Santa Monica Bay National Estuary Program

Comprehensive Monitoring Program

April 2021

Prepared by the Santa Monica Bay National Estuary Program for submittal to the US Environmental Protection Agency

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Comprehensive Monitoring Program

April 2021

Prepared by: The Bay Foundation and Santa Monica Bay Restoration Commission

Prepared for: U.S. Environmental Protection Agency
Santa Monica Bay National Estuary Program's Management Conference

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Acknowledgements

We express our deep gratitude to the leadership of SMBRC's Technical Advisory Committee in authoring this document and developing the indicators and monitoring recommendations for the Santa Monica Bay region. Specifically, those individuals include the following scientists from the above list: R. Ambrose, S. Bay (until February 2020), M. Dojiri, J. Dorsey, P. Grifman, R. Hoenicke, K. Martin, D. Pondella, and E. Stein. Many additional expert scientists contributed substantial time and effort, and this document would not have been possible without their expertise and assistance. Your thoughtful and significant comments, notes, and expertise helped improve this document and increased its relevancy to our region. We would also like to thank the scientists who contributed to the State of the Bay Report (2015), much of the information was utilized here. We also appreciate the efforts of the contributing members of SMBNEP's Management Conference and members of the public.

Recommended Citation

Johnston, K., R. Ambrose, S. Bay, M. Dojiri, J. Dorsey, P. Grifman, K. Martin, D. Pondella, E. Stein, T. Ford, G. Wang, and C. Gray (2021). Santa Monica Bay National Estuary Program Comprehensive Monitoring Program. Prepared for U.S. Environmental Protection Agency. 133 pages.

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Common Acronyms

ADCP	Acoustic Doppler Current Profiler
ASBS	Areas of Special Biological Significance
Bight	Southern California Bight-wide Regional Survey
BMP	Best Management Practice
BWER	Ballona Wetlands Ecological Reserve
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CCMP	Comprehensive Conservation and Management Plan (formerly Bay Restoration Plan)
CCVA	Climate Change Vulnerability Assessment
CDFW	California Department of Fish and Wildlife
CLA-EMD	City of Los Angeles, Environmental Monitoring Division
CMP	Comprehensive Monitoring Program
CNRA	California Natural Resources Agency
CoSMoS	Coastal Storm Modelling System
CPP	California State Polytechnic University, Pomona
CRAM	California Rapid Assessment Method
CRANE	Cooperative Research and Assessment of Nearshore Ecosystems
CRI	Loyola Marymount University's Coastal Research Institute
CSU	California State University
CSULB	California State University, Long Beach
FMP	Fishery Management Plan
HAB	Harmful Algal Bloom
LACDBH	Los Angeles County Department of Beaches and Harbors
LACDPH	Los Angeles County Department of Public Health
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation Districts
LADWP	Los Angeles Department of Water and Power
LASAN	City of Los Angeles Sanitation
LAX	Los Angeles International Airport
LCP	Local Coastal Plan
LVMWD	Las Virgenes Municipal Water District
MARINe	Multi-Agency Rocky Intertidal Network
MERHAB	Monitoring and Event Response for Harmful Algal Blooms
MPA	Marine Protected Area
MS4	Municipal Separate Storm Sewer Systems
MSRP	Montrose Settlement Restoration Program
NEP	National Estuary Program
NMFS	National Oceanic and Atmospheric Administration's National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
OPC	Ocean Protection Council
OTC	Once-Through Cooling
POTW	Publicly Owned Treatment Works
Prop.	Proposition
PV	Palos Verdes
RCDSMM	Resource Conservation District of the Santa Monica Mountains
SCC	California State Coastal Conservancy
SCCOOS	Southern California Ocean Observing Systems
SCCWRP	Southern California Coastal Water Research Project
SCMI	Southern California Marine Institute
SFSC	Southwest Fisheries Science Center
SLR	Sea Level Rise
SMBNEP	Santa Monica Bay National Estuary Program
SMBRC	Santa Monica Bay Restoration Commission
SotB	State of the Bay
SQI	Stream Quality Index
State Parks	California Department of Parks and Recreation
SWRCB	State Water Resources Control Board
TAC	Santa Monica Bay Restoration Commission Technical Advisory Committee
TBF	The Bay Foundation
TMDL	Total Maximum Daily Load
UCLA	University of California Los Angeles
UCSB	University of California Santa Barbara
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Chapter 1 – Introduction

Overview of Comprehensive Monitoring Program

The Santa Monica Bay region needs a Comprehensive Monitoring Program (CMP) to inform the community and interested stakeholders on the status and trends of the condition of key habitats. The purpose of the CMP is to provide a framework to use monitoring data to inform managers, practitioners, and the public on conditions and trends that will result in meaningful actions identified in Santa Monica Bay National Estuary Program's (SMBNEP) Comprehensive Conservation and Management Plan (CCMP). Monitoring data resulting from implementation of this plan will help provide critical information to manage the Bay and its natural resources effectively. This CMP will also inform a revision to the Quality Assurance Program Plan (QAPP) for SMBNEP, which tracks specific quality control and quality assurance goals and objectives associated with monitoring data.

The CMP 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, the primary focus of previous monitoring efforts on major discharges left many acknowledged data gaps, and the lack of coordinated, bay-wide information has partially 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, in part due to the following:

- Greater understanding of the impacts and vulnerabilities associated with climate change and the need to respond adaptively (e.g., Grubbs et al. 2016)
- Development of innovative new technologies that allow for more diverse, comprehensive, and / or robust data collection efforts
- Greater awareness of the regional (and beyond) nature of environmental stressors and impacts
- Increased interest in assessing and managing habitats and resources regionally
- Greater knowledge of the interactions between localized sources of anthropogenic impact and larger-scale environmental processes (e.g., El Niño, Pacific Decadal Oscillation)
- Need to track substantial efforts in recent decades to improve water quality and natural resources in the Santa Monica Bay

This CMP (2021) is one component of the larger CCMP, but also serves as a stand-alone document. It is a complete revision to the last CMP, completed in 2007, and is reflective of the assessment framework developed and used for the 2015 State of the Bay Report (SotB). While several habitats are new since the 2007 CMP, all habitats remain the same as those identified in the 2015 SotB. The 2021 CMP contains new indicators, especially all indicators for assessing climate change vulnerability, and correspondingly new monitoring programs, new technologies, a synthesis of new research and monitoring objectives, and directions for future studies. Specifically, the CMP expands on efforts dating back to the mid 1990's to define a regional framework for monitoring environmental resources and conditions in the Bay. This revised 2021 CMP represents SMBNEP's plan for implementing coordinated monitoring to provide a regional, long-term assessment of the status of the various ecosystems in Santa Monica Bay. The 2021 CMP also incorporates detailed information produced as part of SMBNEP's climate change vulnerability assessment, culminating in the Climate Change Vulnerability Assessment (CCVA) Report completed by SMBNEP in 2016 (Grubbs et al. 2016). The CCVA contained vulnerability assessments for habitats identified in this document and its associated indicators (in the "climate change vulnerability" category) were new additions since the 2015 SotB. While not a 'living document', per se, the CMP may periodically be updated in conjunction with CCMP revision or update processes for SMBNEP as new information becomes available. However, partners, funding, and other monitoring elements may shift more frequently than identified in CMP updates or revisions.

Structure of the Document

Each chapter (Chapters 2-8) describes one of the key habitats identified for the Santa Monica Bay and its watershed (i.e., pelagic, soft bottom, rocky reef, rocky intertidal, sandy shores, coastal wetlands, and freshwater / riparian). The TAC first determined that the habitats identified in the 2015 SotB were the most appropriate to be considered for incorporation in the revised CMP. Several additional habitats were considered and rejected, with the final seven listed above continuing from the 2015 SotB. The chapters devoted to each habitat type identify overarching guiding questions and briefly summarize recent monitoring efforts. Subsequent information includes indicators, monitoring metrics or parameters, information on monitoring data programs, responsible parties, geographic scope or location sites when known, and the frequency of sampling.

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. Implementation of the CMP relies on leveraged work and partnerships. 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. Chapter 9 contains potential funding sources and identified data gaps. SMBNEP acknowledges that listed funding sources are neither exhaustive nor fully inclusive of all opportunities. New funding initiatives should be explored as they arise and not be limited to those included in this document. Additionally, listed existing funding opportunities are unlikely to be able to fully fund all the data gaps identified throughout this document. Furthermore, some existing studies or monitoring programs have consistent long-term funding (e.g., MARINe), and some may have currently identified funding, but only for a temporary or limited time frame (e.g., LMU beach characterization studies). These studies may then become future data gaps, once funding is exhausted, and resultingly may not be identified as gaps in this version of the CMP.

