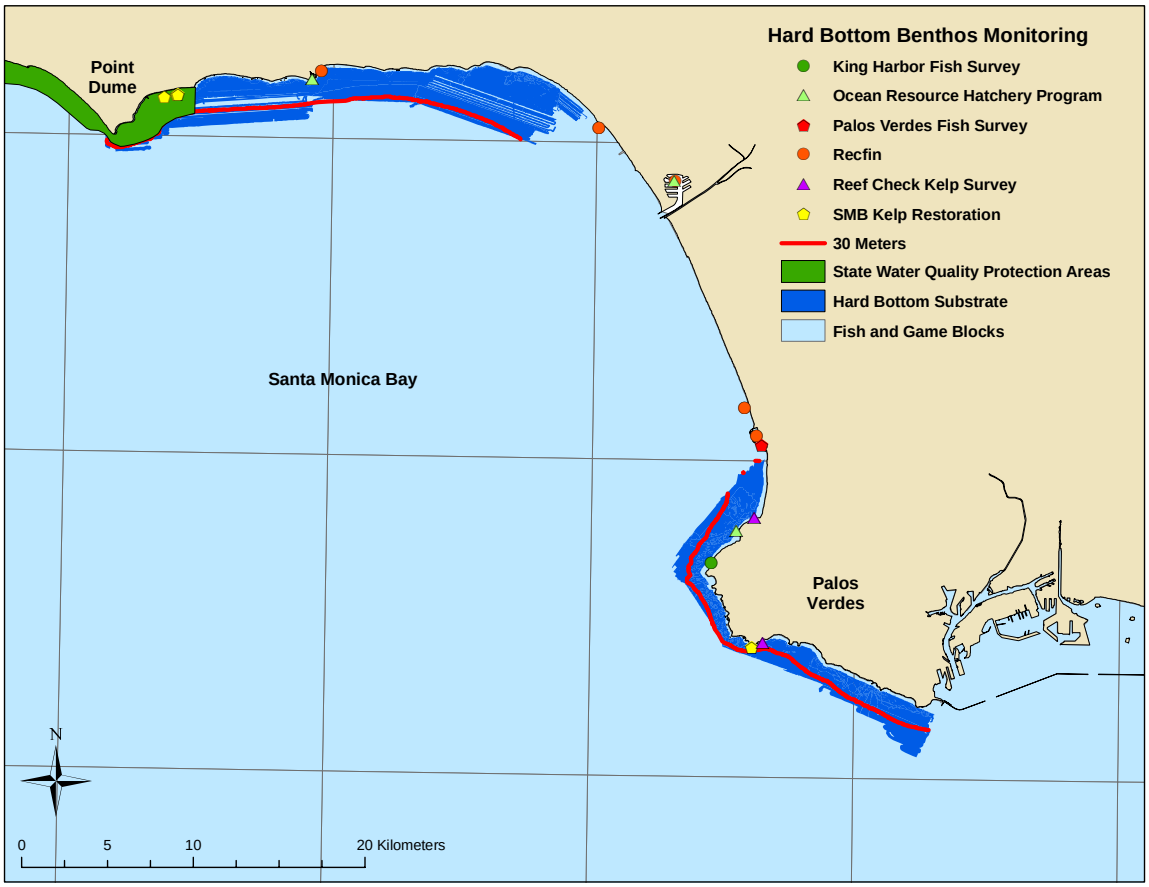
Table 5. Core objectives and monitoring program design elements for the hard bottom ecosystem component of the regional program.

Objective	Strategy	Reference condition	Data products
Determine status of shallow algal, invertebrate, fish communities	Randomized baywide grid CRKSC synoptic overflights Target established indicators	Historical data from Bay Data from Southern California Bight Data from entire Cal Current system	Tables, contour maps of algal, invertebrate, fish indicator values Percent area over subjective thresholds
Track trends in shallow algal, invertebrate, fish communities over time	Track trends over time in above indicators	Historical data from Bay Data from Southern California Bight Data from entire Cal Current system	Trend lines of algal, invertebrate, fish indicator values Trend in percent area over subjective thresholds
Assess deep habitats	Reconnaissance surveys	Historical data from Bay	Abundance, frequency, distribution of indicator species in photo transects
Track trends in shallow algal, invertebrate, fish communities at fixed sites	Fixed trend sites Target established indicators	Historical data from Bay Data from entire Cal Current system	Trend lines in abundance, frequency estimates of algal, invertebrate, fish indicators
Estimate abundance of commercial, recreational species	Focus on individual resources Indirect estimates	Historical data from Bay Data from Bight and from entire Cal Current system	Tables and trend lines in catch statistics Trend lines of fish abundance at fixed sites Statistical comparisons of catch levels to Bight and Cal Current system
Evaluate success of ASBS and marine protected areas	Formal impact assessment (BACI)	Internal reference in the design	Statistical hypothesis tests

Table 6. Design overview for the current hard bottom monitoring of the regional program. Entries in italics in the Description column indicate monitoring components that already exist as part of an ongoing program.

Design approach	Description	Stations, frequency	Indicators / raw data
Sampling grids	Random grid, 5 strata	120 stations divided between north and south Bay, sampled over 2 years; artificial reefs 1 / 2 years	CRANE protocol: invertebrates, fish, algae
	CRKSC overflights	Entire Bay; 4 / year	Estimate of kelp canopy coverage
	Fish & Game blocks	10 blocks in Santa Monica Bay; compiled monthly	Recreational and commercial catch estimates, by fish block, port
	NMFS Recfin sampling sites	5 stations (Hermosa, Malibu, Marina del Rey, Redondo, Santa Monica); daily reporting summarized 1 / year	Number of recreational fishing trips and participants, weight and number of fish caught and/or released, by region
Fixed trend sites	*Santa Monica Baykeeper Kelp Restoration and Monitoring Project*	4 stations; 1 / year in fall	CRANE protocol: invertebrates, fish, algae
	Reef Check kelp reef survey	3 stations; 2 / year in spring and fall	Modified CRANE protocol
	Palos Verdes Point fish surveys-VRG	1 station; 4 / year	All non-cryptic diurnal rocky-reef fishes
	King Harbor fish surveys-VRG	1 station; 4 / year	All non-cryptic diurnal rocky-reef fishes, cryptic fishes, and monthly ichthyoplankton
	Ocean Resource Enhancement Hatchery Program gill net assessment	3 stations (Flat Rock/Palos Verdes, Malibu, and Marina del Rey); 4 / year	Fish density and biomass by species (age class for sea bass)
Targeted areas	ASBS northern Bay	Portion of the random grid; 1 / year	CRANE protocol: invertebrates, fish, algae
	Deep banks, canyons, shelf edge	Reconnaissance survey, then 1 / 10 years	Photo transects of species list, abundance, distribution

Figure 3. Subtidal hard bottom benthos monitoring design, showing both existing and new stations.



The recommended monitoring indicators in Table 6 are described briefly below.

Reef communities at random sites (i.e., algae, invertebrates, fish) measured with the CRANE indicators at a grid of stations throughout the Bay. The CRANE program defines methods for placing and sampling along transects and within quadrats, providing a consistent set of data from sites along the entire coast. However, indices benchmarked to reference conditions have not yet been developed. These data are not currently collected by any program.

Reef communities at fixed sites (i.e., algae, invertebrates, fish) measured with the CRANE protocol at long-term trend sites. These sites are routinely monitored by Santa Monica Baykeeper, the Reef Check program, and the VanTuna Research Group (VRG) at Occidental College. In addition, the Ocean Resource Enhancement Hatchery Program monitors fish communities, focusing primarily on white sea bass.

Kelp canopy overflights are conducted quarterly by the Central Region Kelp Survey Consortium (CRKSC). The maximum canopy extent observed during the year is quantified and reported. These photographic overflights provide quantitative and synoptic estimates of kelp canopy extent within the Bay that can be evaluated in the context of kelp canopy coverage in the entire Southern California Bight. Such estimates indicate the overall health of the kelp resource, but cannot provide information about conditions below the surface.

Reconnaissance studies of deep-water reefs (e.g., Short Bank), canyon walls, and the shelf edge with remotely operated vehicles and submersibles. The goal of these studies would be to determine the feasibility of and methods for routine monitoring of deeper reefs. For example, photographic data from ROV and submersible surveys could be analyzed to derive estimates of abundance for key indicator organisms. Surveys repeated at ten-year intervals would also provide visual evidence of marked changes in habitat condition.

Commercial and recreational catch statistics on rocky reef fishes (see description above under Soft Bottom Benthos).

Power plant impingement of rocky reef organisms (see description above under Pelagic Ecosystem).

The ASBS in the northern part of the Bay will be sampled as a part of the randomized hard bottom grid (see also the soft bottom and intertidal program components). The need for additional samples, in addition to those allocated by the overall sample draw, will not be clear until after the initial sample draw has been completed. In addition, the Bight 2008 Program may address ASBS's throughout the Bight as a distinct stratum (or combination of strata), which would affect the number of stations required for assessing hard bottom substrate in the ASBS in the Bay. A similar approach may be used in the future if new marine protected areas

Special studies

Assess potential MPA sites

The California Department of Fish and Game, as part of the implementation of the Marine Life Protection Act (MLPA), is designating marine reserve sites along the California coast. The site identification, evaluation, and designation process may reach southern California as early as 2007. Accurate information about the location and characteristics of potential reserve sites will

support informed decision making. The SMBRC therefore is conducting a one-time survey of the majority of rocky reefs in the shallow (i.e., less than 60 feet depth) subtidal along the entire length of the Bay's coastline. This special study, which focuses on developing basic descriptive information, is intended to fill the data gap left by the historical focus on the subset of highly valued rocky reefs that support persistent populations of kelp. This special study is being conducted by Dr. Dan Pondella of Occidental Collect and Tom Ford of Santa Monica Baykeeper.

Initial assessment of kelp reefs

Studies of rocky reefs in the Bay that sustain relatively persistent populations of kelp have been ongoing for several years. However, data from these separate studies have not regularly been combined into a baywide summary of kelp status and conditions. An early assessment of kelp conditions and trends, using available data, would provide useful information to the MLPA marine reserves designation process.

Develop index of reef community condition

At present, it is not possible to quantitatively describe rocky reef community condition in terms of its degree of anthropogenic impact and/or difference from a defined reference condition. As a result, it is not possible to estimate, as can be done for the soft bottom habitat, the percentage of the habitat in different categories of condition. Developing an index of community condition would require extensive analytical effort, using data from a wide range of habitat types and conditions. Such an index would also be useful to the PISCO and CRANE programs and this special study could perhaps be carried out as a broader cooperative effort.

Rocky and Sandy Intertidal

The intertidal zone benthos in Santa Monica Bay includes two distinct habitat types, the rocky and the sandy intertidal. These habitats provide substantial recreational and economic opportunities and also support important ecological resources.

The basic question motivating this component of the Bay Comprehensive Monitoring Program is:

> Are the rocky and sandy intertidal ecosystems in Santa Monica Bay protected and healthy?

Answering this question involves focusing on specific indicators and key resources that reflect ecological conditions in these two habitats. This program component is structured largely around the acquisition and integration of existing data, while initiating targeted new monitoring to fill specific data gaps.

Monitoring objectives

As mentioned above, the order of the monitoring objectives is not meant to reflect any inherent priority. Objectives may be grouped conceptually, in terms of common spatial scale, ecosystem process, or other functional aspect.

There are ten primary monitoring objectives that address the status of the rocky and sandy intertidal ecosystems. While these objectives would primarily be assessed at the scale of the Bay as a whole, a particular area of concern is the ASBS in the northern portion of the Bay.

1. Determine the status of the rocky intertidal algal and invertebrate communities throughout the Bay
2. Track changes over time in the status of the algal and invertebrate rocky intertidal communities throughout the Bay
3. Determine location, frequency, and relative intensity of grunion spawning runs on sandy beaches throughout the Bay
4. Track changes in the location, frequency, and relative intensity of grunion spawning runs on sandy beaches
5. Measure species composition and relative abundance of surf-zone fishes at sandy beaches
6. Track changes in the species composition and relative abundance of surf-zone fishes at sandy beaches throughout the Bay
7. Measure the presence, location, and timing of occurrence of key bird species on sandy beaches throughout the Bay
8. Track changes in the presence, location, and timing of occurrence on key bird species on sandy beaches throughout the Bay
9. Determine the abundance and distribution of key plant species on sandy beaches throughout the Bay
10. Track changes in the abundance and distribution of key plant species on sandy beaches throughout the Bay

The first two objectives focus on the overall status of the rocky intertidal community. This will be assessed with the statewide MARINe protocol, supplemented by an expanded list of target species more directly relevant to habitats in the Bay. Fixed sites will be located in a number of different habitat types (e.g., shelf, cobble) as well as in areas with differing degrees of human impact. However, unlike for the soft bottom ecosystem, derived indices of community status, and descriptions of reference conditions, have not yet been developed. Thus, comparisons across sites

and over time will necessarily be based on descriptive data. Data to meet these objectives will come from two existing MARINE sites and a number of new sites and the objectives would be evaluated every year.

The third and fourth objectives focus on the use of the sandy intertidal by an important ecological resource. Grunion and their eggs fill an important place in the food chain and can be directly impacted by human activities such as beach grooming and urban runoff. Grunion runs are monitored routinely at several beaches throughout the Bay by the Grunion Greeters program. These objectives would be evaluated every year.

The fifth and sixth objectives focus on populations of surf-zone fishes. Surf-zone fish are an important recreational resource and many fill an important place in the food chain. These fish will be monitored at three sites in the northern, central, and southern portions of the Bay, using beach seines. Estimates of relative abundance and of changes in abundance over time can also be derived from Department of Fish and Game catch statistics and power plant impingement of nearshore species. Tissue levels of contaminants can provide an indication of the movement of anthropogenic contamination to the nearshore zone, as well a basis for wildlife and human health risk assessments. Data to meet these objectives will come from a new monitoring element and the objectives will be evaluated every year.

The seventh and eighth objectives focus on the wide range of resident and migratory shorebird species that utilize the sandy intertidal as habitat for roosting, feeding, and nesting. While there are several small, independent surveys, the data from these surveys is not readily available, they are not coordinated, and there is no baywide approach in place to monitor this ecosystem component. Shorebirds are of interest for many reasons. Some species are useful indicators of broader oceanic conditions, and some are listed as threatened or endangered under the Endangered Species Act. Taken together, the shorebird community also reflects the overall ability of this habitat to support both human and ecological uses. While many monitoring sites have been identified, a reconnaissance study will be required to finalize sites for the rare species component of the program. Data to meet these objectives will come from a combination of existing and new monitoring efforts and the objectives will be evaluated every year.

The ninth and tenth objectives focus on the extent to which the sandy intertidal habitat supports plant communities that both provide localized habitat for birds and other organisms and maintain some features of historic condition along the beaches. These data, combined with information on beaches' physical characteristics, will provide a starting point for assessments of vegetation restoration potential. Such data exist for a part of the Bay's shoreline and fully addressing these objectives would required additional surveys of the remaining shoreline. These objectives would be evaluated approximately once every ten years.

Monitoring and data acquisition

Each objective can be matched with one or more monitoring strategies, benchmarks or reference conditions that provide a basis for evaluation, data products, and management actions. Summarized in Table 7, this provides a conceptual summary of this element of the overall Comprehensive Program. Table 8 then describes the specific combination of monitoring and data acquisition activities that will be used to accomplish these objectives, including a summary of monitored indicators, while Figure 4 displays the distribution of monitoring sites in the Bay. Table 8 is followed by descriptions of the individual indicators.