Monitoring Program Objectives

USEPA funding guidance for NEPs states that Monitoring Programs should “track and detect changes and / or improvements within the study area, and effectiveness of CCMP Actions” (USEPA 2020). This can be achieved through the assessment of data collected to inform key indicators over time. Indicators for the CMP focused on physical or biological characteristics, indices, and stressors, including climate change. The goal and overarching objective of this CMP is to inform condition changes within the NEP study area, and to be summarized in State of the Bay Reports, produced approximately every five years, and more frequent summary reports as needed. Another key objective of the program is to evaluate whether management actions taken as part of SMBNEP’s CCMP are effective in improving environmental conditions of the Bay. Implementation of actions and projects under the CCMP (Action Plan) are aimed at resulting improvement and restoration of ecosystem health across the seven key habitats, and the CMP is designed to monitor and inform the effectiveness of the CCMP in achieving these objectives over time. For example, CCMP Actions that are taken to improve a specific habitat area (e.g., kelp forest restoration) may be captured in the resulting data collected through implementing this CMP (e.g., rocky subtidal habitat) and tracked through subsequent SotB Reports. When possible, the CMP replicates or modifies relevant indicators from the USEPA Report on the Environment (USEPA ROE 2019) for the water and land use categories.

Specific CMP objectives include addressing the following overarching questions:

1) What is the extent of each habitat in the NEP study area and how has the geographic area for each changed over time?
2) What is the ecological condition of each habitat and how has it changed over time?
3) What are the major stressors impacting each habitat?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with each habitat?

Indicator Development

The TAC engaged expert external scientists for each habitat in the form of individual working groups to compile priority indicators and metrics of evaluation for each habitat type. For the purposes of this document, “indicator” is defined as a summary measure that provides information on the state of, or change in, the system that is being measured (USEPA 2012). The TAC and working groups subsequently compiled and summarized existing monitoring programs that were collecting data in support of the various indicators for each habitat. Existing monitoring programs, developed indices, and indicators that would provide more informative data were prioritized. The target audience for the CMP is broad, and includes agencies, municipalities, NGOs, universities, and other interested stakeholders. Many organizations working in partnership will be required to implement the scope of this CMP.

The number of indicators for each habitat ranged from 13-19 and were categorized into the same four categories for each habitat, including: habitat extent, ecological condition, stressors, and climate vulnerability (Table 1.1). The framework for each of the four categories included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not meant to be exhaustive; instead, it is representative of biological, physical, and/or chemical parameters that provide information about the four condition categories. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

Using indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. Where possible, indicators are reflective of quantitative measurements of extent and condition at specific geospatial scales and trends over time for each habitat.

Table 1.1. Indicator categories consistent across all habitat types.

Indicator Category	Description
Habitat Extent	Functional habitat area, including gain or loss (e.g., fragmentation, accessibility, temporal variability, etc.). Some habitats contain multiple zones.
Ecological Condition	The state of the ecological system, including biological or ecological characteristics and the processes and interactions that connect them (USEPA ROE 2019). Condition may be represented by status or changes to individuals, populations, communities, and ecosystems (e.g., presence of amphibian species in streams, reproductive success of nesting shorebirds, or an index of fish diversity).
Stressors	Human-induced changes in physical, chemical, and biological properties that impact (posing potential risk or disturbance to) the condition of habitat such as exposure to waste and stormwater discharges, nutrient and chlorophyll concentrations, channel morphology of streams and tidal wetlands, abundance of invasive species, eutrophication, fishing pressure, and the intensity of collection activities.
Climate Change Vulnerability	Impacts caused by or associated with one or more of the following climate change stressors: warmer temperatures, warmer waters, increasing drought, increasing storminess, sea level rise, or ocean acidification.

Though the indicators for each habitat were intended to capture condition and trends, they are certainly not an exhaustive list for each habitat, nor do they represent all studies being conducted in the Bay. The indicators were not intended to be fully comprehensive, but instead needed to be reasonable in scope for each habitat type. The authors acknowledge that there are important aspects of the habitat types such as benefits to humans or environmental justice that are not captured in the included indicators. Ecosystems can be both stressed by humans and provide substantial benefits such as education, recreation, strengthened economy, water and air quality improvements, carbon sequestration, and many more.

Ecosystem Services and Environmental Justice

While the discussion of indicators primarily examines elements of ecosystem function and biological integrity, it is important to consider the ways that human activities act not only as stressors on natural systems but also contribute to overall considerations of value of those systems. Human use is an inextricable part of the environment in the urban context of Santa Monica Bay, located on one of the most populous coastlines of the world. The panoply of human-natural interaction provides opportunities for education at all levels, and thus a concomitant grounding for conservation and preservation. Wellness, spirituality, and recreation opportunities enhance quality of life for beach communities.

Additionally, human uses in the context of the urban environment call forth opportunities for enhancing environmental justice, where underserved populations, school groups and other visitors to the seashore benefit from contact with natural places and those natural places derive additional political and community support in recognition of that benefit. Coastal access for underserved communities is also an important environmental justice issue. Ecosystem services benefit people in many ways; much has been written about the values associated with nature for human's well-being (e.g., Ringold et al. 2013). Although the topic of ecosystem services including environmental justice is not addressed by this document, it could be further developed over time for future inclusion into updates to this CMP or future State of the Bay Reports for the Santa Monica Bay.

Partnerships

Implementation of the CMP requires substantial effort from many external partners. Partners are listed as implementers throughout the tables within each habitat chapter. The complexity and scope of the CMP relies on many entities and organizations to be effective. Importantly, the working environment supporting implementation of the CMP is dynamic, and as such, partners and implementers of various monitoring programs are likely to change over time and that variability may not be captured here. Key implementation partners will also continue to support efforts, and CMP indicators overlap where possible with existing efforts by Los Angeles County Sanitation Districts (LACSD), City of Los Angeles Environmental Monitoring Division (CLA-EMD), Southern California Bight-wide Survey Program (Bight), Southern California Coastal Water Research Project (SCCWRP), The Bay Foundation (TBF), Santa Monica Bay Restoration Commission (SMBRC), State Water Resources Control Board (SWRCB), coastal municipalities, and many others. Additionally, many of the studies to inform indicator or index development are led by university partners such as University of California Los Angeles (UCLA), University of California Santa Barbara (UCSB), California State University Long Beach, University of Southern California, Loyola Marymount University (LMU), Occidental College, Pepperdine University, and many others. SMBNEP is grateful for the participation of dozens of entities who will help implement this CMP and fill important data gaps for our region. Partners or implementers may shift over time and will not be captured until updates to this document are undertaken.

Literature Cited

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SMBNEP Comprehensive Monitoring Program
Chapter 2 – Pelagic

Habitat Introduction

The oceanic water column between the surf zone and the continental shelf break represents the coastal pelagic habitat. Within Santa Monica Bay, the coastal pelagic habitat extends north to the Ventura-Los Angeles County line and south to Point Fermin. This is the most extensive habitat in the Bay and includes waters to depths of 1,600 feet.

The coastal contour and bathymetry of Santa Monica Bay influence ocean currents, upwelling, and other oceanographic processes that in turn dictate the physical and chemical properties of this habitat. The Bay generally features a clockwise circulating current. In addition, two eddies—one near Malibu Point, the other near the southern end of the Palos Verdes Peninsula—create upwelling that bring nutrients and less oxygenated and lower-pH water from depth, where they become available to upper water column (or pelagic) marine organisms. Upwelling also occurs when the Santa Ana winds blow offshore. The Bay is also located at a minor transition between warmer and colder biogeographies within the Southern California Bight. This means that a wider variety of species can be found here than elsewhere. The abundance of these species fluctuates as ocean current and temperature regimes undergo change. During El Niño periods, warmer water species (including popular migratory sport fish) increase in abundance, while colder water species likely move north and deeper. Marine organisms found in this habitat include microbes, phytoplankton, zooplankton, small schooling fish, larger predatory fish (e.g., California Barracuda, *Sphyraena argentea*), sea birds, sharks, sea lions, seals, dolphins, and whales.

This habitat is exposed to natural shifts in oceanographic and climatic conditions that occur at scales ranging from local to global. Bight-wide and local impacts related to human activities include point and nonpoint source discharges, ocean intakes, and shipping. The City of Los Angeles and the Sanitation Districts of Los Angeles County discharge treated wastewater into the Bay off El Segundo and Whites Point, Palos Verdes, respectively, and an oil terminal is located in the southern portion of the Bay, offshore from Los Angeles International Airport (LAX). Shipping lanes for the nation's busiest port complex, the Ports of Los Angeles and Long Beach, pass the mouth of the Bay just off the continental shelf, and two ocean water intakes currently operate to support power generation off LAX and Redondo Beach. While a third intake at El Segundo was recently shut down, water suppliers are considering the possibility of desalination, which would likely reopen or create new intakes and discharges. However, many of these activities are heavily regulated to reduce or mitigate their impact on the environment. For example, point and nonpoint source discharges are subject to strict water quality standards, and ocean intakes for once-through cooling power generation facilities are projected to be phased out by 2024. In addition, the coastal pelagic habitat and the species found here support a variety of other human activities, ranging from whale watching to sport and commercial fishing.

The conditions in Santa Monica Bay reflect what is occurring in the rest of the Bight on the grand scale (e.g., El Niño). This can provide context for interpreting the indicators below. However, the Bay has unique characteristics that may result in differences in conditions from the rest of the Bight. Recent data analyses on harmful algal blooms and hypoxia have been conducted by SCCWRP and CRI to inform this monitoring program. Dr. Amber Bratcher-Covino at CRI has been collecting phytoplankton samples from across the Bay to study the presence and timing of HAB species at a wider geographic scale than what is presently monitored by SCCOOS, as well as to investigate bloom patchiness and potential links with localized environmental stressors.

Much of the introductory pelagic information in this chapter was replicated and updated from information in the 2015 SotB Report (Bearzi et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of pelagic habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting pelagic habitat?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with pelagic habitat?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not meant to be exhaustive; instead, it is representative of biological, physical, and/or chemical parameters that provide information about the four condition categories. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

The pelagic habitat working group utilized and prioritized existing monitoring program data condition metrics where possible to allow for consistency in data collection and analysis such as Southern California Bight data, CalCOFI data, and others. Some of the challenges for this habitat were due to the sheer scale of the total area of habitat and the biological diversity that it supports. Several of the stressors may also compress the available high quality habitat area (e.g., hypoxia, ocean acidification, harmful algal blooms, etc.). Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The pelagic habitat includes 13 indicators across four categories which will be used to detect changes in the environment (Table 2.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat.

Table 2.1. Indicators for pelagic habitats in the Santa Monica Bay region.

Indicator Category	Pelagic Indicators
Habitat Extent	Area of Pelagic Habitats
Ecological Condition	Pelagic Zooplankton Community Index
	Ichthyoplankton Diversity Index (or Community Structure)
	Fish Biomass Change
	Marine Mammal Strandings and Deaths
	Sea Bird Strandings and Nesting Function
Stressors	Area of Hypoxia
	Land-Based Pollution Assessment Model (or Source Assessment)
	Harmful Algal Blooms (HABs)
	Fishing Pressure
	Marine Debris and Microplastics Presence and Amount
Climate Change Vulnerability	Water Temperature Change
	Ocean Acidification (or Aragonite Saturation)

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of pelagic habitat providing ecosystem function. Coastal bathymetry may be used for mapping purposes, and models or depths zones may be used to categorize the assessment area. In general, this metric is unlikely to vary considerably in the future unless the pelagic system is redefined in the future as to functional capacity or in another assessment. Data should be updated if major changes to ocean chemistry through pollutant discharge reductions, new desalination or other facilities that impact pelagic waters occurs.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 2.2, 2.3, and 2.4, respectively.

For pelagic, large-scale monitoring programs that have broad state (e.g., CalCOFI) or regional (e.g., Bight Monitoring Program) surveys have some assessment areas within the Santa Monica Bay and provide data for some of the indicators below. Additional research or modeling should occur to develop some of the recommended indices (e.g., pelagic zooplankton community, ichthyoplankton diversity index, harmful algal blooms). Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs. “Unknown” frequency metrics require more information.

Figure 2-1. View of the Santa Monica Bay from TBF’s boat (credit: Amber Bratcher-Covino, CRI).

Table 2.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Pelagic Zooplankton Community Index	Zooplankton data / community study	CalCOFI surveys	Unknown
Ichthyoplankton Community Index	Larvae / egg community studies	NOAA SWFSC integrated ecosystem assessments; CalCOFI surveys	Unknown
Fish Biomass Change	Fish biomass by size class (as indicator of overfishing)	CDFW Marine Region Statistical Unit / NMFS Southwest Fisheries Science Center	Data compiled annually
	Landings by weight of forage fish (commercial) caught in the Bay by species	CDFW Marine Region Statistical Unit / NMFS Southwest Fisheries Science Center	Data compiled annually
	Catch per unit effort of young thresher sharks by size category	CDFW Marine Region Statistical Unit / NMFS Southwest Fisheries Science Center	Data compiled annually
	Loss of large fish (quantify loss, select larger size classes)	CDFW Marine Region Statistical Unit / NMFS Southwest Fisheries Science Center	Data compiled annually
	Presence, movements, and permanence of great white sharks, giant sea bass and other species of interest	C. Lowe Lab at CSULB has eight receivers deployed throughout SM Bay	Data downloaded and compiled quarterly
Marine Mammal Strandings and Deaths	Distribution, frequency of occurrence, seasonality, and behavior of resident species	Ocean Conservation Society / NMFS / Southern California Cascadia Research Collective	Unknown
Sea Bird Strandings and Nesting Function	Density of seabirds	No current programs	Opportunistic surveys / research
	CECs in bird eggs	Historical data collected as part of Bight program	Historical data available

Table 2.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Area of Hypoxia	Habitat compression	ROMS-BEC model estimate (determine problem areas; evaluate stressor inputs)	Once and then only if substantial changes occur
Land-Based Pollution Assessment Model (or Source Assessment)	Proximity to land-based inputs (ID sources and make broader)	POTWs, SCCWRP Bight Monitoring Program are opportunities, this indicator needs to be more developed	Unknown
	Aerial deposition	No current programs	No current programs
Harmful Algal Blooms (HABs)	Season averages of domoic acid and P-N concentrations	SCCOOS harmful algae and red tide monitoring program (some include domoic acid); CRI research by Dr. Amber Bratcher-Covino	Weekly (SCCOOS); Opportunistic surveys for P-N
	Seasonal averages of HAB species (cell / liter)	SCCOOS harmful algae and red tide monitoring program; CRI research by Dr. Amber Bratcher-Covino on HAB species presence	Weekly (SCCOOS); Opportunistic surveys for CRI
Fishing Pressure	Aerial surveys to determine boat activity	LightHawk and TBF conduct quarterly surveys as funding occurs	Opportunistic surveys / research
	MPA Watch (offshore fishing) human activity surveys	MPA Watch collects community science data led by Heal the Bay and LA Waterkeeper (within MPA sites only)	Opportunistic surveys / research
Marine Debris and Microplastics Presence and Amount	Presence and quantification of various types of marine debris by area	Research surveys by Dr. James Landry (CRI); studies by SCCWRP	Opportunistic surveys / research

Table 2.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Water Temperature Change	Temperature trends over time	NOAA / buoys; Dr. Jeremy Pal climate modeling research project (CRI); remote sensing data (satellite)	Daily for buoys; Opportunistic surveys / research for CRI – one set of 11 projection models
Ocean Acidification (or Aragonite Saturation)	pH, pCO_2, aragonite saturation	LACSD and CLAEMD pelagic monitoring / C-CAN – single station with wire walker	Data downloaded quarterly
	Area and frequency of low pH instances in CTD casts	LACSD and CLAEMD pelagic monitoring / C-CAN	Unknown

Data Sharing and Reporting

Pelagic habitat monitoring data will be compiled and analyzed approximately every five years associated with the production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers, and summaries will be publicly available upon request. When possible, data will be incorporated into public databases or other similar public data sharing portals.

Data Gaps and Future Studies

Data gaps associated with the pelagic habitat include some indicators with recommended indices that have not been developed yet (e.g., pelagic zooplankton community, ichthyoplankton diversity index, harmful algal blooms). Many of these indicators and others also do not have established thresholds to be able to determine condition of the habitat. For example, the metrics associated with the land-based pollution assessment model indicator are both largely undeveloped and could benefit from data inputs. Data gaps from the 2015 SotB Report also include indicators such as marine mammals and seabirds, and geographic gaps such as breaks in data due to the distance between monitoring stations or too few stations in the Bay (e.g., CalCOFI, SCCOOS). Acquisition of consistent fishery data and stranding data was also identified as a challenge. Thus, additional research and/or monitoring locations are recommended to fill these data gaps. The impacts of some climate stressors such as ocean acidification on the pelagic zone in the Bay are not well understood, but recent research by SCCWRP and others has further developed models to inform this indicator. Table 2.5 summarizes priority data gaps identified for the pelagic habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.1 of Chapter 9).

New research and studies that are recommended include further development of pelagic habitat models such as those by Dr. Martha Sutula at SCCWRP modeling ocean acidification and hypoxia in the Bay and surrounding waters. Additional specialized research is recommended for important metrics that intersect with the CCMP Action plan such as microplastics studies, harmful algal bloom studies, and other climate stressor analyses to better inform status and trends throughout the Bay. There may also be existing data sets or pilot studies that could further inform new metrics associated with these indicators (e.g., pteropod study by SCCWRP for ocean acidification).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 2.2-2.5, especially the categories that are “no current programs” or “unknowns” and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat.