Table 7. Core objectives and monitoring program design elements for the hard bottom ecosystem component of the regional program.

Objective	Strategy	Reference condition	Data products
Determine status of rocky intertidal algal, invertebrate communities	Fixed sites Compare substrate type, level of impact Target established indicators	Historical data from Bay Data from entire Cal coast	Tables, maps of algal, invertebrate indicator values
Track trends in rocky intertidal algal, invertebrate communities over time	Track trends over time in above indicators	Historical data from Bay Data from entire Cal coast	Trend lines of algal, invertebrate indicator values
Determine location, frequency, intensity of grunion runs	Monitor major runs Target established indicators	Historical data from Bay Data from entire Cal coast	Tables, maps of grunion run indicators
Track trends in location, frequency, intensity of grunion runs	Track trends over time in above indicators	Historical data from Bay Data from entire Cal coast	Trend lines in grunion run indicators
Measure species composition, abundance of surf-zone fishes	Fixed sites Monitor entire community	Historical data from Bay	Tables of abundance, species composition
Track trends in species composition, abundance of surf-zone fishes	Track trends over time in above indicators	Historical data from Bay	Trend lines of abundance, species composition
Determine status of shorebird communities on sandy beaches	Monitor entire Bay and key sites Monitor entire community and key species Use available data, where possible Target established indicators	Historical data from Bay Data from Cal Current system and North Pacific	Tables, maps of species abundance, distribution, breeding, etc.
Track trends in status of shorebird communities	Track trends over time in above indicators	Historical data from Bay Data from Cal Current system and North Pacific	Trends of species abundance, distribution, breeding, etc.
Determine abundance, distribution of shoreline plant community	Visual survey	Historical data from Bay	Maps of vegetation species, communities
Track trends in abundance, distribution of shoreline plant community	Track trends over time in above indicators	Historical data from Bay	Periodic maps over time

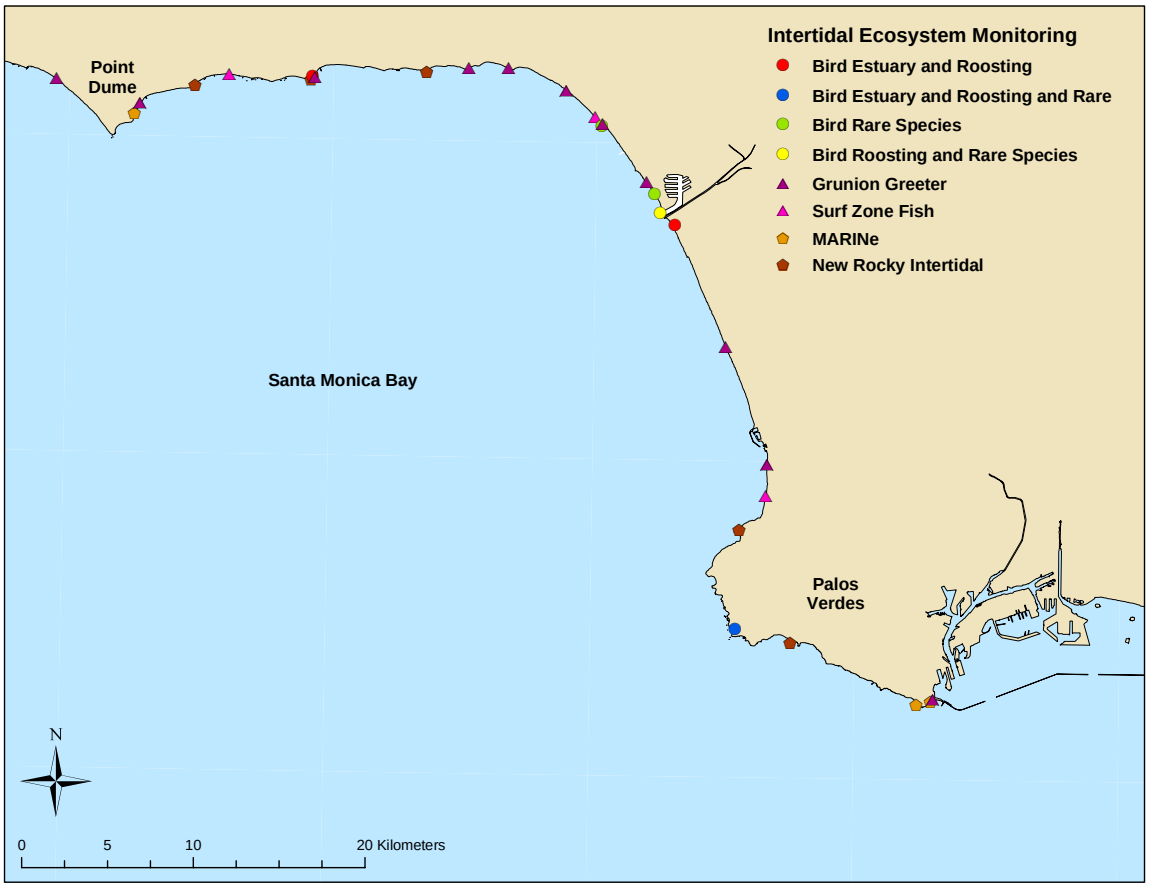
Table 8. Design overview for the rocky and sandy intertidal system component of the regional program. Entries in italics in the Description column indicate monitoring components that already exist as part of an ongoing program.

Design approach	Description	Stations, frequency	Indicators / raw data
Fixed sites	*MARINe rocky intertidal*	3 stations at Paradise Cove, Whites Point, Point Fermin, sampled spring & fall	MARINe suite of indicators (13 indicator species, physical condition)
	8 additional rocky stations	2 rocky bench at Flat Rock (PV Peninsula), Malibu, sampled spring and fall 3 cobble/boulder (1 on PV Peninsula, 2 in Malibu (incl. cobble reef off Malibu Lagoon)), sampled spring and fall 3 re visitor impact at Abalone Cove, Latigo, Big Rock	Expanded list of local/regional species Index of intertidal community structure
	Grunion Greeter survey	7 stations in Bay, 10 times from April through June (Trancas Lagoon / Zuma Beach, Malibu Lagoon State Beach, Will Rogers State Beach, Venice Beach at pier, Manhattan Beach at pier, Hermosa to Redondo Beach, Cabrillo Beach)	Location, frequency, relative intensity of grunion runs
	Surf-zone fish survey	3 stations, 1 / year in summer index period	Species identification and relative abundance
	Bird roosting site survey	6 stations, 8 times in fall & winter (Playa del Rey breakwater, Lower Ballona Creek / Ballona Wetlands, Malibu Lagoon, Zuma Creek mouth, other)	Presence/absence, counts, timing of gulls, terns, shorebirds
	*Bird estuary survey **	5 stations, 4 times in fall, 4 times in winter, 12 times in breeding season (Mar – June) (Malibu Lagoon, Ballona Freshwater Marsh, Ballona Lagoon, Lower Ballona Creek/Ballona Wetlands, Zuma Creek mouth)	Presence/absence, counts, timing of gulls, terns, shorebirds, T&E species
	*Bird rare species survey **		
	• *Snowy Plover (FWS, PRBO)*	4 beaches (Zuma Beach Santa Monica Beach, Venice Beach, Hermosa Beach), 1 / year	Abundance of adults
	• *Least Tern (CDF&G)*	Venice Beach, 1 / year	Abundance of adults, young, total nesting attempts
	• *Beldings Sparrow*	Ballona Wetlands, 1 / 5 years (CDF&G), 1 / 2 years	Abundance of adults, territory counts, occasional

Design approach	Description	Stations, frequency	Indicators / raw data
	(CDF&G, Corps)	(Corps)	fledgling success Additional rare species, e.g., Black-vented Shearwater, Brandt's Cormorant, Pelagic Cormorant, Snowy Egret, Long-billed Curley
Regional survey	Sandy beach plant survey	All sandy beaches, 1 / year	Plant species, relative abundance, location

* Most of these surveys are onging, conducted by a variety of public, private, and nonprofit entities. The Comprehensive Monitoring Program would need to coordinate with these, fill in some additional sites, and provide for data entry and QA. In addition, a reconnaissance study will be required to finalize sites for the rare species survey.

Figure 4. Rocky and sandy intertidal monitoring design, showing both existing and new stations.



The recommended monitoring indicators in Table 8 are described briefly below.

Rocky intertidal community status, which includes measures of substrate characteristics and plant and invertebrate communities, provides a means to identify significant impacts (e.g., oil spills) and track recovery from these over time. In addition, the placement of monitoring sites in locations with varying levels of human access and use furnishes an opportunity to assess the impacts of such disturbances. Because these sites will be sampled with an established statewide protocol (MARINe), data from elsewhere in California could provide a larger context for evaluating findings from Santa Monica Bay. The MARINe protocol will be expanded with additional species relevant to local / regional conditions. Interpretation of intertidal data is problematic, however, because there is no derived index or metric on which to base such comparisons. Developing such an index is problematic because of the difficulty in defining clear reference site and gradients of condition or impact. Three of the 11 sites in the Bay are routinely monitored by the statewide MARINe network.

Grunion spawning runs occur regularly in the spring on sandy beaches. Grunion eggs provide food for birds and other organisms and the grunion themselves are an important part of the nearshore foodweb. The success of spawning runs can be strongly affected by human activities such as beach grooming. Grunion runs are routinely monitored by the statewide Grunion Greeter program.

Surf-zone fish populations live at the interface between the terrestrial and marine environment, are an important recreational resource, and can be directly impacted by human activities. These populations have never been routinely monitored.

Bird populations of several kinds regularly use sandy beach habitats for year-round nesting and feeding, as well as stopover points on their seasonal migrations. The Bay's beaches are also home to species designated as threatened or endangered, including the Least Tern, Snowy Plover, and Belding's Savannah Sparrow. Several agencies and volunteer groups conduct regular surveys targeted at specific locations, but these data are not integrated into a single, readily accessible database. Snowy Plover monitoring targets simple counts of adults in winter. Least Tern monitoring targets counts of adults and young, as well as total nesting attempts. Belding's Savannah Sparrow monitoring targets adult counts and number of territories, and occasionally fledging success. In addition, the baywide roosting site survey would constitute a new monitoring effort.

Reconnaissance of rare bird survey sites

Several sensitive bird taxa utilize the intertidal zone of Santa Monica Bay, yet currently only three (Snowy Plover, Least Tern and "Belding's" Savannah Sparrow) are being monitored in any comprehensive manner. However, additional priority species of high conservation concern regularly utilize inshore habitats of Santa Monica Bay, including:

- Black-vented Shearwater
- Brandt's Cormorant
- Pelagic Cormorant
- Snowy Egret
- Snowy Plover
- Long-billed Curlew.

Other species of "moderate" conservation concern that use a variety of Santa Monica Bay habitats in large numbers include Western Grebe, Brown Pelican, Black Turnstone, Sanderling, Heermann's Gull and Elegant Tern. All of these species occur widely along Santa Monica Bay and at various seasons, some in exceptionally large numbers (e.g., Brown Pelican). Aside from Black-vented Shearwater, breeding Least Terns and wintering Snowy Plovers, the locations of concentrations of these species along the bayshore and in inshore waters is unknown.

Since only one of these species nests along the bayshore (Least Tern), none of the potential indicator species would require breeding bird surveys for detection. A baywide reconnaissance survey, conducted in coordination with other routine bird monitoring, would provide a more accurate list of indicator species with details on their usage of the Bay's shoreline. Combined with input from local scientists and conservationists, this will provide the basis for decision making about the need for and design of systematic monitoring of bird species of conservation concern.

Vegetation was historically present along many of the sandy beaches in the Bay but has disappeared in most locations as the result of heavy human disturbance, including beach maintenance activities. Natural vegetation provides habitat for birds and other species that use the sandy intertidal habitat. The SMBRC has conducted a survey of vegetation along a portion of the Bay's coastline, but large areas have yet to be surveyed. An annual survey of all sandy beaches would be conducted to document the types and relative abundance of plants.

Special studies

Develop index of rocky intertidal community condition

At present, it is not possible to quantitatively describe rocky intertidal community condition in terms of its degree of anthropogenic impact and/or difference from a defined reference condition. Developing an index of community condition would require extensive analytical effort, using data from a wide range of habitat types and conditions. Such an index would also be useful to the MARINe program and this special study could perhaps be carried out as a broader cooperative effort.

Investigate potential grunion egg indicator

Like amphibians and other fishes, grunion embryos are vulnerable to chemicals and pollutants through the thin chorionic membrane that surrounds the shell-less egg. However, unlike amphibians and many other fish species, grunion eggs lack a surrounding protective jelly coat. Grunion embryos have been used in toxicity tests for common environmental contaminants including the hydrocarbons benzo(a)pyrene and carbophenothion, and the pesticide chloropyrifos. In fact, the grunion were the first marine fish from Pacific coastal waters to be used in an early life-stage toxicity test, and the methods for laboratory assessment of toxicity in early life stages of grunion are well described. Grunion embryos exposed in the laboratory to the non-thermal effluent from a power plant had reduced hatching success. These studies exposed grunion embryos to known, ecologically relevant concentrations of pollutants and examined them for developmental anomalies and changes in hatching success.

Incubating eggs can be collected from routine monitoring sites, and the embryos examined for gross developmental abnormalities. The viability of hatchlings from each site can also be measured. These data can be used to estimate the quality of specific beach habitats for grunion reproduction. The data can then be correlated with environmental monitoring done by other

agencies, such as regional water monitoring, to identify indicators of specific environmental conditions.

Archive historical bird survey data

The majority of existing data on shorebird populations in Santa Monica Bay is dispersed among a number of private individuals, conservation organizations, and resource management agencies with either an interest in or responsibility for a limited aspect of bird status and dynamics. In addition, the majority of these data have not been entered onto digital media, but exist as hard copy data sheets. Finally, even digital data have not been aggregated into a single, readily accessible database of bird observations. A one-time effort to identify, acquire, and enter historical bird monitoring and observational data from the Bay into a database that provides for easy data entry, QA/QC functions, and routine data access and retrieval would provide a substantial benefit to both the SMBRC and the wider community of bird researchers. Such a database would enable the SMBRC to more easily and efficiently carry out its baywide assessment task.

Develop index of regional bird community condition

As for the hard bottom and rocky intertidal ecosystems, there is no quantitative community assessment tool available for tracking the status and trends of bird communities that utilize the Bay's shoreline. Development of such an index would support the SMBRC's regional assessment effort by providing a broader and more objective picture of the status of the bird community than is currently available from monitoring that is focused primarily on single species.

Investigate tissue contamination in surf-zone fish

Surf-zone fish are both an important recreational resource and a link in the foodchain to shorebirds, larger predatory fish, and marine mammals. They therefore represent a potential pathway for the transfer of anthropogenic contaminants to humans and to higher levels of the foodchain. While existing monitoring provides information about tissue concentrations in both demersal and pelagic fish in the Bay, surf zone fish represent a data gap of concern. This is because they may be directly exposed to urban runoff to the nearshore zone, are fished by a separate population of sport fishers, and are potential prey to shorebirds and other predators that frequent the nearshore zone. In the absence of information about patterns of tissue contamination in nearshore fish, it has not been possible to determine whether such potential foodchain transfers are of concern or not. A special study to document tissue contamination in corbina, California halibut, barred surf perch, and other common nearshore fishes would resolve this uncertainty. This study should sample at different times of year to assess the effect of changes in lipid content and should position stations on gradients away from contaminant inputs to determine whether spatial patterns of contamination are related to such inputs. This study should also compare tissue contamination in surf-zone fish to that in pier-caught fish to determine whether there are consistent differences that suggest the need for separate monitoring efforts.