Table 2.5. Pelagic Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Pelagic Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Geographic gaps between monitoring stations	Single metric	CalCOFI, SCCOOS
Ecological Condition	Pelagic Zooplankton Community Index	Index development	CalCOFI
	Ichthyoplankton Community Index	Index development; Special study (existing data)	NOAA, SFSC Integrated Ecosystem Assessment
	Fish biomass change	Special study (existing data)	Unknown
	Marine mammal and seabird stranding	Single metric	NMFS and others
Stressor	Area of Hypoxia	Special study (existing data, new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	HAB Seasonal changes (species, domoic acid, P-N concentration)	Single metric; Special study (existing data)	SCCOOS
	Marine debris and microplastics presence	Single metric	SCCWRP Bight Monitoring Program, LMU
Climate Vulnerability	Temperature trends	Single metric, special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Area and frequency of Ocean Acidification	Single metric, special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

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SMBNEP Comprehensive Monitoring Program
Chapter 3 – Soft Bottom

Habitat Introduction

Soft sediments composed of sand, silt, and clay make up the majority of the bottom habitat in the Bay. These are found throughout the Bay, with exceptions in the deep-water canyon off Point Dume; on Short Bank in the middle of the Bay; on the shelf off Rocky Point; and along the coast from the county line to Lechuza Point, from Point Dume to Malibu Point, and off the Palos Verdes Peninsula. In addition, soft bottom habitat is broken up by numerous artificial reefs, breakwaters, groins and infrastructure. It also supports eelgrass beds (*Zostera pacifica* and *Z. marina*). Eelgrass beds in coastal marine soft bottom habitats brings services such as habitat for marine fishes and invertebrates, improvements to sediment and water quality, stabilization of offshore sediments, reduction in shoreline erosion, carbon sequestration, amelioration of ocean acidification, economic and fishery support, and educational outreach opportunities.

Soft sediments provide both shelter and foraging grounds for thousands of benthic invertebrate species, ranging from tiny worms, shrimps, and crabs to sea stars, clams, and sea slugs. These bottom organisms are near the base of the food web that supports an abundant and diverse assemblage of bottom-dwelling fishes. Soft-bottom fish found in the Bay include, for example, flatfishes, rockfishes, sculpins, combfishes, and eelpouts. Some of these fishes utilize the ecotone between the sand and structures, such as California Halibut (*Paralichthys californicus*), California Scorpionfish (*Scorpaena guttata*), Barred Sand Bass (*Paralabrax nebulifer*), and White Croaker (*Genyonemus lineatus*), and account for a significant percentage of recreational fish catches from piers and boats.

Soft sediments are also a major reservoir of chemical contaminants in the Bay. Many chemical contaminants bind to organic material on sediment particles, where they can accumulate to high levels and provide an ongoing source of exposure to marine life. Chemical contaminants have been introduced to this habitat primarily through historical wastewater discharges through outfalls offshore from Hyperion Treatment Plant (Hyperion) near Los Angeles International Airport and the Joint Water Pollution Control Plant (JWPCP) near White Point on the Palos Verdes Peninsula. Other significant contributors are dry and wet weather runoff from rivers and creeks and industrial discharges to the Bay. Historical contributors also include ocean dumping of containerized waste (Kivenson et al. 2019).

City of Los Angeles Environmental Monitoring Division monitors 44 sites in SM Bay annually for benthic infauna, sediment grain size, and total organic carbon. Nine of the 44 sites are tested annually for sediment toxicity and chemical constituents. Demersal epibenthic trawl sampling is conducted semi-annually at 12 sites in SM Bay. Recent monitoring of eelgrass habitats (*Z. pacifica*) in the Bay have been conducted by TBF and partners to evaluate the potential to implement eelgrass restoration projects.

Much of the introductory information for soft bottom habitat in this chapter was replicated and updated from information in the 2015 SotB Report (Bay et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of soft bottom habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting soft bottom benthos?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with soft bottom habitat?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not meant to be exhaustive; instead, it is representative of biological, physical, and/or chemical parameters that provide information about the four condition categories. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

The soft bottom benthos habitat working group prioritized existing long-term monitoring data where possible, especially those conducted regularly and at repeated stations by publicly owned treatment works (POTWs) such as Sanitation Districts of Los Angeles County (LACSD) and City of Los Angeles, Environmental Monitoring Division (CLA-EMD). Many of the indicators for this habitat were replicated from the State of the Bay Report (2015) due to the long-term availability of data in support of those indicators. New indicators are proposed for the climate change vulnerability indicator category, with some overlap (e.g., dissolution of invertebrate shells due to ocean acidification) with other habitats in this plan. Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The soft bottom habitat includes 12 indicators across four categories which will be used to detect changes in the environment (Table 3.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat.

Table 3.1. Indicators for soft bottom habitats in the Santa Monica Bay region.

Indicator Category	Soft Bottom Habitat Indicators
Habitat Extent	Area of Soft Bottom Habitat
Ecological Condition	Submerged Aquatic Vegetation Condition
	Benthic Community Condition
	Fish Community Condition
Stressors	CEC Loading in Fish
	Sediment Contaminant Load (Legacy Contaminants)
	Hypoxic Zones / Dissolved Oxygen
	Fish Tissue Contamination (Legacy Contaminants)
Climate Change Vulnerability	Fish Habitat Change for Key Species
	Physical Change to Habitat (Area)
	Ecosystem Metabolism
	Dissolution of Carbonate Structures (Organismal)

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking overall surface area of soft bottom habitat and change over time. This metric has been identified to be consistent and stable over time and is unlikely to vary considerably in the future unless large scale changes in effluent or inputs to the Bay occur. Data should be updated every few years or after major regulatory changes. However, future development of this indicator is recommended, including potentially adding to the level of detailed information through breaking up the area into smaller habitat categories such as area and extent of eelgrass beds, juvenile fish recruitment areas, *Phragmatopoma* habitat, etc. Additionally, a future component of this indicator could be developed relating to vertical habitat availability, which is intended to describe changes in the distribution of water quality conditions near the sediment surface needed to support healthy benthic communities (e.g., depth range of temperature, pH, and dissolved oxygen).

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 3.2, 3.3, and 3.4, respectively.

Data collected to inform trends associated with various soft bottom indicators are conducted regularly by groups such as LACSD and CLA-EMD at fixed repeatable locations over time. However, some indicators have not yet been developed, are not comprehensive, or would need to be informed through research. Additional details are available in the 'data gaps' section at the end of the chapter. Note that monitoring programs in the tables below that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state "opportunistic surveys / research" or "no current programs" in the tables below as they may not currently be funded programs.

Figure 3-1. Bat Ray and eelgrass along soft bottom habitat (credit: TBF).

Figure 3-2. Eelgrass habitat off Catalina Island (credit: TBF).

Figure 3-3. Eelgrass patch habitat off Catalina Island (credit: TBF).

Table 3.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Submerged Aquatic Vegetation Condition	Shoot height, density, and percent cover	TBF and partners collecting some data for *Zostera pacifica* in Malibu	Annually
	Above ground biomass, carbon, and nitrogen content	No current programs	Opportunistic surveys / research
	Invertebrate infauna and epifauna	No current programs	Opportunistic surveys / research
Benthic Community Condition	Percent surface area in each class of values for the Benthic Response Index (BRI)	LACSD and CLA-EMD benthic infauna monitoring; SCCWRP (Bight-wide survey)	Annually (LACSD and CLA-EMD); every five years (SCCWRP, anticipated 2023)
Fish Community Condition	Fish community index	LACSD and CLA-EMD fish community monitoring; SCCWRP (Bight-wide survey)	Annually (LACSD and CLA-EMD); every five years (SCCWRP, anticipated 2023)

Table 3.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
CEC Loading in Fish	Fish tissue samples for contaminants of emerging concern (e.g., flame retardants)	No current programs	Opportunistic surveys / research
Sediment Contaminant Load (Legacy Contaminants)	Percent surface area of legacy contaminants (PCB, DDT, mercury)	LACSD and CLA-EMD sediment chemistry (contamination) monitoring (subset of benthic monitoring stations)	Annually
Hypoxic Zones / Dissolved Oxygen	Persistence of exposure to hypoxia by area	SCCWRP modeling	Opportunistic surveys / research
Fish Tissue Contamination (Legacy Contaminants)	Fish tissue samples	CLA-EMD Local Bioaccumulation Trends Survey (LBST, White Croaker and Hornyhead Turbot); CLA-EMD Local Seafood Safety Survey (LSSS, White Croaker, Kelp Bass, Barred Sand Bass, Black Perch, Rockfish); LACSD, CLA-EMD, and SCCWRP Bight Survey fish contamination monitoring	LBST Annually; LSSS Biennially; Bight-wide every five years

Table 3.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Fish Habitat Change for Key Species	New species records	No current programs	Opportunistic surveys / research
	Distribution of key species and predictive responses	Vantuna Research Group has existing temperature models for fish	Opportunistic surveys / research
Physical Change to Habitat (Area)	Sediment burial of nearshore benthic habitats (e.g., SAV)	No current programs	No current programs
	Changes in sediment grain size	LACSD and CLA-EMD benthic monitoring	Annually
Ecosystem Metabolism	Model predictive outcomes of various climate stressors	Indicator needs further development	No current programs
Dissolution of Carbonate Structures (Organismal)	pH, pCO_2	Indicator needs further development	No current programs
	Faunal response	Indicator needs further development	No current programs

Data Sharing and Reporting

Soft bottom monitoring data will be compiled and analyzed approximately every five years associated with the production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers, and summaries will be publicly available upon request. When possible, data will be incorporated into public databases.

Data Gaps and Future Studies

Former data gaps identified for soft bottom habitat by the 2015 SotB Report were specific to key indicators such as fish community, vertical habitat availability, and all categories of vulnerability. The Report also recommended further development of the habitat extent indicator into habitat types (e.g., eelgrass area) and the advancement of the vertical distribution metric. Data for several of the habitat types, especially the nearshore systems, may be obtained or supplemented using side-scan sonar or similar methods. Additionally, little is known about the benthic community, *Phragmatopoma;* some information was collected for the Bight '18 program but was not available for this plan.

Another of the major recommendations and data gaps is the development of an eelgrass condition index. Standardizing submerged aquatic vegetation (SAV) monitoring practices for Southern California has become an important recommendation by many groups, including the SAV Technical Advisory Committee (SAV TAC) led by SCCWRP and Dr. Christine Whitcraft of CSU Long Beach. The most recent document produced by the SAV TAC, "Methods and Guidance on Assessing the Ecological Functioning of Submerged Aquatic Vegetation in Southern California Estuaries and Embayments," provides detailed recommendations for survey protocols and methods that should be replicated for this habitat. These protocols include several priority recommendations that are not currently being surveyed in the Bay, including above ground biomass, carbon, and nitrogen content, and invertebrate infauna and epifauna. It is also recommended that a potential index be explored building on the protocols recommended and established by the SAV TAC. Additionally, evaluated metrics may also inform sediment burial of nearshore benthic habitats such as SAV beds.

While the Benthic Response Index (BRI) exists and is well developed, additional community data, response indicators, or an index is recommended for fish. Fish community condition or an index was identified as a high priority by the working group, especially because there may be fishery data available that could be utilized as a component of this indicator. Additionally, the CEC loading indicator needs further development, as many CECs have the potential to bioaccumulate and create food web impacts. Fish tissue samples for CECs are also a data gap. This could be evaluated with a limited analyte list to search for key CECs but should be informed by expert advisors.

Several new metrics associated with the new “climate change vulnerability” category are also identified in the tables above as data gaps. Dr. Dan Pondella at Vantuna Research Group, Occidental College and partners have conducted predictive evaluations of fish response to temperature changes, but additional research would support further evaluations for this indicator. Santa Monica Bay is at the transition between the cold and warm faunas on our coastline, and as such, is sensitive to fish community changes that are a result of climate change. Similarly, SCCWRP has conducted extensive modeling for dissolved oxygen in the Bay, but additional interactions between DO and ocean acidification are not understood, nor are they understood at a high depth or spatial resolution. Both the ecosystem metabolism and dissolution of carbonate structures indicators need further development. Further, there is no known identified threshold that incorporates both concentration and duration of acidification or hypoxia. Additionally, there are no known local studies for faunal impacts of ocean acidification, though SCCWRP is drafting a manuscript detailing response of infauna to acidification with indicator recommendations. Table 3.5 summarizes priority data gaps identified for the soft bottom habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.2 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 3.2-3.5, especially the categories that are “no current programs” or “unknowns” and require more information, ”, as well as additional new studies that could further support the evaluation of the key indices for this habitat. New studies that are recommended include supplemental modeling and threshold development for DO, OA, and other stressors or climate indicators; further understanding of the potential impacts of fish contamination to beneficial uses by humans; index development for several of the indicators mentioned above, including SAV and eelgrass; and fish community studies. Additional SAV monitoring and research following the recommended protocols would also improve local understanding for this habitat.

Table 3.5. Soft Bottom Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Soft Bottom Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Eelgrass area mapping using side-scan sonar or similar methods	Single metric; Special study (existing data)	Prop. 50 (2019 CCMP Finance Plan Action #4)
Ecological Condition	SAV Survey of aboveground biomass, carbon, and nitrogen content	Index component	Prop. 50 (2019 CCMP Finance Plan Action #4)
	SAV Survey of invertebrate infauna and epifauna	Index component	Prop. 50 (2019 CCMP Finance Plan Action #4)
	Fish community condition or index informed by fishery	Index development; Index component	NPDES Program, SCCWRP
Stressor	CEC loading in fish	Single metric	SWRCB
Climate Vulnerability	Predictive evaluations of fish response to temperature changes	Special study (existing data)	Unknown
	Interactions between DO and ocean acidification or hypoxia	Special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Local faunal impacts of ocean acidification	Special study (new data acquisition)	Sea Grant, OPC, SCC, others

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SMBNEP Comprehensive Monitoring Program
Chapter 4 – Rocky Reefs

Habitat Introduction

In Santa Monica Bay, hard bottom, rocky reefs, and outcrops are primarily located in the shallow subtidal zone off Malibu (from the Ventura County line to Sunset Blvd., north hereafter) and Palos Verdes (from Malaga Cove to Point Fermin, south hereafter). These rocky reefs are composed of sedimentary strata, marked by shale boulders and shelves separated by reaches of sand and cobble.

Although the area of rocky reef habitat is relatively small compared to other habitats in the Bay, they support some of the Bay's most diverse and productive biological communities. The abundance and diversity of marine life are especially apparent in the giant kelp forests (*Macrocystis pyrifera*) that cover some rocky reefs. The kelp beds provide protection and habitat for more than eight hundred species of fish and invertebrates, including a few protected species, such as the green abalone (*Haliotis fulgens*), Giant Sea Bass (*Stereolepis gigas*) and endangered white abalone (*H. sorenseni*). Because of the diverse and abundant assemblage of organisms, rocky reefs in the Bay are important sites for commercial and recreational diving and fishing. Some of the key commercial and recreational species in this habitat are California spiny lobsters (*Panulirus interruptus*), Kelp Bass (*Paralabrax clathratus*), and White Seabass (*Atractoscion nobilis*). Growing scientific research describes the value of kelp forests to assist in the mitigation of climate change through mechanisms such as carbon sequestration, reduction in currents and wave energy, and localized elevation of pH, which may provide a refuge for ocean acidification. When the kelp drifts away from the rocky reef, it provides habitat and nutrients to many other coastal systems of interest to SMBNEP and other coastal resource managers.

Giant kelp tends to grow and die along with changing oceanographic conditions (it grows better in colder water, with plenty of upwelled nutrients) and the frequency and intensity of storm events (heavy surf can rip entire kelp plants from the rocky substrate) that are a part of the natural cycle of kelp. However, it is also susceptible to poor water quality in the form of suspended solids and shifts toward purple sea urchin (*Strongylocentrotus purpuratus*)-dominated systems. Rocky reefs in the south are susceptible to landslides that have the potential to bury rocky substrate for decades and are a source of habitat loss along this stretch of Santa Monica Bay.

In recent years (since 2013), TBF has been restoring and monitoring rocky reefs off the Palos Verdes Peninsula. This project represents one of the larger and most successful kelp restoration projects in existence. Over 55 acres have been restored through 2020 requiring over 10,000 hours of SCUBA diving. The restoration target was the systematic reduction of purple urchin density to approximately two per m^2. Data on community response to these restoration efforts are collected annually. Monitoring results have described a community wide response on the restored reefs including increased diversity of macroalgae, increased acreage of kelp canopy, higher densities and biomass of kelp bass and other fish species, increased density of CA spiny lobster, increased invertebrate diversity at all restoration sites, and increased urchin gonadosomatic indices (Grime et al. 2020). These increases are comparable to reference site values developed from contemporaneous monitoring within healthy kelp forests on the Palos Verdes Peninsula.

In 2020, the Montrose Settlement Restoration Program (MSRP) implemented the Palos Verdes Restoration Reef project to restore buried rocky reef across 42 acres near Bunker Point off the Palos Verdes Peninsula. This restoration project was also supported with funding through Proposition 12 overseen by the California State Coastal Conservancy. The project, completed in September 2020, is being studied and monitored annually with sonar and the state's standardized reef monitoring program survey techniques. This is the first rocky-reef restoration program of its type in California. It is uniquely designed to restore lost habitat, *in situ*, utilizing state-of-the-art techniques for maximizing the production of fishery species. As a secondary goal, the project has a replicated design that will allow rigorous assessments providing information for best practices for future reefing programs.