Investigate tissue contamination in sand crabs

Data from the central California coast shows that tissue contamination in sand crab populations reflects patterns in terrestrial inputs of contaminants. Thus, sand crabs may represent an important pathway for the transfer of contaminants to higher levels in the foodchain. Based on the results of the special study on tissue contamination in surf-zone fish, it may be informative to evaluate tissue contamination in sand crabs.

Conduct reconnaissance of shallow nearshore infauna community

The benthic infaunal community in the shallow nearshore portions of the Bay is not sampled by either the Bight Program's periodic monitoring effort or the routine compliance monitoring conducted by dischargers to the Bay. This data gap is due to the combination of this habitat's relative distance from major discharges (which typically discharge offshore) and the difficulty of sampling in the turbulent nearshore zone. The infaunal benthic community in this habitat is an important part of the food chain for surf-zone fish and may also be a pathway through which contaminants in urban runoff enter the Bay's ecosystems. In the absence of any extensive information about this community, a reconnaissance study including representative sites around the Bay's shoreline, and focused on collecting information on species composition and variability, would be useful in making decisions about the need for more routine monitoring of this habitat.

Wetlands

The coastal wetlands habitat in Santa Monica Bay includes larger wetlands, such as the Ballona Creek Estuary and Malibu Lagoon, as well as smaller areas at the mouths of creeks in the northern portion of the Bay. These wetlands provide important ecological habitat for a wide variety of resident and migratory birds and for both juvenile and adult life stages of marine and estuarine fishes. Because the vast majority of wetlands in southern California have been destroyed by urbanization, the wetlands that do remain have inreased importance and are highly valued.

The basic question motivating this component of the Bay Comprehensive Monitoring Program is:

> Are the wetland ecosystems in Santa Monica Bay protected and healthy?

Answering this question involves assessing wetlands' structural integrity (e.g., area, hydrology) as well as the health of the plant and animal communities they support. The Wetlands Recovery Project (WRP), a large interagency effort, is currently developing a statewide monitoring program that would assess both these aspects of wetlands over the long term. The southern California portion of this monitoring program, the Integrated Wetlands Regional Assessment Program (IWRAP) is in the final stages of development, with initial implementation planned for the summer of 2007. The SMBRC's approach is to coordinate closely with IWRAP, using IWRAP's design as the foundation on which to add additional monitoring sites to provide a more complete picture of wetland conditions in the Bay.

Monitoring objectives

As mentioned above, the order of the monitoring objectives is not meant to reflect any inherent priority. Objectives may be grouped conceptually, in terms of common spatial scale, ecosystem process, or other functional aspect.

There are six primary monitoring objectives drawn from IWRAP and that address the overall status of wetlands in the Bay. While these objectives would primarily be assessed at the scale of the Bay as a whole, a particular area of concern is the ASBS in the northern portion of the Bay.

1. Determine the locations and sizes of wetlands and how they are distributed across the region by habitat type
2. Determine the condition of wetlands and associated resources on a regional scale
3. Track changes over time in the condition of wetlands and associated resources
4. Identify the major stressors on wetlands
5. Track changes in the nature and magnitude of stressors over time
6. Assess the effects of restoration and mitigation projects on the overall condition of wetlands and associated resources
7. Evaluate the effectiveness of individual restoration projects

The first objective focuses on mapping the location and extent of wetlands in the Bay. This effort is being conducted by the WRP, using the US Fish and Wildlife Service's National Wetlands Inventory (NWI) database of digital maps as a starting point. The NWI maps are being updated with more current data, where that is available. In addition, IWRAP must finalize its list of wetlands, establish clear criteria for defining their inland boundaries, resolve discrepancies in wetland names, and define the boundaries of the intertidal and subtidal sampling strata. This

effort is scheduled for completion by the end of 2006 and would be addressed once every ten years in the future.

The second and third objectives focus on an overall assessment of physical, chemical, and biological conditions in wetlands at a regional scale. This is the goal of Level 2 of the IWRAP monitoring design, which includes a range of indicators that document stressors, overall condition, physical processes, contaminants, biochemistry and eutrophication, and fish, bird, infauna, and plant resources. These indicators would be monitored at a set of 60 randomly selected sites throughout southern California. The 60 sites will be divided among large and small wetlands, and between intertidal and subtidal sampling strata. The SMBRC would develop a locally intensified monitoring design built on the IWRAP design. In addition, the SMBRC would phase in the full suite of IWRAP indicators, beginning in 2007 in tandem with the IWRAP's implementation schedule, with a more restricted set including California Rapid Assessment Method (CRAM) attributes, inlet condition, tidal range, and plant species and abundance. These objectives would be evaluated every five years.

The fourth and fifth objectives involve quantifying key stressors such as surrounding landuses and percent impervious area, as well as chemical contamination, invasive plant and animal species, and other forms of human disturbance. Some stressor indicators (e.g., surrounding landuses) could be captured in the mapping effort being undertaken to address objective #1. Others would be monitored as the complete list of indicators is implemented over time. These objectives would be evaluated every five years.

The sixth objective will focuses on determining whether specific restoration and mitigation projects are improving wetland condition and area over time. The objective will be accomplished through use of the Project Tracker database software being developed by the WRP. This software allows for entry of detailed information on each restoration or mitigation project and for linking that information with monitoring data. This objective would be evaluated on a regional basis every five years. However, Project Tracker will also provide the ability to evaluate individual projects on a site-specific schedule, as needed.

The seventh objective focuses on determining whether individual restoration projects are meeting their stated objectives. While project-level monitoring will be conducted by individual projects, and not by the Program, the Program has an interest in ensuring that such monitoring is effectively designed and carried out. Project-level monitoring is defined as Level 3 in the IWRAP structure, and IWRAP will be producing detailed design guidance for monitoring at the project scale by the end of 2007. In the interim, the Program supports the basic guidelines described in Tables 9 and 10 below. These include sampling both before and after restoration begins, locating stations in all subwatersheds and/or drainages of the watershed, and monitoring all key processes and components. Monitoring data should be evaluated in comparison to quantitative restoration targets, Sediment Quality Objectives thresholds, and regional reference conditions as determined by IWRAP monitoring. The IWRAP schedule should provide detailed project-specific monitoring designs in time for use in restoration projects in the Bay. It is unlikely that any new projects, with the exception of Malibu Lagoon, will be initiated in 2007, and a detailed monitoring program for this project already exists. Ballona, the next likely restoration project in the Bay, is intended to be the IWRAP's template for defining the details of project-specific monitoring.

Monitoring and data acquisition

Each objective can be matched with one or more monitoring strategies, benchmarks or reference conditions that provide a basis for evaluation, data products, and management actions. Summarized in Table 9, this provides a conceptual summary of this element of the overall Comprehensive Program. Table 10 then describes the specific combination of monitoring and data acquisition activities that will be used to accomplish these objectives, including a summary of monitored indicators, while Figure 5 displays the distribution of monitoring sites in the Bay. Table 10 is followed by descriptions of the individual indicators.

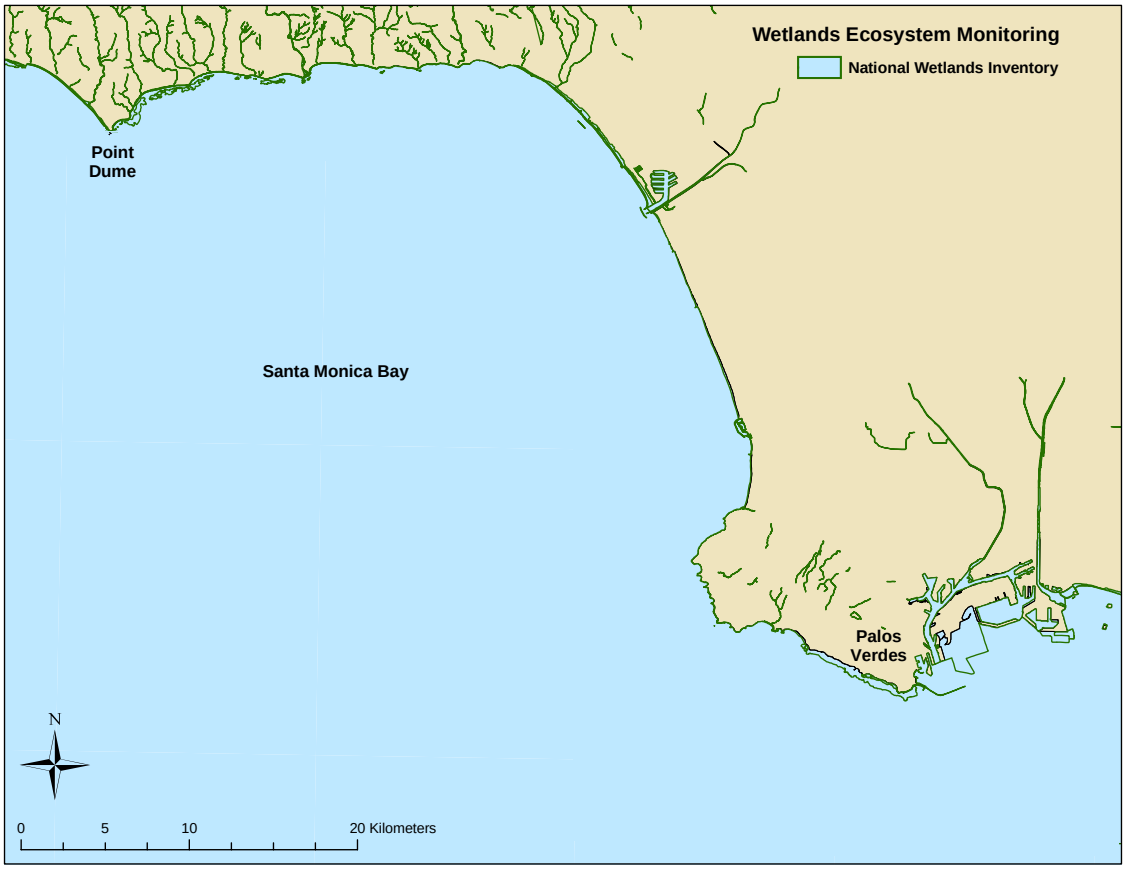
Table 9. Core objectives and monitoring program design elements for the hard bottom ecosystem component of the regional program.

Objective	Strategy	Reference condition	Data products
Determine location, size of wetlands	Update existing NWI database	Historical data from the Bay	Maps of wetland location, extent
Determine condition of wetlands and associated resources	Randomized baywide grid Target subset of IWRAP indicators Phase in other indicators over time	Bightwide reference from Bight program Historical data from Bay	Tables, maps of indicator values
Track trends in wetland condition over time	Track trends over time in above indicators	Historical data from Bay	Trend lines of indicator values
Identify major stressors on wetlands	Randomized baywide grid Target subset of IWRAP indicators Phase in other indicators over time	Historical data from Bay	Tables, maps of indicator values
Track trends in nature, magnitude of stressors over time	Track trends over time in above indicators	Historical data from Bay	Trend lines of indicator values
Assess regional effects of restoration, mitigation	Project Tracker database for project-specific data Aggregate before – after comparisons at baywide scale	Summary of pre-project conditions	Trend lines of key regional indicator values
Evaluate individual restoration projects	Before – after comparisons at project scale Assess all key processes and components	Before-project condition Quantitative restoration targets Regional reference background Sediment Quality Objectives	Statistical before-after comparisons Statistical comparisons with restoration targets Comparison to Sediment Quality Objectives

Table 10. Design overview for the rocky and sandy intertidal system component of the regional program. Entries in italics in the Description column indicate monitoring components that already exist as part of an ongoing program.

Design approach	Description	Stations, frequency	Indicators / raw data
Sampling grids	*IWRAP bightwide grid*	60 stations in the Bight in large & small wetlands, intertidal & subtidal strata (number of stations in Bay yet to be determined); 1 / 5 years	IWRAP suite of indicators (stressors, CRAM, hydrology, physical processes, contamination, biochemistry, eutrophication, fish, infauna, birds)
	Intensified random grid in Bay	60 staions in large & small wetlands, intertidal & subtidal strata; 1 / 5 years	CRAM, inlet condition, tidal range, plant community
Targeted areas	Project-specific evaluations	Stations distributed in every subwatershed or drainage; plants, infauna, fish, sediment chemistry and toxicity in summer, birds in fall and winter	Hydrology, soils, key plant and animal taxa (including infauna), water quality, sediment chemistry, sediment toxicity
		Sampling before and after project begins	Landscape context, interaction with other habitats
			Metrics related to all restoration targets

Figure 5. Wetlands in the Bay. Monitoring stations have not yet been identified. This map is preliminary; the final version, developed by the Wetlands Recovery Project based on National Wetlands Inventory data, will be available in early 2007.



The recommended monitoring indicators in Table 10 are described briefly below.

The **California Rapid Assessment Methodology (CRAM)** is a rapid assessment tool whose primary emphasis is on the overall physical and biological structure of the system, including hydrology, geomorphology, vegetation (including both native and invasive species), the riparian zone, and the floodplain. CRAM's biological measurements focus primarily on the riparian and floodplain zones rather than on aquatic organisms. The SMBRC will target CRAM for the initial portion of its phased implementation because the methodology is well worked out, the method provides a broad overview of conditions, and is relatively inexpensive compared to the full suite of IWRAP indicators. IWRAP will sample a number (yet to be determined) of stations in the Bay, while the SMBRC will monitor an additional 60 stations, once every five years.

Inlet condition documents whether the inlet from the ocean is open or closed and the relative accessibility to tidal flows. This information provides needed context for interpreting other physical and biological data from the wetland, since the presence or absence of tidal interchange with the ocean is a key determinant of many processes within the wetland.

Tidal range measures the vertical and horizontal extent of tidal excursions within the wetland. This information is important for interpreting the distributions of animals and plants within the wetland.

Plant species and abundance will provide a measure of the biological integrity of the wetland and the degree to which it has been impacted by invasive species and other human disturbances. The distributions of key indicator species can be correlated with information on the wetland's phyiscal structure and processes. Much of the needed information on the plant community will be collected as part of the CRAM procedure. Most plant species do not have pronounced seasonal abundance patterns and the plant community can therefore be sampled once a year, preferably in the summer.

Hydrology will document flows of water through the wetland, including the interchange of water with the ocean and freshwater inputs in the upper wetland. Flow patterns affect important functional characteristics of the wetland, including retention and flushing times, primary and secondary productivity, sediment deposition and movement dynamics, and thus ultimately the viability of restored habitats.

Soil characteristics affect the stability of shorelines and other habitat structures, as well as soil moisture and other factors that affect the structure and functioning of vegetation communities.

Benthic infauna are important prey items for fish and birds and benthic community structure reflects impacts due to contamination and physical disturbance. The State Water Quality Control Board is developing Sediment Quality Objectives that include thresholds for a derived index of benthic community condition. Benthic infauna, along with sediment chemistry and sediment toxicity, would be sampled once a year, in the summer.