Much of the introductory information for rocky reefs in this chapter was replicated and updated from information in the 2015 SotB Report (Pondella 2015).

The overarching questions for this habitat include the following:

1) What is the extent of rocky reef habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting rocky reefs?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with rocky reefs?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

Rocky reefs have been monitored extensively for ecological data by groups such as Vantuna Research Group (VRG) at Occidental College, California Polytechnic Los

Angeles, Paua Marine Research Group, NOAA, and TBF. Physical and chemical surveys have been less extensive but have been conducted by groups of researchers from UC Davis, TBF, UCLA, Cal State Northridge, and Cal State Monterey. Monitoring program priorities developed by the working group included indicators that were part of existing monitoring programs such as fish community data, kelp cover, and invertebrate indicator species. Additional potential research questions and studies are identified in the data gaps subsection at the end of the chapter. Some of the identified challenges for this habitat by the working group were making sure some of the indicators did not have overlap in the monitoring data feeding into them and discussions about the potential to merge several indicators into a future index that has not yet been developed. Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The rocky reef habitat includes 12 indicators across four categories which will be used to detect changes in the environment (Table 6.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales.

Table 4.1. Indicators for rocky reef habitats in the Santa Monica Bay region.

Indicator Category	Rocky Reef Indicators
Habitat Extent	Area of Rocky Reef Habitats
Ecological Condition	Kelp Canopy Coverage / Urchin Barren Extent
	Invertebrate Indicator Species
	Rocky Reef Fish Production
	Invasive Indicator Species
Stressors	Fishing Pressure
	Anthropogenic Discharges and Runoff
	Landslides and Sedimentation (Landscape Modification)
	Turbidity / Light Penetration
Climate Change Vulnerability	Water Temperature Change
	Increased Storminess
	Invertebrate Recruitment

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of hard substrata by depth and category (e.g., deep reef, kelp beds, artificial reefs including outfall pipes, surfgrass, rock, etc.). Various geospatial layers can be used to inform this indicator, including those of Pondella et al. 2015 and Claisse et al. 2012 and armoring matrices surrounding and including outfall pipes (such as those of LASAN Hyperion Water Treatment Plant). Multispectral aerial imagery may also serve to inform this indicator or others below. Perhaps equally important is the three-dimensional structure of rocky reef habitat. A metric of vertical complexity needs to be developed for this habitat. Some measure of rugosity is possible, but side-scan sonar or some other recent technology may be well suited to capture this information for habitat extent.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 4.2, 4.3, and 4.4, respectively.

While VRG is conducting large-scale biological and side-scan monitoring, there are still geographic data gaps that need to be filled to be comprehensive across all rocky subtidal reef habitats. There are also categories of habitat type that are largely data gaps such as deep reef systems, artificial reefs, or areas with surfgrass. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs.

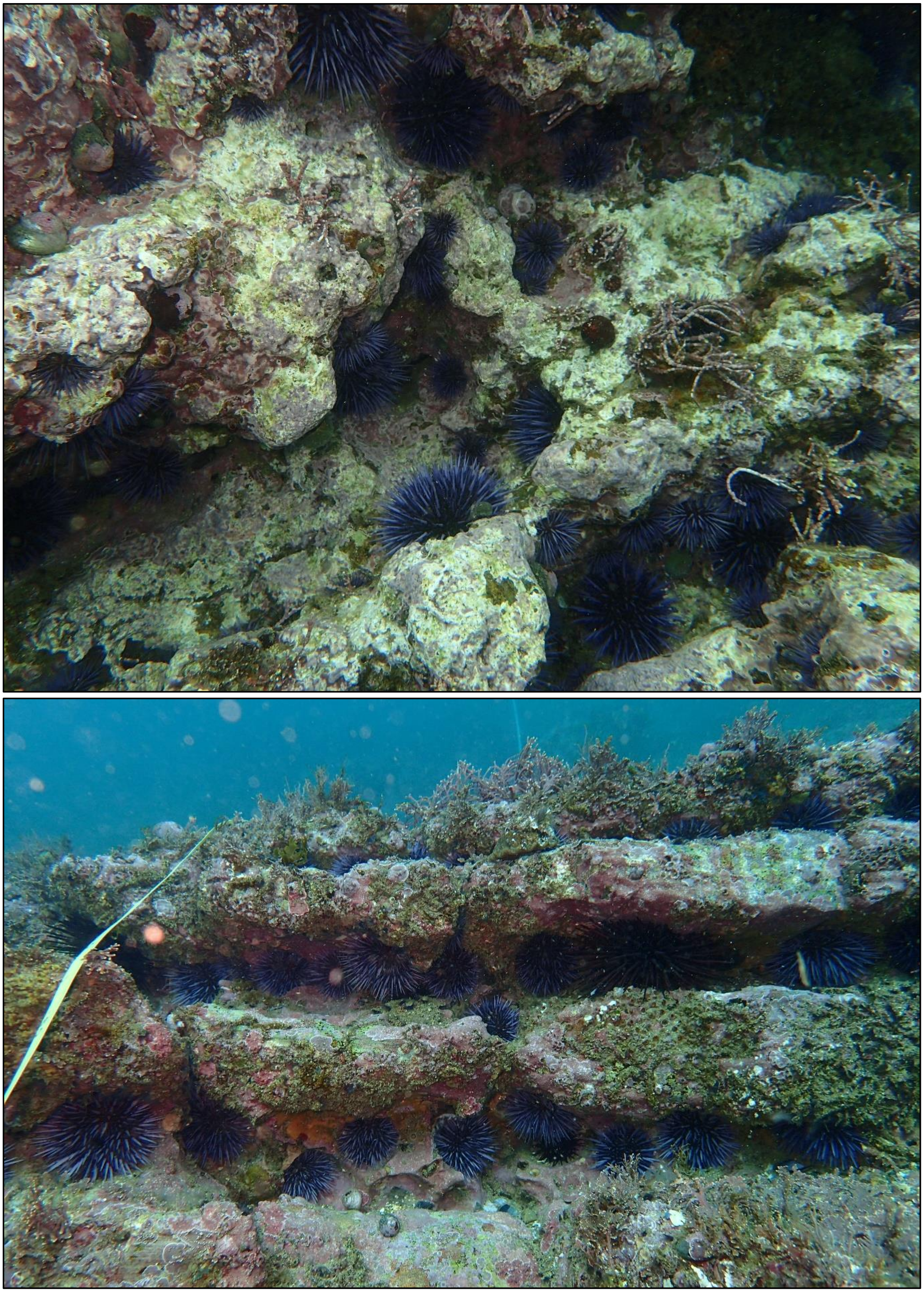

Figure 4-1. Rocky reef habitat as urchin barrens (pre-restoration) (credit: TBF).

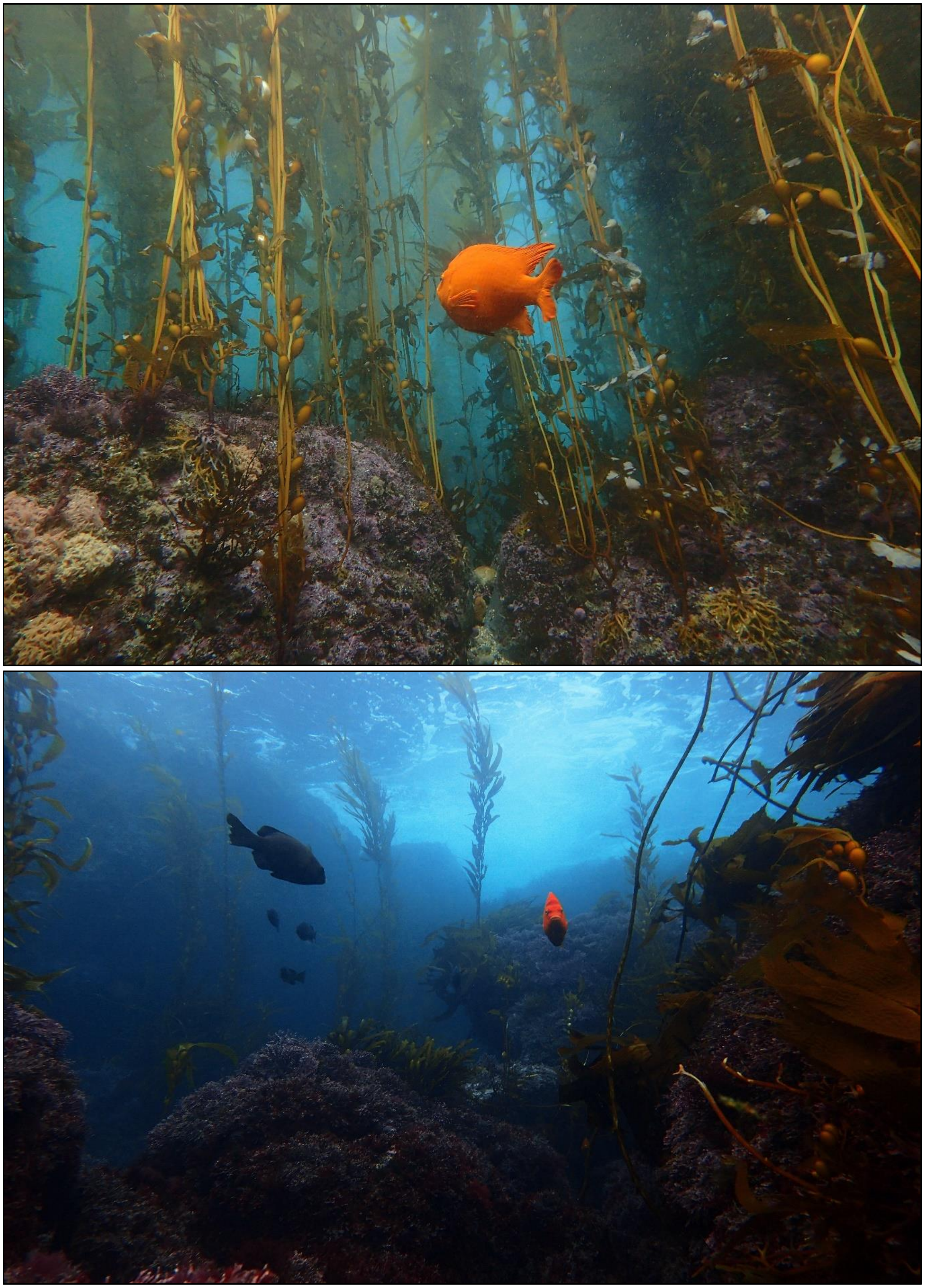

Figure 4-2. Rocky reef habitat as kelp forest with high diversity (credit: TBF).

Table 4.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Kelp Canopy Coverage / Urchin Barren Extent	Kelp aerial coverage	Central Region Kelp Survey Consortium aerial visual surveys (Ventura to Mexico); satellite data from NASA as LandSat data or other satellites; Dr. Kyle Cavanaugh at UCLA conducts periodic drone surveys and analyzes Planet (satellite) data	Quarterly for aerial surveys; opportunistic research for satellite data and drone surveys
	Percent of rocky reef by urchin density threshold	TBF pre- and post-data from kelp restoration areas off the PV Peninsula	Data collected in response to restoration efforts; analyzed and summarized annually
	Kelp density and understory macroalgae	TBF pre- and post-data from kelp restoration areas off the PV Peninsula; VRG surveys of several sites off PV Peninsula	Data collected in response to restoration efforts; analyzed and summarized annually; VRG annually
Invertebrate Indicator species	Spiny lobster densities	CDFW fishing data; CRANE surveys conducted by VRG; MPA data by VRG in Malibu	CRANE annually
	Sea stars and important commercial invertebrates	California Department of Fish and Wildlife fishing data; CRANE surveys conducted by VRG; MPA data by VRG in Malibu	CRANE annually
Rocky Reef Fish Production	Fish Production	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually
	Diversity and biomass index sensitive to fishing	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually
Invasive Indicator Species	Density and distribution of invasive algae and invertebrates	CRANE surveys by VRG and others; MPA data by VRG in Malibu; several location data gaps	CRANE annually

Table 4.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Fishing Pressure Index	Index of fishing pressure	Commercial Passenger Fishing Vessel logs by CDFW; aerial surveys conducted by LightHawk and TBF	Opportunistic quarterly surveys; unknowns due to COVID and funding; CDFW frequency unknown
Anthropogenic Discharges and Runoff	Plume probability mapping	Remote sensing data (satellite)	Opportunistic surveys / research
	Runoff pollutants and point-source discharge	No current programs	No current programs
Landslides and Sedimentation (Landscape Modification)	Maps of landslide events and vulnerability assessment	Possible remote sensing data (Planet satellite)	Opportunistic surveys / research
	Direct burial, scour, etc.	Possible remote sensing data (Planet satellite)	Opportunistic surveys / research
	Water velocities and patterns	Some historical data from ADCPs along PV Peninsula	Opportunistic surveys / research
Turbidity / Light Penetration	Light penetration / depth	Some historical data may be available from one site location (Marguerite) by UC Davis	No current programs
	Tracking HAB events	No current programs	No current programs
	Chlorophyll	Remote sensing data (satellite)	Opportunistic surveys / research

Table 4.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Water Temperature Change	Temperature	SCCOOS SM Pier data; National Weather Service offshore station data	SCCOOS – hourly, when available; NWS daily
		TBF and UC Davis HOBO-loggers collecting temperature data (15-minute interval) and miniDOT data on abalone sites (10-minute interval)	TBF data opportunistically for four-month periods
		CTD by CLA-EMD	Annually
		UC Davis miniCTD deployed historically at Marguerite for approximately two years	Historical data
Increased Storminess	Wave energy	Bottom-mounted pressure sensors (Seabird Wave and Tide Gauges and Open Wave Height Loggers) from UC Davis (historical study); buoy data from NOAA and Scripps Institution of Oceanography	Historical data for UC Davis study (periodically 2016-2019); real time data from NOAA/Scripps
Invertebrate Recruitment (OA)	pCO_2, dissolved oxygen, pH	LACSD has a single location offshore annual dataset (pCO_2, pH; see pelagic chapter); TBF deploys miniDOT data on abalone sites (10-minute interval)	LACSD – one site annually (not on a reef); TBF data opportunistically for four-month periods
	Benthic invertebrate composition and size class	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually

Data Sharing and Reporting

Rocky reef monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases or data sharing portals.

Data Gaps and Future Studies

Habitat extent data for rocky reefs are present for some categories of habitats (e.g., maps of urchin barrens versus kelp forests) and limited in others (e.g., surfgrass areas). Additionally, an important metric for habitat extent that still needs development is a metric of vertical complexity using sonar or another method.

Many of the major outstanding data gaps that remain for the rocky reef habitat include limited geographic scope of many of the biological and physical indicators. Geographic ranges for existing data have been focused around the PV Peninsula and limited in places such as Malibu. Expansion of existing standardized protocols such as CRANE surveys into new geographic regions in the Bay is recommended. Additional geographic limitations include categories of habitat such as deep reefs, artificial reefs, and surfgrass habitats. Some data collection at the Hyperion outfall pipes (1-mile and 5-mile) is being conducted by LASAN, but it has not been translated into the indicators listed above. Additionally, little quantitative information associated with landslides is known or tracked impacting rocky reef systems.

Data gaps identified in the 2015 SotB Report included recommendations for further development of the rocky reef fish index, commercially important and other invertebrate data analyses, and other biological response variables. Several CMP rocky reef indicators are either not fully developed or do not have identified monitoring programs (e.g., anthropogenic discharges, landslides and sedimentation, and turbidity / light penetration). Additionally, the invertebrate recruitment indicator categorized in the "climate vulnerability" category needs further development. Table 4.5 summarizes priority data gaps identified for the rocky reefs habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.3 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 4.2-4.5, especially the categories that are "no current programs" and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat. Note that Tables 4.2-4.4 may look complete, but still may have spatial or metric data gaps. Future studies that are recommended include expansion of data sets identified for priority indicators in the tables above and use of additional monitoring methods or research tools. Examples include drone surveys for high resolution kelp cover, fishery stock models for Santa Monica Bay, ROV-AUV surveys, or data for deep reefs and other sites. There is an expressed interest for better tracking for stormwater plumes, coastal landslides, and spatially increased water quality data. Specific efforts should also prioritize water quality to better characterize the inputs of wildfires. Additionally, several indicators in the tables above could be supported by analysis of targeted satellite data from NASA over time.

Table 4.5. Rocky Reef Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Rocky Reef Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	ROV, sonar, and other surveys for characterization of deep reefs, surfgrass habitats, and other sites	Special study (new data acquisition, new methods/tools development)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
	Metric for vertical complexity	Special study (new methods/tools)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
Ecological Condition	Expansion of existing CRANE surveys into new geographic regions in the Bay	Index component	Unknown
Stressor	Fishing Pressure Index	Index development; Index component	Prop. 50, others
	Point source discharge and runoff pollutant loading and plume mapping	Single metric; Special study (existing data, new methods/tools development)	Unknown
	Landslide event mapping and vulnerability assessment	Single metric; Special study (existing data)	Unknown
	HAB tracking with remote sensing	Single metric; Special study (new methods/tools development)	OPC, NOAA, MERHAB program (2019 CCMP Finance Plan Action #35)
Climate Vulnerability	Impacts of acidification on benthic invertebrate mortality	Special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

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SMBNEP Comprehensive Monitoring Program
Chapter 5 – Rocky Intertidal

Habitat Introduction

Rocky intertidal habitats are found at the interface between the ocean and land; in Southern California, these habitats can support as many as 500 species of macroinvertebrates and macrophytes (Littler 1980), including the iconic ochre seastar (*Pisaster ochraceus*), ever-present acorn barnacles (*Chthamalus* spp*. and Balanus glandula*), and federally endangered black abalone (*Haliotis cracherodii*).