Sediment chemistry is a direct measure of anthropogenic impacts and of the exposure of biological commmunities to potential contaminant effects. Contaminated sediments can affect infaunal community structure and also be a source of indirect effects on organisms higher in the food chain, such as fish and birds. As for benthic infauna, Sediment Quality Objectives are being developed that include thresholds for a range of common sediment contaminants.

Sediment toxicity is a measure of potential contaminant effects on benthic infauna. The Sediment Quality Objectives project has identified specific recommended toxicity tests and is developing thresholds to be used in the overall evaluation of sediment quality.

Water quality parameters measure basic water mass characteristics (e.g., pH, salinity, hardness, temperature) as well as concentrations of contaminants of concern. Basic water mass characteristics can provide insight into the hydrology of the wetland, while data on contaminants can help identify sources and contribute to a more complete understanding of impacts.

Animal taxa include primarily fish and birds, along with benthic infauna. Many fish and birds can have marked seasonal patterns, while this is true only for some plant species. In addition, benthic infauna typically do not exhibit pronounced seasonal patterns. Thus, benthic infauna can be sampled once a year. While many fish species do show seasonal patterns, overall abundance and species richness peak in the summer. As a result, fish can be sampled once a year in the summer. This represents a reasonable compromise because of the difficulty and expense of fish sampling. Birds, in contrast, should be sampled seasonally, at least during fall and winter, since many key species are simply absent during some seasons of the year. Bird sampling should be closely coordinated with the bird monitoring component of the intertidal program.

Revisions to Existing Program Components

Previous efforts to defne a comprehensive monitoring program for Santa Monica Bay identified 16 distinct ecosystem elements that should be monitored (SMBRP 1993) and proposed adjustments to existing compliance monitoring (SMBRP 2000) to better reflect current understanding, improve efficiency, and free up funding and other resources to address many of these ecosystem elements. The current status of the recommendations is described in detail in SMBRP (2000).

In summary, several key program elements have been addressed, primarily a more regional approach to monitoring the pelagic ecosystem, tissue contamination in sportfish, stormwater plumes, and kelpbed canopy extent. In addition, a regional approach to wetland monitoring is in the planning phase, although it will not monitor at the level of spatial intensity envisioned by the Comprehensive Monitoring Program. Other monitoring elements, such as intertidal and resident fish population monitoring have not been addressed in any substantive way since the 2000 report. These efforts have been carried out under a number of separate cooperate agreements involving varying combinations of stakeholders

Implementation Plan

Implementation schedule

The components that make up the SMBRC's Comprehensive Monitoring Program (Figure 6) include three main categories of activities:

1. Existing long-term programs with an independent funding base
2. Existing programs that are designed to be long term but are funded by soft money and would benefit from additional support and visibility
3. New monitoring efforts, including enhancements to the Bight Program and other existing programs, that would require new funding

Monitoring components in the first category include efforts such as the NPDES permit compliance monitoring, CalCOFI oceanography, Bight regional survey, and shorebird endangered species programs. These programs require no additional study design effort or funding, but do provide both sources of important data and opportunities for coordination in sampling as well as data analysis and assessment. Monitoring components in the second category include efforts such as the Grunion Greeters and the Santa Monica Baykeeper's Kelp Restoration and Monitoring Project. These programs fulfill key data needs but are dependent on grants, shorter-term contracts, and/or volunteer efforts. Their primary need is for more secure funding, and such funding could, in some cases, enable sampling to be conducted by contracted consultants rather than volunteers and/or students. Monitoring components in the third category include efforts such as the fish larvae, randomized hard bottom, and non-IWRAP wetlands monitoring programs. These programs are new and require a full range of design, sampling, and funding support from the SMBRC. If a program in the second category were to lose its funding, then, for all intents and purposes, it would move into category three, requiring full support from the SMBRC. Table 11 summarizes the types of effort required of the SMBRC for each program category. As the preceding paragraph describes, these range from data acquisition to a more comprehensive deisgn and funding effort.

The workgroup considered a number of possible criteria for prioritizing the range of monitoring efforts and agreed that the following criteria should be used to determine the order in which individual program components are implemented (note that the order of the list is not indicative of the importance of the criteria):

- Existing programs that require more secure funding (category #2 above)
- Overall cost-benefit, defined as a combination of cost and the degree to which a monitoring effort would fill a data gap that is either critical to a management decision or completes a program component and thus facilitates a more complete assessment
- Opportunity for coordination with other program development efforts
- Management need, including the ability for a management response within the Bay
- Public / stakeholder interest

While these priorities provide useful overall guidance, the existing schedules of other programs (e.g., Bight Program, IWRAP) to some extent constrain the Program's choices. For example, planning for Bight '08 will begin in the summer of 2007, as will the first round of IWRAP wetland sampling, and other aspects of the Bay Program's schedule must therefore accommodate these events, which are outside the Program's control. The proposed implementation schedule (Figure 6) takes these external constraints into account and also identifies the design, coordination, data managament, and assessment components of each Program element. In addition to these core monitoring activities, Figure 6 identifies and schedules a number of special studies considered to be high priorities by the workgroup.

Management infrastructure

Managing the Comprehensive Monitoring Program will be a challenge in many respects. It will require:

- Relationship building with existing programs to implement efficient data acquisition and data sharing arrangements
- Coordination with existing programs to ensure that collaborative sampling and design efforts are adequately staffed and efficiently carried out
- Allocation of sufficient expertise to complete design and implementation details for new monitoring components
- Ongoing management oversight to establish schedules and ensure milestones are being met
- Allocation of sufficient expertise to complete scheduled assessments

In addition to these management activities, the SMBRC must develop and implement a data management strategy to support the extensive data acquisition, storage, integration, and analysis efforts that will necessarily be involved in preparing assessments for individual program components and for the Bay as a whole.

These efforts are complex, their scale substantially exceeds the SMBRC's previous undertakings, and they must be sustained over the long term. The workgroup recommends that the following roles, at a minimum, are essential to the implementation and success of the Comprehensive Monitoring Program:

- Program manager: Responsible for overall coordination and management of all program elements, for scheduling, costing,and contracting, and for establishing and maintaining collaborative relationships with other programs essential as partners and/or data sources for the Comprehensive Monitoring Program.

- Data manager: Responsible for establishing, implementing, and maintaining data acquisition, sharing, and QA/QC policies. Also responsible for developing an overall data management strategy as well as any needed databases and associated data management tools.

- Assessment manager: Responsible for designing data analysis approaches and broader integrative assessment strategies for each program component. Also responsible for overseeing design of the periodic State of the Bay report, including ecosystem assessment approaches that tie the various program components together.

The workgroup believes that no single implementation approach will suffice for all program elements and special studies, and recommends the management structure illustrated in Figure 7. Therefore, while the SMBRC could readily contract with consulting companies, universities, or nonprofit groups for individual aspects of the Program, the SMBRC should itself provide overall coordination and management oversight of all Program activities. This requires that the program manager and assessment manager positions be filled by full-time SMBRC staff who are dedicated primarily to these roles. The workgroup recommends that SMBRC utilize the Surface Water Ambient Monitoring Program's (SWAMP) regional data node at the Southern California Coastal Water Research Project (SCCWRP) as the central element of the data management effort. Depending on how this relationship is implemented, the data manager position may be filled by a member of SCCWRP's staff.

While the program and assessment manager roles should be filled by permanent SMBRC staff, the workgroup also recommends that the Program make maximum use of scientific, technical, and management expertise throughout the region by building and/or maintaining relationships with the TAC, partners in other agencies and in academia, and with contractors. This will result in a more efficient use of the available expertise and resources in the region. However, it will also increase the necessity for the SMBRC to exercise continuous, careful management oversight of the Program.

The three core functions are discussed more fully in the following subsections.

Program management

Overall management of the Program will require knowledge of the scientific and management issues facing the Bay, basic familiarity with monitoring design and monitoring methods, and well-developed project management skills. The likelihood that the Program will involve multiple, separate funding agreements means that the SMBRC must engage in active management and oversight of progress on each monitoring element. This will require:

- Tracking and adjusting the Program schedule to ensure coordination among different Program elements as well as with outside efforts that provide opportunities for collaboration and/or cost sharing
- Establishing clear and consistent procedures for efficient communication among Program participants
- Ensuring that adequate data managent and assessment tools and procedures have been established
- Ensuring that data are being processed and input to databases as scheduled

Data management

The technical workgroup was clear that the SMBRC should not attempt to develop a stand-alone, centralized database to house all the data generated by the program elements listed in Figure 6. Such an effort would require an inordinate amount of time and effort, tax the institutional capacity of the SMBRC, and duplicate data management activities of the major monitoring efforts (e.g., CalCOFI, Bight, SCCOOS) that will provide data for the Program's assessments. However, the workgroup did recognize that there are several important data management goals the Program must accomplish. These include:

- Providing a home for small and/or orphan datasets that otherwise would be lost or inaccessible to the Program's assessment effort and its participants
- Establishing data management standards that will apply to Program participants or contractors implementing new monitoring elements
- Crafting agreements that define the technical aspects of data acquisition from other ongoing monitoring efforts
- Specifying standardized data transfer formats to facilitate the movement of data into the project database and among particpants working on the various assessments
- Constructing a working database for storing and organizing data and data products used during periodic assessments

Given the large number of participants, data sources, and datatypes in the Program, it is essential that these goals be accomplished early in the Program's development in order to ensure the Program's ability to accomplish needed data analyses and assessments.

There may be datasets that are essential to the Program's assessment efforts but that are either fragmented or are not currently stored in a reliable, permanent location. Historical bird survey data collected by a variety of resource agencies and volunteer groups in the Bay are one example

of such data, and others may be identified as the Program continues to develop. SMBRC must develop a database with an adaptable table structure in order to accommodate a potentially wide range of datatypes.

Several aspects of the Program (e.g., fish larvae, surf-zone fish, rocky intertidal) represent new monitoring efforts that will be implemented either by Program participants or by contractors. In these cases, it will be important for the Program to establish clear data management and QA/QC procedures and standards. Such procedures and standards will ensure that data from these sources will be reliable and can be acquired and integrated into the assessment process as efficiently as possible.

The Program's assessment efforts (see next section) will involve identifying, obtaining, organizing, storing, and then using an extremely wide range of data and data products (e.g., reports, maps, data analysis results) developed by other monitoring programs as well as by the Program's own monitoring efforts. Obtaining needed data and data products in the formats and on the schedule required to support the assessment will require clear and well-developed relationships with data sources as well as technical procedures for data transfers. In some cases, this may involve agreements that define or limit the ways in which data can be used or published, the timing of data availability, or a condition that the "owner" of the data have the right to review assessment results involving their data. The method of data transfer must be clearly specified if the SMBRC is to avoid excessive amounts of data management effort such as reformatting data, resolving discrepancies, and standardizing units.

While acquired data and data products will not permanently reside in a centralized Program database, they must be efficiently organized and stored in a manner that supports the various assessment efforts. This will require the ability to store and index both digital and hard copy information, as well as contact information for the data sources and scientists associated with each type of data. Such information management systems have been developed elsewhere and the Program should investigate the applicability of other existing systems rather than developing an information management system de novo.

The workgroup recommends that the Program point toward incorporating its data in the SWAMP regional data center being established at SCCWRP. The regional data center is intended as an element of a distributed statewide database system whose purpose is to support regional and statewide monitoring and assessment. In preparation for this step, the Program should use SCCWRP's expertise to develop the database structures, data entry routines, QA/QC procedures, and query functions needed to reliably store and use the Program's data. In addition to these core database functions, SCCWRP should also provide the technical support needed to accomplish the other data management goals listed above (e.g., establish data management standards, define data transfer formats).

The workgroup recommends that the Program adopt the three-level data access policy developed by the Bight Program. Data are first made available to the technical staff working on each individual assessment. Once data have been reviewed and corrected, they are then compiled and made available, via standardized transfer formats, to other technical groups in the Program who might find the data useful in their assessments. Finally, once the formal assessment reports are completed and published, the data are made available to the broader public.

Assessment

The workgroup identified three levels of assessment essential to the Program's ability to analyze and interpret monitoring results, make data and data products available to its audiences, and synthesize the results of the Program's many monitoring elements into a cohesive view of the Bay as a whole. These three levels of assessment are:

- Project level that annually summarizes basic findings for individual monitoring elements
- Habitat level, conducted every five years, that integrates and synthesizes data from all datatypes relevant to the five major habitats in the Bay (pelagic, hard bottom, soft bottom, intertidal, wetlands)
- Program level, including a summary biannual report and a more comprehensive assessment conducted every five years, that compiles findings from habitat assessments into a picture of the Bay as a whole

The three assessment levels represent increasing levels of spatial scale and integration across datatypes.

Project level assessment focuses on the most discrete monitoring efforts that are planned and conducted independently, for example, zooplankton (pelagic), artificial reefs (hard bottom), rocky intertidal (intertidal), and shoreline birds (intertidal). This level of assessment inclues initial data entry, quality control, and data summarization. It may include basic reporting such as plotting trends or mapping data values. It typically would not include acquiring complementary data from other programs, synthesizing different datatypes, or involved data analyses requiring more sophisticated statistical expertise. Project level assessment reports would be produced annually, or less frequently if a particular monitoring element was conducted less than annually. More involved analyses and reports could certainly be prepared by each project's principal investigator(s), but this level of effort is not reflected in the Program's schedule (Figure 6) and budget (Table 12).

Habitat level assessment focuses on integrating data within the major Program ecosystem categories of pelagic, soft bottom, hard bottom, intertidal, and wetlands. These assessments would bring together the broad range of different datatypes, from multiple sources, needed to fully describe spatial patterns, temporal trends, environmental impacts, and interactions among ecosystem components. Such assessments, for example, would address the relative influences of anthropogenic impacts and natural sources of variability and habitat change. The habitat level assessment will be the most challenging and complex of the three assessment levels. Because of their complexity, habitat level assessments would be conducted once every five years, as a part of the overall Program assessment.

The Program level assessment would be performed once every five years in order to present a picture of conditions in the Bay as a whole. It would be intended for a public audience and would be developed largely by compiling and summarizing findings and products from the individual habitat assessments. While the Program assessment could contain some synthesis of findings across multiple habitats, these would not involve new data analyses or modeling at the ecosystem level.

These three types of assessment are intended to be an integral part of the Program's structure. In addition, the Program may identify a number of preliminary assessments, designed to take advantage of readily available existing data and meet immediate, short-term needs for evaluating specific resources. Three examples mentioned by the workgroup included kelpbeds, rocky intertidal, and shorebirds.

The technical workgroup defined both interim and long-term models of how the SMBRC should accomplish its assessment goals. For all three assessment levels, the SMBRC's assessment manager, with input from the TAC, should define the scope of the assessments and the methods to be used in conducting them. This should include, at a minimum, core questions, data summarization and/or analysis approaches, data and analysis products, and the general content and format for reports. Assessment methods should include specific provisions for ensuring that the methods used in the project and habitat assessment levels are compatible and provide the basis for using datasets, data products, and findings in subsequent, higher-level assessments.

For habitat and Program level assessments, the workgroup envisioned that the SMBRC assessment manager would convene an assessment team that includes the necessary expertise, and provide the assessment team with ready access to required data and data products. Assessment teams could include a combination of Program participants, other researchers, and/or contractors. The assessment manager will also track each assessment team's progress, review results as they are developed, and ensure that the assessment is consistent with the Program's overall goals and priorities. In some cases, larger or more involved assessments may be conducted in collaboration with other monitoring or research programs.

In the short term, the habitat and Program level assessments would necessarily be based largely on readily available data products developed by other programs and data sources. The SMBRC's role in the early period of the Program would thus be one of summarizing, evaluating, and integrating existing, separate data products. This role would expand, over the longer term, as data from the Program's own monitoring efforts accumulate and as relationships with outside data sources expand. The workgroup envisioned that the SMBRC would work toward expanding its ability to support more sophisticated data analyses and syntheses that would explore relationships among different aspects of the Bay's ecosystems. The workgroup used the metaphor of a "digital conference room" to describe the capability to provide an assessment team with the ability to identify, retrieve, display, combine, and modify data and data products from a number of related monitoring studies.

Results of all assessments would contribute to periodic evaluations and adjustments of the Program's monitoring priorities and designs.

Costs and funding

Costs are presented for each program component for the first five years of the Program. The total annual cost associated with the Comprehensive Monitoring Program ranges from approximately $3.8 million (2009) to $4.3 million (2008). However, much of this cost is already funded primarily through NPDES permit compliance monitoring programs within the Bay. The annual cost for new monitoring components for which funding would in large part through the SMBRC varies from a low of $1.5 million in 2009 to a high of $2.1 million in 2008. This variance is due to the staged implementation schedule (Figure 6) and the fac that certain activities (e.g., assessment, Bight planning) do not occur every year. There are a variety of funding sources and models available to the Program and these have expanded as a result of successful bond issues in the November 2006 election.

Cost estimates

Table 12 provides a summary of costs for each program component. The total estimated cost for new monitoring elements that would be funded by the Comprehensive Monitoring Program range from a low of $1.5 million in 2009 and 2011 to a high of $2.1 million in 2008. These cost estimates are intended as an informed starting point for further planning, fund raising, and contracting. All core monitoring, planning, and assessment efforts are costed; however, only a high-priority subset of the identified special studies are costed.

This overall cost, and its component cost estimates, are based on a number of assumptions that were intended to provide a common basis for comparing costs and for investigating alternative levels of effort. Nearly all program elements were converted to labor estimates, with the exceptions being specific cases (e.g., IWRAP wetland sampling, POTW and power plant compliance programd, Bight Program) that already have well-developed unit costs. Estimated labor hours were divided into three categories, with the following average hourly rates:

- Technician @ $50 / hr

- Research associate @ $80 / hr
- Principal investigator @ $140 / hr

These rates are the approximate midrange of billing rates current in southern California across universities, government and nonprofit agencies, and consulting companies.

There are several assumptions that should be kept in mind when evaluating the cost estimates in Table 12:

- Costs for existing programs that would be included as parts of the Comprehensive Monitoring Program (e.g., bird surveys, hard bottom dive surveys) were recosted according to the standard labor rates above. This typically raised the cost of the program because current efforts are often staffed by lower-priced staff such as volunteers and/or students. However, it may not be feasible to continue depending on such sources of lower-priced labor given the exapnded scope of these and other program components.
- Some portion of the labor involved in the planning and assessment tasks may be contributed as in-kind support by program participants. However, this is not guaranteed.
- The labor required to conduct the planning and assessment efforts is a best guess based on past experience. These estimates may well be inaccurate and should be revisited once more detailed plans and scopes of work have been produced.
- The estimates for program management, data management, and the Bay wide assessment are rough figures based on past experience. These estimates should also be revisited once more detailed plans are available.
- Total costs are presented for the program as a whole and for the SMBRC portion, which is all program elements except for the POTW and power plant compliance monitoring.
- The budget presents cost estimates for the five year period 2007 – 2011. However, cost estimates do not include any yearly inflation escalator.

Funding sources and models

There are a range of potential funding sources for the Comprehensive Monitoring Program. As noted at the beginning of this chapter, some Program elements have secure long-term funding, others are funded only with soft money whose future is uncertain, and others exist only as designs with no funding as yet. This section discusses only those program elements in the second and third categories. Program elements with independent, long-term funding, such as compliance monitoring, the Bight Program, and the Department of Fish and Game's recreational catch monitoring, are not considered to be candidates for support from the Program's funding resources.

Table 12 summarizes potential sources of funding for the Program, at the federal, state, and local levels. By far the largest potential source of funding is the state bond initiatives, Propositions 12, 54, and possibly 84. Proposition 54 is the largest of these, and specifically allocates funds to the SMBRC. However, the requirements and/or restrictions placed on how these funds can be spent have not yet been clarified. Federal funds are available, to a significantly lesser degree, and are primarily dedicated to supporting existing SMBRC staff. While some of these funds may support staff who are involved in program management and assessment, they are not likely to be available for support of direct monitoring activities. Finally, local funds from NRG have the potential to act as start-up funds, while adjustments to existing compliance monitoring programs could provide additional long-term funds, depending on the nature of any such permit adjustments. While the two large POTWs discharging to the Bay already conduct a substantial amount of monitoring and special studies relevant to potential impacts from their discharge to the Bay, other dischargers (e.g., industrial dischargers, MS4, or stormwater, programs) are much less involved in in-Bay monitoring and assessment.

As the SMBRC considers how to fund the Program, it can look to a number of other regional monitoring and assessment programs for examples of alternative funding approaches. For example the Regional Monitoring Program for Toxic Substances in San Francisco Bay assesses each major permitted discharger into the Bay a fee based on their loadings to the Bay of key contaminants. These fees are then combined and used to support the regional monitoring, data analysis, and reporting activities carried out by the San Francisco Estuary Institute. The San Gabriel River Regional Monitoring Program funded its first two years' of monitoring with a combination of in-kind support, collaboration with other programs, and temporary offsets to compliance monitoring. It has recently established a long-term funding base with a permanent compliance monitoring offset based on streamlining compliance monitoring. These funds are then transferred to the Los Angeles and San Gabriel Rivers Watershed Council, which manages watershed monitoring and reporting activities. The Southern California Bight Program is funded with a combination of in-kind support and monetary contributions from participants, much of which is made available as the result of periodic compliance monitoring offsets.

The workgroup agreed that there are elements of these and other programs that could prove useful in funding the Comprehensive Monitoring Program. The workgroup also agreed that a number of funding models could be appropriate as the program evolves over time. However, the workgroup did not make a decision at this time about the choice of a specific funding mechanism.

Table 11. Types of support the SMBRC could provide for monitoring programs in three general categories of development.

Implementation category	Design	Sampling	Acquire data	Identify funding	Assess data
Existing with independent funding base			X		X
Existing with soft funding base		(X)	X	X	X
New program components	X	X		X	X

Table 12. Cost summary for major components of the SMBRC's Comprehensive Monitoring Program. Program components are listed in the same order as in Tables 2, 4, 6, 8, and 10, followed by planning activities and assessments. Components in italics already exist as part of an ongoing program. The column titled "Total SMBRC Items" includes costs for all Program components except ongoing compliance monitoring efforts and the Bight Program.

Program Component	2007							
	Field / Lab	Data/ Basic Report	Staging, boat, etc.	Planning	Lab	Assessment	Total	Total SMBRC Items
Pelagic ecosystem								
Add nutrients to POTW Central Bight Water Quality Program (revise grid)	0	0	0	0	28,992	0	28,992	
Fish larvae, zooplankton biomass transects	37,950	17,280	36,000	0	0	0	91,230	
Bottlenose dolphin & seabird surveys	152,000	0	72,000	0	50,000	0	274,000	
Power plant impingement & entrainment	54,000	14,400	0	0	0	0	68,400	
Power plant water quality grid	51,525	0	0	0	0	0	51,525	
CLA,EMD—Inshore monitoring (indicator bacteria)—Annual	2,170	30	0	0	3,421	37	5,658	
CLA,EMD—Offshore monitoring (indicator bacteria)—Quarterly	3,265	200	0	0	26,235	220	29,920	
CLA,EMD—Offshore monitoring (CTD, etc)—Quarterly	19,332	50	0	0	19,332	55	38,769	
LACSD WQ Grid	87,241	0	0	0	0	0	87,241	
LACSD Inshore Bacteria	86,725	0	0	0	0	0	86,725	
LACSD Offshore Bacteria	7,551	0	0	0	0	0	7,551	
LACSD Bight Program	25,000	25,000	0	0	0	0	50,000	
Develop pelagic habitat assessment strategy							0	
Complete pelagic habitat assessment							0	
Subtotal							820,011	394,222
Soft bottom								
Participate in Bight '08 planning (incl. ASBS sites)	0	0	0	24,000	0	0	24,000	
CLA,EMD participate in Bight '08 planning	0	20,000	11,370	0	0	20,000	51,370	
Sample in coordination w/ Bight '08							0	
Acquire data on bottom fishing	0	2,360	0	0	0	0	2,360	
Power plant benthic infauna	136,034	0	0	0	0	0	136,034	
Power plant benthic sediment chemistry	16,520	0	0	0	0	0	16,520	
Power plant demersal fish & invertebrates	2,900	0	0	0	0	0	2,900	
CLA,EMD benthic infauna	12,606	0	0	0	72,116	33	84,755	
CLA,EMD benthic sediment chemistry	12,606	0	0	0	47,628	172	60,406	
CLA,EMD—Local fish & invert survey (community analysis)--biannual	6,500	0	0	0	0	33	6,533	
CLA,EMD—Local bioaccumulation survey (Hornyhead Turbot)—annual	6,500	0	0	0	13,653	172	20,325	
CLA,EMD—Local seafood safety survey (sportfish)—odd number yrs	30,000	0	0	0	11,470	330	41,800	
CLA,EMD—SMB biennial assessment report	0	0	0	0	0	55,000	55,000	
LACSD benthic infauna	103,368	0	0	0	0	0	103,368	
LACSD benthic sediment chemistry	60,824	0	0	0	0	0	60,824	
LACSD demersal fish & invertebrates	63,693	0	0	0	0	0	63,693	
LACSD fish tissue	67,230	0	0	0	0	0	67,230	
LACSD Bight Program	100,000	14,000	0	0	0	0	114,000	
Develop soft bottom habitat assessment strategy							0	
Complete soft bottom habitat assessment							0	
Subtotal							911,118	26,360
Hard bottom								
Sample natural substrate random grid	36,800	17,280	5,000	0	0	0	59,080	
Sample artifical substrate random grid	9,200	10,000	1,250	0	0	0	20,450	
Santa Monica Baykeeper fixed sites	25,875	10,000	3,500	0	0	0	39,375	
Reef Check fixed sites	3,450	10,000	0	0	0	0	13,450	
VRG fixed sites (Palos Verdes & King Harbor)	14,720	10,000	2,000	0	0	0	26,720	
Ocean Resource Enhancement Hatchery Program	74,520	25,920	12,000	0	0	0	112,440	
Conduct reconniassance of deep reefs							0	
Power plant CRKSC overflights	19,200	0	0	0	0	0	19,200	
LACSD CRKSC overflights	42,000	0	0	0	0	0	42,000	
Assess existing data	0	0	0	0	0	32,000	32,000	
Participate in Bight '08 planning	0	0	0	24,000	0	0	24,000	
Sample ASBS in coordination w/Bight '08							0	
Develop hard bottom assessment strategy							0	
Complete hard bottom habitat assessment							0	
Subtotal							388,715	327,515
Intertidal								
MARINe rocky sampling	29,440	11,470	0	0	0	0	40,910	
Sample expanded species list at MARINe sites	16,560	43,350	0	0	0	0	59,910	
Sample 8 additional rocky stations	44,160	115,600	0	0	0	0	159,760	
Sample surf zone fish sites	10,156	6,480	0	0	0	0	16,636	
Sample grunion runs	32,028	6,480	0	0	0	0	38,508	
Sample bird roosting sites	13,800	10,800	0	0	0	0	24,600	
Sample bird estuary sites	28,750	10,800	0	0	0	0	39,550	
Sample bird rare species sites	1,150	3,840	0	0	0	0	4,990	
Sandy beach plant survey	6,900	5,840	0	0	0	0	12,740	
CLA,EMD—Shoreline monitoring (indicator bacteria)—Daily	270,217	1,000	0	0	357,294	1,050	629,561	
LACSD shoreline bacteria	78,222	0	0	0	0	0	78,222	
Develop intertidal habitat assessment strategy							0	
Complete intertidal habitat assessment							0	
Subtotal							1,105,386	397,603
Wetlands								
Select Bay sites 07 sampling	8,800	0	0	0	0	0	8,800	
Sample core indicators in coordination w/ IWRAP	120,000	0	0	0	0	0	120,000	
Sample tidal range, etc. in coordination w/ IWRAP	80,000	0	0	0	0	0	80,000	
Finalize full indicator list	10,000	0	0	0	0	0	10,000	
Participate in Bight '08 planning	0	0	0	8,800	0	0	8,800	
Sample in coordination w/ Bight '08							0	
Complete design in coordination w/ IWRAP							0	
Monitor wetlands in coordination w/ IWRAP							0	
CLA,EMD—Ballona Wetland (Benthic Macrofauna)—Annual	2,228	3,000	0	0	8,952	3,275	17,455	
CLA,EMD—Ballona Wetland (Fish & Megainverts)—Annual	17,764	3,000	0	0	0	3,275	24,039	
CLA,EMD—Ballona Wetland (Vegetation & Soil Chemistry)—Annual	2,500	3,000	0	0	3,380	3,275	12,155	
CLA,EMD—Ballona Wetland (Birds)—Annual—(Contracted out)	0	0	0	0	0	0	0	
CLA,EMD—Ballona Lagoon Monitoring—Annual	14,914	3,000	0	0	14,817	3,275	36,006	
LACSD Bight Program (Various)	163,847	0	0	0	0	0	163,847	
Develop wetlands habitat assessment strategy							0	
Complete wetlands habitat assessment							0	
Subtotal							481,102	227,600
Data management / integration								
Implement database				200,000			200,000	
Maintain and update database							0	
Program management				120,000			120,000	
Assessment Manager				120,000			120,000	
Develop biannual report strategy							0	
Prepare biannual summary report							0	
Develop Baywide assessment strategy							0	
Prepare Baywide assessment							0	
Hold State of the Bay conference							0	
Subtotal							440,000	440,000
PROGRAM TOTAL							4,146,332	1,813,300

Table 12. (Continued)

Program Component	2008 Field / Lab	Data/ Basic Report	Staging, boat, etc.	Planning	Lab	Assessment	Total	Total SMBRC Items
Pelagic ecosystem								
Add nutrients to POTW Central Bight Water Quality Program (revise grid)	0	0	0	0	28,992	0	28,992	
Fish larvae, zooplankton biomass transects	37,950	17,280	36,000	0	0	0	91,230	
Bottlenose dolphin & seabird surveys	152,000	0	72,000	0	50,000	0	274,000	
Power plant impingement & entrainment	54,000	14,400	0	0	0	0	68,400	
Power plant water quality grid	51,525	0	0	0	0	0	51,525	
CLA,EMD—Inshore monitoring (indicator bacteria)—Annual	2,170	30	0	0	3,421	37	5,658	
CLA,EMD—Offshore monitoring (indicator bacteria)—Quarterly	3,265	200	0	0	26,235	220	29,920	
CLA,EMD—Offshore monitoring (CTD, etc)—Quarterly	19,332	50	0	0	19,332	55	38,769	
LACSD WQ Grid	87,241	0	0	0	0	0	87,241	
LACSD Inshore Bacteria	86,725	0	0	0	0	0	86,725	
LACSD Offshore Bacteria	7,551	0	0	0	0	0	7,551	
LACSD Bight Program	25,000	25,000	0	0	0	0	50,000	
Develop pelagic habitat assessment strategy							0	
Complete pelagic habitat assessment							0	
Subtotal							820,011	394,222
Soft bottom								
Participate in Bight '08 planning (incl. ASBS sites)	0	0	0	24,000	0	0	24,000	
CLA,EMD participate in Bight '08 planning	0	20,000	11,370	0	0	20,000	51,370	
Sample in coordination w/ Bight '08	150,000	0	0	0	0	0	150,000	
Acquire data on bottom fishing	0	2,360	0	0	0	0	2,360	
Power plant benthic infauna	136,034	0	0	0	0	0	136,034	
Power plant benthic sediment chemistry	16,520	0	0	0	0	0	16,520	
Power plant demersal fish & invertebrates	2,900	0	0	0	0	0	2,900	
CLA,EMD benthic infauna	12,606	0	0	0	72,116	33	84,755	
CLA,EMD benthic sediment chemistry	12,606	0	0	0	47,628	172	60,406	
CLA,EMD—Local fish & invert survey (community analysis)--biannual							0	
CLA,EMD—Local bioaccumulation survey (Hornyhead Turbot)—annual	6,500	0	0	0	13,653	172	20,325	
CLA,EMD—Local seafood safety survey (sportfish)—odd number yrs							0	
CLA,EMD—SMB biennial assessment report							0	
LACSD benthic infauna	103,368	0	0	0	0	0	103,368	
LACSD benthic sediment chemistry	60,824	0	0	0	0	0	60,824	
LACSD demersal fish & invertebrates	63,693	0	0	0	0	0	63,693	
LACSD fish tissue	67,230	0	0	0	0	0	67,230	
LACSD Bight Program	100,000	14,000	0	0	0	0	114,000	
Develop soft bottom habitat assessment strategy							0	
Complete soft bottom habitat assessment							0	
Subtotal							957,785	176,360
Hard bottom								
Sample natural substrate random grid	36,800	17,280	5,000	0	0	0	59,080	
Sample artifical substrate random grid							0	
Santa Monica Baykeeper fixed sites	25,875	10,000	3,500	0	0	0	39,375	
Reef Check fixed sites	3,450	10,000	0	0	0	0	13,450	
VRG fixed sites (Palos Verdes & King Harbor)	14,720	10,000	2,000	0	0	0	26,720	
Ocean Resource Enhancement Hatchery Program	74,520	25,920	12,000	0	0	0	112,440	
Conduct reconniassance of deep reefs							0	
Power plant CRKSC overflights	19,200	0	0	0	0	0	19,200	
LACSD CRKSC overflights	42,000	0	0	0	0	0	42,000	
Assess existing data							0	
Participate in Bight '08 planning	0	0	0	24,000	0	0	24,000	
Sample ASBS in coordination w/Bight '08	150,000	0	0	0	0	0	150,000	
Develop hard bottom assessment strategy							0	
Complete hard bottom habitat assessment							0	
Subtotal							486,265	425,065
Intertidal								
MARINe rocky sampling	29,440	11,470	0	0	0	0	40,910	
Sample expanded species list at MARINe sites	16,560	43,350	0	0	0	0	59,910	
Sample 8 additional rocky stations	44,160	115,600	0	0	0	0	159,760	
Sample surf zone fish sites	10,156	6,480	0	0	0	0	16,636	
Sample grunion runs	32,028	6,480	0	0	0	0	38,508	
Sample bird roosting sites	13,800	10,800	0	0	0	0	24,600	
Sample bird estuary sites	28,750	10,800	0	0	0	0	39,550	
Sample bird rare species sites	1,150	3,840	0	0	0	0	4,990	
Sandy beach plant survey	6,900	5,840	0	0	0	0	12,740	
CLA,EMD—Shoreline monitoring (indicator bacteria)—Daily	270,217	1,000	0	0	357,294	1,050	629,561	
LACSD shoreline bacteria	78,222	0	0	0	0	0	78,222	
Develop intertidal habitat assessment strategy							0	
Complete intertidal habitat assessment							0	
Subtotal							1,105,386	397,603
Wetlands								
Select Bay sites 07 sampling							0	
Sample core indicators in coordination w/ IWRAP							0	
Sample tidal range, etc. in coordination w/ IWRAP							0	
Finalize full indicator list							0	
Participate in Bight '08 planning	0	0	0	8,800	0	0	8,800	
Sample in coordination w/ Bight '08	200,000	0	0	0	0	0	200,000	
Complete design in coordination w/ IWRAP	0	0	0	0	0	0	0	
Monitor wetlands in coordination w/ IWRAP	0	0	0	0	0	0	0	
CLA,EMD—Ballona Wetland (Benthic Macrofauna)—Annual	2,228	3,000	0	0	8,952	3,275	17,455	
CLA,EMD—Ballona Wetland (Fish & Megainverts)—Annual	17,764	3,000	0	0	0	3,275	24,039	
CLA,EMD—Ballona Wetland (Vegetation & Soil Chemistry)—Annual	2,500	3,000	0	0	3,380	3,275	12,155	
CLA,EMD—Ballona Wetland (Birds)—Annual—(Contracted out)	0	0	0	0	0	0	0	
CLA,EMD—Ballona Lagoon Monitoring—Annual	14,914	3,000	0	0	14,817	3,275	36,006	
LACSD Bight Program (Various)	163,847	0	0	0	0	0	163,847	
Develop wetlands habitat assessment strategy							0	
Complete wetlands habitat assessment							0	
Subtotal							462,302	208,800
Data management / integration								
Implement database				200,000			200,000	
Maintain and update database							0	
Program management				120,000			120,000	
Assessment Manager				120,000			120,000	
Develop biannual report strategy				17,600			17,600	
Prepare biannual summary report				39,200			39,200	
Develop Baywide assessment strategy							0	
Prepare Baywide assessment							0	
Hold State of the Bay conference							0	
Subtotal							496,800	496,800
PROGRAM TOTAL							4,328,549	2,098,850

Table 12. (Continued)

Program Component	2009							
	Field / Lab	Data/ Basic Report	Staging, boat, etc.	Planning	Lab	Assessment	Total	Total SMBRC Items
Pelagic ecosystem								
Add nutrients to POTW Central Bight Water Quality Program (revise grid)	0	0	0	0	28,992	0	28,992	
Fish larvae, zooplankton biomass transects	37,950	17,280	36,000	0	0	0	91,230	
Bottlenose dolphin & seabird surveys	152,000	0	72,000	0	50,000	0	274,000	
Power plant impingement & entrainment	54,000	14,400	0	0	0	0	68,400	
Power plant water quality grid	51,525	0	0	0	0	0	51,525	
CLA,EMD—Inshore monitoring (indicator bacteria)—Annual	2,170	30	0	0	3,421	37	5,658	
CLA,EMD—Offshore monitoring (indicator bacteria)—Quarterly	3,265	200	0	0	26,235	220	29,920	
CLA,EMD—Offshore monitoring (CTD, etc)—Quarterly	19,332	50	0	0	19,332	55	38,769	
LACSD WQ Grid	87,241	0	0	0	0	0	87,241	
LACSD Inshore Bacteria	86,725	0	0	0	0	0	86,725	
LACSD Offshore Bacteria	7,551	0	0	0	0	0	7,551	
LACSD Bight Program	25,000	25,000	0	0	0	0	50,000	
Develop pelagic habitat assessment strategy							0	
Complete pelagic habitat assessment							0	
Subtotal							820,011	394,222
Soft bottom								
Participate in Bight '08 planning (incl. ASBS sites)							0	
CLA,EMD participate in Bight '08 planning	0	20,000	11,370	0	0	20,000	51,370	
Sample in coordination w/ Bight '08							0	
Acquire data on bottom fishing	0	2,360	0	0	0	0	2,360	
Power plant benthic infauna	136,034	0	0	0	0	0	136,034	
Power plant benthic sediment chemistry	16,520	0	0	0	0	0	16,520	
Power plant demersal fish & invertebrates	2,900	0	0	0	0	0	2,900	
CLA,EMD benthic infauna	12,606	0	0	0	72,116	33	84,755	
CLA,EMD benthic sediment chemistry	12,606	0	0	0	47,628	172	60,406	
CLA,EMD—Local fish & invert survey (community analysis)--biannual	6,500	0	0	0	0	33	6,533	
CLA,EMD—Local bioaccumulation survey (Hornyhead Turbot)—annual	6,500	0	0	0	13,653	172	20,325	
CLA,EMD—Local seafood safety survey (sportfish)—odd number yrs	30,000	0	0	0	11,470	330	41,800	
CLA,EMD—SMB biennial assessment report	0	0	0	0	0	55,000	55,000	
LACSD benthic infauna	103,368	0	0	0	0	0	103,368	
LACSD benthic sediment chemistry	60,824	0	0	0	0	0	60,824	
LACSD demersal fish & invertebrates	63,693	0	0	0	0	0	63,693	
LACSD fish tissue	67,230	0	0	0	0	0	67,230	
LACSD Bight Program	100,000	14,000	0	0	0	0	114,000	
Develop soft bottom habitat assessment strategy							0	
Complete soft bottom habitat assessment							0	
Subtotal							887,118	2,360
Hard bottom								
Sample natural substrate random grid	36,800	17,280	5,000	0	0	0	59,080	
Sample artifical substrate random grid	9,200	10,000	1,250	0	0	0	20,450	
Santa Monica Baykeeper fixed sites	25,875	10,000	3,500	0	0	0	39,375	
Reef Check fixed sites	3,450	10,000	0	0	0	0	13,450	
VRG fixed sites (Palos Verdes & King Harbor)	14,720	10,000	2,000	0	0	0	26,720	
Ocean Resource Enhancement Hatchery Program	74,520	25,920	12,000	0	0	0	112,440	
Conduct reconniassance of deep reefs	0	11,400	87,500	0	0	10,800	109,700	
Power plant CRKSC overflights	19,200	0	0	0	0	0	19,200	
LACSD CRKSC overflights	42,000	0	0	0	0	0	42,000	
Assess existing data							0	
Participate in Bight '08 planning							0	
Sample ASBS in coordination w/Bight '08							0	
Develop hard bottom assessment strategy							0	
Complete hard bottom habitat assessment							0	
Subtotal							442,415	381,215
Intertidal								
MARINe rocky sampling	29,440	11,470	0	0	0	0	40,910	
Sample expanded species list at MARINe sites	16,560	43,350	0	0	0	0	59,910	
Sample 8 additional rocky stations	44,160	115,600	0	0	0	0	159,760	
Sample surf zone fish sites	10,156	6,480	0	0	0	0	16,636	
Sample grunion runs	32,028	6,480	0	0	0	0	38,508	
Sample bird roosting sites	13,800	10,800	0	0	0	0	24,600	
Sample bird estuary sites	28,750	10,800	0	0	0	0	39,550	
Sample bird rare species sites	1,150	3,840	0	0	0	0	4,990	
Sandy beach plant survey	6,900	5,840	0	0	0	0	12,740	
CLA,EMD—Shoreline monitoring (indicator bacteria)—Daily	270,217	1,000	0	0	357,294	1,050	629,561	
LACSD shoreline bacteria	78,222	0	0	0	0	0	78,222	
Develop intertidal habitat assessment strategy							0	
Complete intertidal habitat assessment							0	
Subtotal							1,105,386	397,603
Wetlands								
Select Bay sites 07 sampling							0	
Sample core indicators in coordination w/ IWRAP							0	
Sample tidal range, etc. in coordination w/ IWRAP							0	
Finalize full indicator list							0	
Participate in Bight '08 planning							0	
Sample in coordination w/ Bight '08							0	
Complete design in coordination w/ IWRAP							0	
Monitor wetlands in coordination w/ IWRAP							0	
CLA,EMD—Ballona Wetland (Benthic Macrofauna)—Annual	2,228	3,000	0	0	8,952	3,275	17,455	
CLA,EMD—Ballona Wetland (Fish & Megainverts)—Annual	17,764	3,000	0	0	0	3,275	24,039	
CLA,EMD—Ballona Wetland (Vegetation & Soil Chemistry)—Annual	2,500	3,000	0	0	3,380	3,275	12,155	
CLA,EMD—Ballona Wetland (Birds)—Annual—(Contracted out)	0	0	0	0	0	0	0	
CLA,EMD—Ballona Lagoon Monitoring—Annual	14,914	3,000	0	0	14,817	3,275	36,006	
LACSD Bight Program (Various)	163,847	0	0	0	0	0	163,847	
Develop wetlands habitat assessment strategy							0	
Complete wetlands habitat assessment							0	
Subtotal							253,502	0
Data management / integration								
Implement database							0	
Maintain and update database				100,000			100,000	
Program management				120,000			120,000	
Assessment Manager				120,000			120,000	
Develop biannual report strategy							0	
Prepare biannual summary report							0	
Develop Baywide assessment strategy							0	
Prepare Baywide assessment							0	
Hold State of the Bay conference							0	
Subtotal							340,000	340,000
PROGRAM TOTAL							3,848,432	1,515,400

Table 12. (Continued)

Program Component	2010							
	Field / Lab	Data/ Basic Report	Staging, boat, etc.	Planning	Lab	Assessment	Total	Total SMBRC Items
Pelagic ecosystem								
Add nutrients to POTW Central Bight Water Quality Program (revise grid)	0	0	0	0	28,992	0	28,992	
Fish larvae, zooplankton biomass transects	37,950	17,280	36,000	0	0	0	91,230	
Bottlenose dolphin & seabird surveys	152,000	0	72,000	0	50,000	0	274,000	
Power plant impingement & entrainment	54,000	14,400	0	0	0	0	68,400	
Power plant water quality grid	51,525	0	0	0	0	0	51,525	
CLA,EMD—Inshore monitoring (indicator bacteria)—Annual	2,170	30	0	0	3,421	37	5,658	
CLA,EMD—Offshore monitoring (indicator bacteria)—Quarterly	3,265	200	0	0	26,235	220	29,920	
CLA,EMD—Offshore monitoring (CTD, etc)—Quarterly	19,332	50	0	0	19,332	55	38,769	
LACSD WQ Grid	87,241	0	0	0	0	0	87,241	
LACSD Inshore Bacteria	86,725	0	0	0	0	0	86,725	
LACSD Offshore Bacteria	7,551	0	0	0	0	0	7,551	
LACSD Bight Program	25,000	25,000	0	0	0	0	50,000	
Develop pelagic habitat assessment strategy	0	0	0	0	0	17,600	17,600	
Complete pelagic habitat assessment	0	0	0	0	0	32,000	32,000	
Subtotal							869,611	443,822
Soft bottom								
Participate in Bight '08 planning (incl. ASBS sites)							0	
CLA,EMD participate in Bight '08 planning	0	20,000	11,370	0	0	20,000	51,370	
Sample in coordination w/ Bight '08							0	
Acquire data on bottom fishing	0	2,360	0	0	0	0	2,360	
Power plant benthic infauna	136,034	0	0	0	0	0	136,034	
Power plant benthic sediment chemistry	16,520	0	0	0	0	0	16,520	
Power plant demersal fish & invertebrates	2,900	0	0	0	0	0	2,900	
CLA,EMD benthic infauna	12,606	0	0	0	72,116	33	84,755	
CLA,EMD benthic sediment chemistry	12,606	0	0	0	47,628	172	60,406	
CLA,EMD—Local fish & invert survey (community analysis)--biannual							0	
CLA,EMD—Local bioaccumulation survey (Hornyhead Turbot)—annual	6,500	0	0	0	13,653	172	20,325	
CLA,EMD—Local seafood safety survey (sportfish)—odd number yrs							0	
CLA,EMD—SMB biennial assessment report							0	
LACSD benthic infauna	103,368	0	0	0	0	0	103,368	
LACSD benthic sediment chemistry	60,824	0	0	0	0	0	60,824	
LACSD demersal fish & invertebrates	63,693	0	0	0	0	0	63,693	
LACSD fish tissue	67,230	0	0	0	0	0	67,230	
LACSD Bight Program	100,000	14,000	0	0	0	0	114,000	
Develop soft bottom habitat assessment strategy	0	0	0	17,600	0	0	17,600	
Complete soft bottom habitat assessment	0	0	0	0	0	54,400	54,400	
Subtotal							855,785	74,360
Hard bottom								
Sample natural substrate random grid	36,800	17,280	5,000	0	0	0	59,080	
Sample artifical substrate random grid							0	
Santa Monica Baykeeper fixed sites	25,875	10,000	3,500	0	0	0	39,375	
Reef Check fixed sites	3,450	10,000	0	0	0	0	13,450	
VRG fixed sites (Palos Verdes & King Harbor)	14,720	10,000	2,000	0	0	0	26,720	
Ocean Resource Enhancement Hatchery Program	74,520	25,920	12,000	0	0	0	112,440	
Conduct reconniassance of deep reefs							0	
Power plant CRKSC overflights	19,200	0	0	0	0	0	19,200	
LACSD CRKSC overflights	42,000	0	0	0	0	0	42,000	
Assess existing data							0	
Participate in Bight '08 planning							0	
Sample ASBS in coordination w/Bight '08							0	
Develop hard bottom assessment strategy	0	0	0	17,600	0	0	17,600	
Complete hard bottom habitat assessment	0	0	0	0	0	54,400	54,400	
Subtotal							384,265	323,065
Intertidal								
MARINe rocky sampling	29,440	11,470	0	0	0	0	40,910	
Sample expanded species list at MARINe sites	16,560	43,350	0	0	0	0	59,910	
Sample 8 additional rocky stations	44,160	115,600	0	0	0	0	159,760	
Sample surf zone fish sites	10,156	6,480	0	0	0	0	16,636	
Sample grunion runs	32,028	6,480	0	0	0	0	38,508	
Sample bird roosting sites	13,800	10,800	0	0	0	0	24,600	
Sample bird estuary sites	28,750	10,800	0	0	0	0	39,550	
Sample bird rare species sites	1,150	3,840	0	0	0	0	4,990	
Sandy beach plant survey	6,900	5,840	0	0	0	0	12,740	
CLA,EMD—Shoreline monitoring (indicator bacteria)—Daily	270,217	1,000	0	0	357,294	1,050	629,561	
LACSD shoreline bacteria	78,222	0	0	0	0	0	78,222	
Develop intertidal habitat assessment strategy	0	0	0	17,600	0	0	17,600	
Complete intertidal habitat assessment	0	0	0	0	0	54,400	54,400	
Subtotal							1,177,386	469,603
Wetlands								
Select Bay sites 07 sampling							0	
Sample core indicators in coordination w/ IWRAP							0	
Sample tidal range, etc. in coordination w/ IWRAP							0	
Finalize full indicator list							0	
Participate in Bight '08 planning							0	
Sample in coordination w/ Bight '08							0	
Complete design in coordination w/ IWRAP							0	
Monitor wetlands in coordination w/ IWRAP							0	
CLA,EMD—Ballona Wetland (Benthic Macrofauna)—Annual	2,228	3,000	0	0	8,952	3,275	17,455	
CLA,EMD—Ballona Wetland (Fish & Megainverts)—Annual	17,764	3,000	0	0	0	3,275	24,039	
CLA,EMD—Ballona Wetland (Vegetation & Soil Chemistry)—Annual	2,500	3,000	0	0	3,380	3,275	12,155	
CLA,EMD—Ballona Wetland (Birds)—Annual—(Contracted out)	0	0	0	0	0	0	0	
CLA,EMD—Ballona Lagoon Monitoring—Annual	14,914	3,000	0	0	14,817	3,275	36,006	
LACSD Bight Program (Various)	163,847	0	0	0	0	0	163,847	
Develop wetlands habitat assessment strategy	0	0	0	17,600	0	0	17,600	
Complete wetlands habitat assessment	0	0	0	0	0	54,400	54,400	
Subtotal							325,502	72,000
Data management / integration								
Implement database							0	
Maintain and update database				100,000			100,000	
Program management				120,000			120,000	
Assessment Manager				120,000			120,000	
Develop biannual report strategy							0	
Prepare biannual summary report				39,200			39,200	
Develop Baywide assessment strategy				17,600			17,600	
Prepare Baywide assessment							0	
Hold State of the Bay conference							0	
Subtotal							396,800	396,800
PROGRAM TOTAL							4,009,349	1,779,650

Table 12. (Continued)

Program Component	2011							
	Field / Lab	Data/ Basic Report	Staging, boat, etc.	Planning	Lab	Assessment	Total	Total SMBRC Items
Pelagic ecosystem								
Add nutrients to POTW Central Bight Water Quality Program (revise grid)	0	0	0	0	28,992	0	28,992	
Fish larvae, zooplankton biomass transects	37,950	17,280	36,000	0	0	0	91,230	
Bottlenose dolphin & seabird surveys	152,000	0	72,000	0	50,000	0	274,000	
Power plant impingement & entrainment	54,000	14,400	0	0	0	0	68,400	
Power plant water quality grid	51,525	0	0	0	0	0	51,525	
CLA,EMD—Inshore monitoring (indicator bacteria)—Annual	2,170	30	0	0	3,421	37	5,658	
CLA,EMD—Offshore monitoring (indicator bacteria)—Quarterly	3,265	200	0	0	26,235	220	29,920	
CLA,EMD—Offshore monitoring (CTD, etc)—Quarterly	19,332	50	0	0	19,332	55	38,769	
LACSD WQ Grid	87,241	0	0	0	0	0	87,241	
LACSD Inshore Bacteria	86,725	0	0	0	0	0	86,725	
LACSD Offshore Bacteria	7,551	0	0	0	0	0	7,551	
LACSD Bight Program	25,000	25,000	0	0	0	0	50,000	
Develop pelagic habitat assessment strategy							0	
Complete pelagic habitat assessment							0	
Subtotal							820,011	394,222
Soft bottom								
Participate in Bight '08 planning (incl. ASBS sites)							0	
CLA,EMD participate in Bight '08 planning	0	20,000	11,370	0	0	20,000	51,370	
Sample in coordination w/ Bight '08							0	
Acquire data on bottom fishing	0	2,360	0	0	0	0	2,360	
Power plant benthic infauna	136,034	0	0	0	0	0	136,034	
Power plant benthic sediment chemistry	16,520	0	0	0	0	0	16,520	
Power plant demersal fish & invertebrates	2,900	0	0	0	0	0	2,900	
CLA,EMD benthic infauna	12,606	0	0	0	72,116	33	84,755	
CLA,EMD benthic sediment chemistry	12,606	0	0	0	47,628	172	60,406	
CLA,EMD—Local fish & invert survey (community analysis)--biannual	6,500	0	0	0	0	33	6,533	
CLA,EMD—Local bioaccumulation survey (Hornyhead Turbot)—annual	6,500	0	0	0	13,653	172	20,325	
CLA,EMD—Local seafood safety survey (sportfish)—odd number yrs	30,000	0	0	0	11,470	330	41,800	
CLA,EMD—SMB biennial assessment report	0	0	0	0	0	55,000	55,000	
LACSD benthic infauna	103,368	0	0	0	0	0	103,368	
LACSD benthic sediment chemistry	60,824	0	0	0	0	0	60,824	
LACSD demersal fish & invertebrates	63,693	0	0	0	0	0	63,693	
LACSD fish tissue	67,230	0	0	0	0	0	67,230	
LACSD Bight Program	100,000	14,000	0	0	0	0	114,000	
Develop soft bottom habitat assessment strategy							0	
Complete soft bottom habitat assessment							0	
Subtotal							887,118	2,360
Hard bottom								
Sample natural substrate random grid	36,800	17,280	5,000	0	0	0	59,080	
Sample artifical substrate random grid							0	
Santa Monica Baykeeper fixed sites	25,875	10,000	3,500	0	0	0	39,375	
Reef Check fixed sites	3,450	10,000	0	0	0	0	13,450	
VRG fixed sites (Palos Verdes & King Harbor)	14,720	10,000	2,000	0	0	0	26,720	
Ocean Resource Enhancement Hatchery Program	74,520	25,920	12,000	0	0	0	112,440	
Conduct reconniassance of deep reefs							0	
Power plant CRKSC overflights	19,200	0	0	0	0	0	19,200	
LACSD CRKSC overflights	42,000	0	0	0	0	0	42,000	
Assess existing data							0	
Participate in Bight '08 planning							0	
Sample ASBS in coordination w/Bight '08							0	
Develop hard bottom assessment strategy							0	
Complete hard bottom habitat assessment							0	
Subtotal							312,265	251,065
Intertidal								
MARINe rocky sampling	29,440	11,470	0	0	0	0	40,910	
Sample expanded species list at MARINe sites	16,560	43,350	0	0	0	0	59,910	
Sample 8 additional rocky stations	44,160	115,600	0	0	0	0	159,760	
Sample surf zone fish sites	10,156	6,480	0	0	0	0	16,636	
Sample grunion runs	32,028	6,480	0	0	0	0	38,508	
Sample bird roosting sites	13,800	10,800	0	0	0	0	24,600	
Sample bird estuary sites	28,750	10,800	0	0	0	0	39,550	
Sample bird rare species sites	1,150	3,840	0	0	0	0	4,990	
Sandy beach plant survey	6,900	5,840	0	0	0	0	12,740	
CLA,EMD—Shoreline monitoring (indicator bacteria)—Daily	270,217	1,000	0	0	357,294	1,050	629,561	
LACSD shoreline bacteria	78,222	0	0	0	0	0	78,222	
Develop intertidal habitat assessment strategy							0	
Complete intertidal habitat assessment							0	
Subtotal							1,105,386	397,603
Wetlands								
Select Bay sites 07 sampling							0	
Sample core indicators in coordination w/ IWRAP							0	
Sample tidal range, etc. in coordination w/ IWRAP							0	
Finalize full indicator list							0	
Participate in Bight '08 planning							0	
Sample in coordination w/ Bight '08							0	
Complete design in coordination w/ IWRAP							0	
Monitor wetlands in coordination w/ IWRAP							0	
CLA,EMD—Ballona Wetland (Benthic Macrofauna)—Annual	2,228	3,000	0	0	8,952	3,275	17,455	
CLA,EMD—Ballona Wetland (Fish & Megainverts)—Annual	17,764	3,000	0	0	0	3,275	24,039	
CLA,EMD—Ballona Wetland (Vegetation & Soil Chemistry)—Annual	2,500	3,000	0	0	3,380	3,275	12,155	
CLA,EMD—Ballona Wetland (Birds)—Annual—(Contracted out)	0	0	0	0	0	0	0	
CLA,EMD—Ballona Lagoon Monitoring—Annual	14,914	3,000	0	0	14,817	3,275	36,006	
LACSD Bight Program (Various)	163,847	0	0	0	0	0	163,847	
Develop wetlands habitat assessment strategy							0	
Complete wetlands habitat assessment							0	
Subtotal							253,502	0
Data management / integration								
Implement database							0	
Maintain and update database				100,000			100,000	
Program management				120,000			120,000	
Assessment Manager				120,000			120,000	
Develop biannual report strategy							0	
Prepare biannual summary report							0	
Develop Baywide assessment strategy				17,600			17,600	
Prepare Baywide assessment				54,400			54,400	
Hold State of the Bay conference				100,000			100,000	
Subtotal							512,000	512,000
PROGRAM TOTAL							3,890,282	1,557,250

Program Total Cost (2007-2011)
$20,222,945

Total SMBRC Items (2007-2011)
$8,764,451

Table 13. Potential sources of funding for the Comprehensive Monitoring Program.

Source	Amount	Notes
Federal		
National Estuary Program	$500,000 / yr	Annual operating funds, primarily for existing staff, some of which could be spent to support monitoring
EPA PV Shelf Superfund Program / NOAA Montrose Settlement Restoration Program	$70 million	Remediation of Montrose Chemical damage on Palos Verdes shelf; some might be directed to monitoring.
State		
Proposition 12	$5 million remaining	Few restrictions on spending
Proposition 84	$18 million	Earmarked for Bay restoration projects. Restrictions not yet clear though it may be primarily restricted to capital projects
Ocean Protecion Council	$90 million	Allocated to Ocean Protection Trust Fund by Prop. 84 for development of scientific data needed for adaptive marine resource management
Legislature	Unknown	Possibility for direct appropriation
SWAMP	$11 million	Focused primarily on inland waters at present
Local		
NRG	$800,000	Paid to Commission as one-time lump sum as part of licensing condition
Permittees	Unknown	Potential monitoring offsets form adjustments to existing monitoring

Figure 6. Implementation timeline for major components of the SMBRC's Comprehensive Monitoring Program. Program components are listed in the same order as in Tables 2, 4, 6, 8, and 10, followed by planning activities, assessments, and special studies (marked with an asterisk (*)). Components in *italics* already exist as part of an ongoing program.

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Pelagic ecosystem																				
CalCOFI program																				
Central Bight Water Quality Monitoring Program																				
Add nutrients to Bight Water Quality grid																				
Fish larvae, zooplankton biomass transects																				
Shoreline temperature network																				
Fish catch (CDF&G, NMFS)																				
Bottlenose dolphin & seabird surveys																				
DHS Marine Biotixin Monitoring Program																				
Power plant impingement & entrainment																				
Power plant water quality grid																				
POTW inshore / offshore bacteria monitoring																				
ACS Gray Whale Census & Behavior Project																				
SCCOOS oceanography buoys, etc.																				
NOAA oceanographic indices																				
NOAA satellite remote sensing																				
SCCOOS surface currents																				
NMFS mammal stranding network																				
NMFS thresher shark survey																				
USFWS seabird conservation																				
Develop collaboration w/USC MERHAB project *																				
Develop pelagic habitat assessment strategy																				
Conduct pelagic habitat assessment																				

Figure 6. (Continued)

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Soft bottom																				
Participate in Bight '08 planning (incl. ASBS sites)																				
Bight '08 soft bottom sampling																				
Sample in coordination w/ Bight '08																				
Acquire data on bottom fishing																				
Power plant benthic infauna																				
Power plant benthic infauna																				
Power plant benthic sediment chemistry																				
POTW benthic infauna grid																				
POTW demersal fish & invertebrate gird																				
POTW sediment chemistry grid																				
POTW fish tissue zones																				
Fish catch (CDF&G, NMFS)																				
Acquire data on bottom fishing																				
Investigate nearshore halibut nursery grounds *																				
Develop soft bottom habitat assessment strategy																				
Conduct soft bottom habitat assessment																				

Figure 6. (Continued)

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Hard bottom																				
Sample natural substrate random grid																				
Sample artifical substrate random grid																				
CRKSC overflights																				
Fish catch (CDF&G, NMFS)																				
Santa Monica Baykeeper fixed sites																				
Reef Check fixed sites																				
VRG Palos Verdes Point fish survey																				
VRG King Harbor fish survey																				
Ocean Resource Enhancement Hatchery Program																				
Select additional ASBS and other sites																				
Conduct econnaissance of deep reefs																				
Assess potential MPA sites *																				
Assess existing data																				
Participate in Bight '08 planning																				
Select additional ASBS and other sites																				
Sample ASBS in coordination w/ Bight '08																				
Conduct initial assessment of data on kelp reefs *																				
Develop index of reef community condition *																				
Develop hard bottom habitat assessment strategy																				
Conduct hard bottom habitat assessment																				

Figure 6. (Continued)

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Intertidal																				
MARINe rocky sampling																				
Sample expanded species list at MARINe sites																				
Sample 8 additional rocky stations																				
Sample surf zone fish sites																				
Sample grunion runs																				
Sample bird roosting sites																				
Sample bird estuary sites																				
Sample bird rare species sites																				
Conduct beach plant survey																				
POTW shoreline bacteria monitoring																				
Develop index of rocky community condition *																				
Investigate grunion egg indicator *																				
Archive historical bird survey data *																				
Develop index of bird community condition *																				
Investigate tissue contamination in surf-zone fish *																				
Investigate tissue contamination in sand crabs *																				
Investigate shallow nearshore infauna *																				
Develop intertidal habitat assessment strategy																				
Conduct intertidal habitat assessment																				

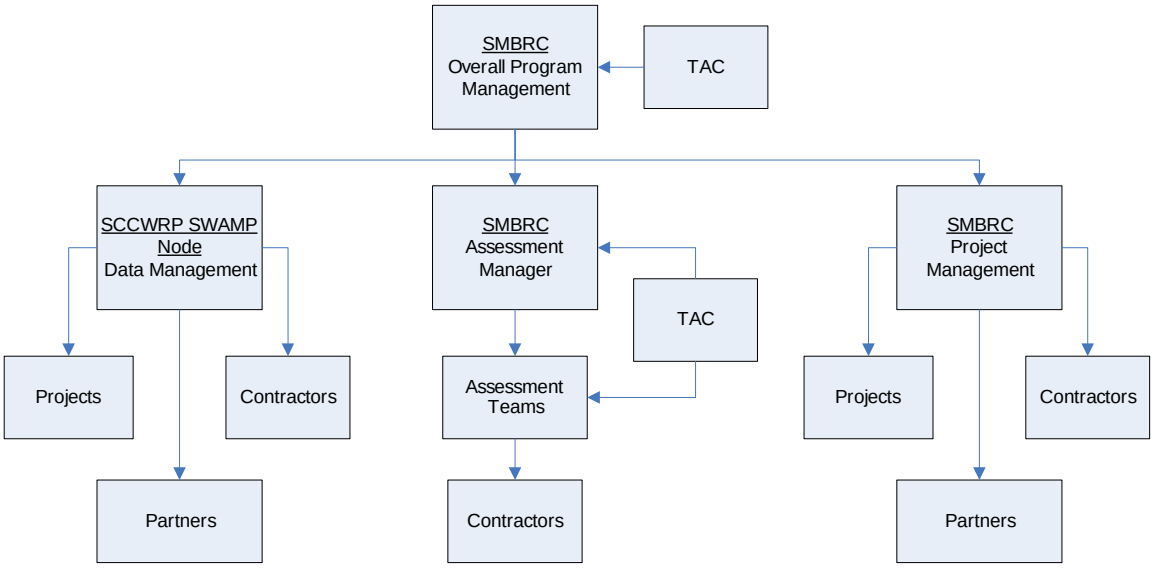
Figure 6. (Continued)

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Wetlands																				
IWRAP completes sampling frame																				
Select Bay sites 07 sampling																				
IWRAP core indicator sampling																				
Sample core indicators in coordination w/ IWRAP																				
Finalize full indicator list																				
Participate in Bight '08 planning																				
Bight '08 / IWRAP wetland sampling																				
Sample in coordination w/ Bight '08																				
Complete design in coordination w/IWRAP																				
Monitor wetlands in coordination w/IWRAP																				
POTW wetlands monitoring																				
Develop wetlands habitat assessment strategy																				
Conduct wetlands habitat assessment																				

Figure 6. (Continued)

Program component	03 07	06 07	09 07	12 07	03 08	06 08	09 08	12 08	03 09	06 09	09 09	12 09	03 10	06 10	09 10	12 10	03 11	06 11	09 11	12 11
Data management / integration																				
Implement database																				
Maintain and update database																				
Develop biannual report strategy																				
Prepare biannual summary report																				
Develop Bay wide assessment strategy																				
Prepare Bay wide assessment																				
Hold State of the Bay conference																				

Figure 7. Management structure for the Program.



Sources of Information

Reports and websites that contain detailed information on the design and implementation methods for existing efforts. Monitoring elements are shown in the order they appear in the tables at the end of each chapter above.

Introduction

Santa Monica Bay Restoration Project (SMBRP). 1993. Regional Monitoring Comprehensive Framework. Los Angeles, CA.

Santa Monica Bay Restoration Project (SMBRP). 2000. An Assessment of the Compliance Monitoring System in Santa Monica Bay. Los Angeles, CA.

Santa Monica Bay Restoration Commission (SMBRC). 2005. Implementation Update Santa Monica Bay Comprehensive Monitoring Program (August 2005 Draft). Los Angeles, CA.

Pelagic ecosystem

Monitoring element	References / sources	Status of data
CalCOFI Program	Program description available at: www.calcofi.org	Data available online at program website
Central Bight Water Quality Monitoring Program	LA City Hyperion program annual data report available from: Los Angeles Regional Water Quality Control Board LA City Hyperion program description and biennial reports available at: www.lacity.org/san/emd/products/index.htm LACSD White Point annual reports available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts	Hyperion data available on request from: Los Angeles Regional Water Quality Control Board City of Los Angeles Environmental Management Division White Point data available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts
Shoreline temperature network	Program description available at: www.SCCOOS.org	Data available online at program website
California Department of Fish and Game catch data		Data available on request from: Joanne Eres, jeres@dfg.ca.gov
National Marine Fisheries Service Recfin recreational catch data	Data and methods available at: www.psmfc.org/recfin (entire west coast) swfscdata.nmfs.noaa.gov/LaTimes/Default.asp (southern CA)	Data available from: www.psmfc.org/recfin/forms/dsamp.htm swfscdata.nmfs.noaa.gov/LaTimes/Default.asp
Bottlenose dolphin and seabird surveys	Survey methods described in: Bearzi 2005. Journal of Cetacean Research and Management 7(1): 75-83 Bearzi 2005. Southern California Academy of Science Bulletin 104(3):113-124	Data not yet available
California Department of Health Services Marine Biotoxin Monitoring Program	Program description and reports available from: www.dhs.ca.gov/ps/ddwem/environmental/Shellfish/default.htm	Data available online at program website
Power plant impingement and entrainment studies	Scattergood, Redondo Beach, and El Segundo programs described at: www.swrcb.ca.gov/rwqcb4/html/permits/316b_Issues.html	Scattergood, Redondo Beach, and El Segundo data available from: Los Angeles Regional Water Quality Control Board

American Cetacean Society Gray Whale Census and Behavior Project	Program description and survey methods described at: www.acs-la.org/GWCensus.htm	Data and reports available online at: www.acs-la.org/GWCensus.htm
SCCOOS	All program descriptions available at: www.SCCOOS.org	Data available online at program website
NOAA oceanographic indices	PDO index described at: jisao.washington.edu/pdo/PDO.latest ENSO index described at: www.cdc.noaa.gov/people/klaus.wolter/MEI/ Upwelling index described at: www.pfeg.noaa.gov/products/PFEL/modeled/indices/PFELindices.html	PDO index available at: jisao.washington.edu/pdo/PDO.latest ENSO index available at: www.cdc.noaa.gov/people/klaus.wolter/MEI/ Upwelling indices available at: www.pfeg.noaa.gov/products/PFEL/modeled/indices/PFELindices.html
NOAA satellite remote sensing	Program descriptions available at: www.noaa.gov/satellites.html , http://www.nesdis.noaa.gov/ noaasis.noaa.gov/NOAASIS/ml/avhrr.html modis.gsfc.nasa.gov/ www.sccoos.org/data/ocm/ocm_regions.php?r=3	Data available online at program websites
NMFS marine mammal stranding network	Program description available at: www.nmfs.noaa.gov/pr/health/ seahorse.nmfs.noaa.gov/msdbs/	Data available on request from: Joe Cordaro, Southwest Regional Stranding Coordinator, NMFS Long Beach, 562-980-4017, joe.cordaro@noaa.gov
NMFS thresher shark surveys	Program description: swfsc.noaa.gov/textblock.aspx?Division=FRD&ParentMenuId=87&id=915 Occasional reports available from: Southwest Fisheries Science Center, http://swfsc.noaa.gov	Data available on request from: Southwest Fisheries Science Center, swfsc.noaa.gov
USFWS seabird conservation	Program descriptions available at: www.fws.gov/pacific/migratorybirds/Seabird_Conservation_Plan_Webpages/Complete_USFWS_Seabird_Conservation_Plan.pdf	Data available from: USFWS Region 1

http://www.fws.gov/pacific/migratorybirds/Seabird_Conservation_Plan_Webpages/Complete_USFWS_Seabird_Conservation_Plan.pdf
Regional seabird conservation plan, Pacific Region, USFWS.

Soft bottom benthos

Monitoring element	References / sources	Status of data
Bight Program grid	Program description and reports available at: www.sccwrp.org (Regional Monitoring pulldown menu)	Data available online at: www.sccwrp.org
POTW benthic infauna grid	LA City Hyperion program annual data report available from: Los Angeles Regional Water Quality Control Board LA City Hyperion program description and biennial reports available at: www.lacity.org/san/emd/products/index.htm LACSD White Point annual reports available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts	Hyperion data available on request from: Los Angeles Regional Water Quality Control Board City of Los Angeles Environmental Management Division White Point data available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts
POTW demersal fish & invertebrate gird	LA City Hyperion program annual data report available from: Los Angeles Regional Water Quality Control Board LA City Hyperion program description and biennial reports available at: www.lacity.org/san/emd/products/index.htm LACSD White Point annual reports available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts	Hyperion data available on request from: Los Angeles Regional Water Quality Control Board City of Los Angeles Environmental Management Division White Point data available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts
POTW sediment chemistry grid	LA City Hyperion program annual data report available from: Los Angeles Regional Water Quality Control Board LA City Hyperion program description and biennial reports available at: www.lacity.org/san/emd/products/index.htm LACSD White Point annual reports available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts	Hyperion data available on request from: Los Angeles Regional Water Quality Control Board City of Los Angeles Environmental Management Division White Point data available on request from: Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts
POTW fish tissue zones	LA City Hyperion program annual data report available from: Los Angeles Regional Water Quality Control Board LA City Hyperion program description and biennial reports available at: www.lacity.org/san/emd/products/index.htm LACSD White Point annual reports available on request from:	Hyperion data available on request from: Los Angeles Regional Water Quality Control Board City of Los Angeles Environmental Management Division White Point data available on request from:

	Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts	Los Angeles Regional Water Quality Control Board Los Angeles County Sanitation Districts
California Department of Fish and Game catch data		Data available on request from: Joanne Eres, jeres@dfg.ca.gov
National Marine Fisheries Service Recfin recreational catch data	Data and methods available at: http://www.psmfc.org/recfin (entire west coast) http://swfscdata.nmfs.noaa.gov/LaTimes/Default.asp (southern CA)	Data available from: http://www.psmfc.org/recfin/forms/dsamp.htm http://swfscdata.nmfs.noaa.gov/LaTimes/Default.asp
Commercial bottom fishing		Data available on request from: Joanne Eres, jeres@dfg.ca.gov

Hard bottom benthos

Monitoring element	References / sources	Status of data
CRKSC overflights	Annual reports, including program description available from: LA Regional Water Quality Contorl Board	Data available in annual reports
California Department of Fish and Game catch data		Data available on request from: Joanne Eres, jeres@dfg.ca.gov
National Marine Fisheries Service Recfin recreational catch data	Data and methods available at: www.psmfc.org/recfin (entire west coast) swfscdata.nmfs.noaa.gov/LaTimes/Default.asp (southern CA)	Data available from: www.psmfc.org/recfin/forms/dsamp.htm swfscdata.nmfs.noaa.gov/LaTimes/Default.asp
Santa Monica Baykeeper Kelp Restoration and Monitoring Project	Program description available at: www.smbaykeeper.org/index.php?func=programs&program_id=0004 2005 assessment report available on request from: Santa Monica Baykeeper	Data available from Santa Monica Baykeeper: www.smbaykeeper.org
CRANE reef surveys		
Palos Verdes Point fish surveys-VRG		
King Harbor fish surveys-VRG		
Ocean Resource Enhancement Hatchery Program	Program description available at: Pondella and Allen. 2000. Proceedings of the 5th California Islands Symposium http://www.dfg.ca.gov/mrd/wsfmp/	Analysis results available at: Pondella and Allen. 2000. Proceedings of the 5th California Islands Symposium http://www.dfg.ca.gov/mrd/wsfmp/ Data available from: Dan Pondella, Occidental College

Rocky and sandy intertidal

Monitoring element	References / sources	Status of data
MARINe rocky intertidal	Program description and survey methods available at: www.marine.gov Reports available at: www.marine.gov Biodiversity survey component described at: cbsurveys.ucsc.edu/	Summary species trends available at: www.marine.gov Full data summary and analysis available in: C. M. Minor, et al. 2005. Monitoring of rocky intertidal resources along the central and southern California mainland. Minerals Management Service, Pacific OCS Region, Camarillo, CA. MMS-2005-071 Biodiversity summary findings available at: cbsurveys.ucsc.edu/
Grunion Greeter survey	Program description and survey methods available at: www.grunion.org	Data available on request from: Karen Martin, Pepperdine University
Bird estuary survey	Conducted by a variety of nonprofit groups and private individuals. Program descriptions not readily available at present. No consistent reporting.	Data not readily available at present.
Bird rare species survey • Snowy Plover (USFWS) • Least Tern (CDF&G) • Beldings Sparrow (CDF&G)	Periodic synthesis (last in 2001) produced by USFWS Program description and survey methods described at: www.dfg.ca.gov/hcpb/info/bm_research/bm_pdfrpts/2005_01.pdf No program description or reports prepared	Data available on request from USFWS Data and analysis results availabe at: www.dfg.ca.gov/hcpb/info/bm_research/bm_pdfrpts/2005_01.pdf Data available on request from CDF&G, report at: www.dfg.ca.gov/hcpb/info/bm_research/bm_pdfrpts/2002_01.pdf

Wetlands

Monitoring element	References / sources	Status of data
IWRAP Bightwide grid	Program description not yet available to public	No data collected until 2007