Physical conditions in rocky intertidal habitats are highly variable. Primary environmental factors that drive differences in species composition and biodiversity at the site level are geomorphology (e.g., bedrock, cobble/boulder, or mixed sand-rock), wave regime (e.g., exposed or protected), sand exposure, slope, substratum relief, water temperature, air temperature during low-tide immersion, and adjacent coastal habitat. Some of these factors, such as temperature and wave / sand exposure, vary seasonally as well as geographically. Site-to-site differences in these physical features result in expected differences in community composition (e.g., a site that has more wave exposure will have different species abundance patterns than a site that is protected). Thus, comparing data across multiple sites requires similar physical characteristics to accurately assess trends.

Much of the rocky intertidal habitat in the south end of Santa Monica Bay (off Palos Verdes) is characterized by warmer water and tends to be composed of bedrock that is not strongly influenced by sand (although landslides have added sediment with local impacts). This contrasts with the rocky intertidal habitat in the north end of Santa Monica Bay (off the Malibu coastline), where water temperatures are usually cooler, and the substratum is composed mostly of cobble/boulder outcrops surrounded and influenced by sand. Recognizing these differences, analyses of biota performed by the Marine Life Protection Act-Science Advisory Team (MLPA-SAT) placed the northern Bay into a northerly, cooler water biogeographic subregion and habitats along the Palos Verdes Peninsula in a southerly, warmer subregion.

In addition to natural environmental disturbance, rocky intertidal habitats are vulnerable to a range of human impacts. They provide a multitude of benefits to humans, including recreational value and important educational and experiential learning resources and opportunities. However, tide-poolers can relocate organisms from the intertidal to less hospitable habitats and can inadvertently trample invertebrates and vulnerable algal species; fishermen and collectors remove select species; and, where there are storm drains, urban runoff can alter salinity, nutrient levels, water quality, and water clarity. All of these disturbances can impact species diversity, community composition, and ecosystem functions. Larger-scale processes (e.g., rising sea level, increasing temperature, ocean acidification) are also of regional concern, but cannot be addressed solely by local management actions.

Some management actions have been taken to address collection and other human-caused impacts on local rocky intertidal sites. Various marine protected areas (MPAs) were established over the past several decades in Santa Monica Bay, prohibiting the collection of most intertidal organisms within their boundaries. These MPAs were realigned in 2012 as part of the South Coast Marine Life Protection Act (MLPA) process. Now, four MPAs are present in the region, including Point Vicente SCMA, Abalone Cove SMCA, Point Dume SMR, and Point Dume SMCA. These MPAs provide protection for a portion of the Bay's intertidal resources. Additional protection is provided by the Area of Special Biological Significance (ASBS) located in northern Santa Monica Bay beginning east of Point Dume and continuing west to Mugu Lagoon. ASBS' are state water quality protection areas that are monitored and maintained for improved local water quality.

Additional management measures to reduce trampling and other tidepooling-related impacts have been proposed, including installing educational signs and displays, developing an educator program whereby trained docents are on site during low tides, increasing enforcement of MPA regulations through the use of park rangers and lifeguards, and restricting certain activities in rocky intertidal areas. Cabrillo Marine Aquarium has a docent and volunteer education program, highlighting rocky intertidal habitats and organisms.

Within MPAs, recent efforts have included the development of a Los Angeles MPA Collaborative, a component of the California MPA Collaborative network (https://www.mpacollaborative.org/). For rocky intertidal habitats outside of MPA areas, a focus in recent years has been on outreach and enforcement associated with locations impacted by heavy collecting, particularly at White Point. Excessive harvesting has been reported during the Covid-19 pandemic. Local volunteers responded by creating the White Point Patrol, with help from the LA MPA Collaborative, and CDFW focused attention on enforcing licensing regulations in this area as well.

Standardized rocky intertidal monitoring data are collected statewide and beyond by the Multi-Agency Rocky Intertidal Network (MARINe), which includes seven sites in the Santa Monica Bay region, three of which have a full suite of indicators being monitored by UCLA (i.e., Point Fermin, White Point and Paradise Cove). Several additional sites have had biodiversity surveys conducted periodically over time. MARINe data at some sites have been collected for over 30 years, and long-term trends are publicly available through the online data portal (www.pacificrockyintertidal.org). MARINe protocols and information are available for download on the MARINe website (Engle 2008). Additional data are collected by UCLA and California State Polytechnic University, Pomona (CPP) to inform the rockweed restoration project, research data collected by TBF and CRI, and others.

Much of the introductory information for rocky intertidal in this chapter was replicated and updated slightly from information in the 2015 SotB Report (Ambrose et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of rocky intertidal habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting rocky intertidal habitat?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with rocky intertidal habitat?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not meant to be exhaustive; instead, it is representative of biological, physical, and/or chemical parameters that provide information about the four condition categories. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

The rocky intertidal working group utilized and prioritized standardized data condition metrics where possible (e.g., MARINe data), to allow for consistency in data collection and analysis. Additionally, the expert scientists identified existing monitoring programs for this habitat and prioritized indicators across a range of biological, physical, and human use data parameters such as biodiversity, shorebirds, and various measures of disturbance. Some of the challenges for this habitat included varied climate stressors and high vulnerability to sea level rise, ocean acidification, and others. Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The rocky intertidal includes 13 indicators across four categories which will be used to detect changes in the environment (Table 5.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales.

Table 5.1. Indicators for rocky intertidal habitats in the Santa Monica Bay region.

Indicator Category	Rocky Intertidal Indicators
Habitat Extent	Area of Rocky Intertidal Habitats
Ecological Condition	Response to Human Disturbance
	Response to Elevated Nutrients
	Biodiversity Survey
	Shorebird Count
Stressors	Invasive Species
	Human Activities
	Sediment Deposition Events
	Presence of Disease
Climate Change Vulnerability	Habitat Change due to Sea Level Rise
	Temperature Change (Water and Air)
	Increased Storminess
	Dissolution of Carbonate Structures (Organismal)

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of rocky intertidal habitat. Various geospatial layers can be used to inform this indicator, including maps developed by UCLA, the NOAA sensitivity index, recent nearshore survey maps, and mapping data from CRI's beach characterization study. Aerial photographs such as from the California Coastal Records Project (www.californiacoastline.org) may also serve to inform this indicator or others below. In general, data layers for habitat extent are unlikely to frequently exhibit substantial changes unless restoration actions are undertaken or artificial habitats are created, so this indicator may be updated biennially, or less frequently. This indicator may be expanded or further developed in the future to include finer habitat categories that are frequently overlooked such as interspersed or buried rocks under sand, areas with smaller rocks, less permanent sites, or artificial beach armoring structures or jetties. Beaches that transition to have more sand or more rocks seasonally or across a multi-year time scale are also important to capture.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 5.2, 5.3, and 5.4, respectively.

MARINe field locations and other monitoring program locations may not be geographically comprehensive across the Bay. Instead, they are intended to be representative for the Los Angeles region, as one component of the MARINe program which spans the entirety of the West Coast assessment area. These locations also tend to be permanent rocky bedrock type habitats rather than cobble reefs or transitional rock / sand habitat areas. Additional sites implementing MARINe surveys would increase the comprehensive assessment of this habitat across the Bay. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs.

Figure 5-1. Student group visiting Leo Carrillo State Beach rocky intertidal habitat (credit: R. Ambrose, UCLA).

Figure 5-2. Scientists conducting rocky intertidal surveys at Paradise Cove (credit: R. Ambrose, UCLA).

Figure 5-3. Sea stars, mussels, and other invertebrates at Paradise Cove rocky intertidal habitat (credit: R. Ambrose, UCLA).

Figure 5-4. Wave event at White Point rocky intertidal habitat (credit: R. Ambrose, UCLA).

Figure 5-5. Group of students at Point Fermin rocky intertidal habitat (credit: R. Ambrose, UCLA).

Table 5.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Response to Human Disturbance	Abundance of upper shore rockweeds	MARINe long-term monitoring surveys at Point Fermin only	Annually
	Abundance of mussels	MARINe long-term monitoring surveys (three existing sites in Bay); biodiversity surveys (four additional sites)	Annually at three sites; Biodiversity surveys conducted opportunistically at other sites
	Size frequencies of black abalone and owl limpets	MARINe data (three existing sites in Bay)	Annually
Response to Elevated Nutrients	Nutrient levels in discharges onto rocky intertidal sites	No current programs	No current programs
	Percent cover of small, fast-growing opportunistic algae	MARINe long-term monitoring surveys (three existing sites in Bay); biodiversity surveys (four addition sites)	Annually at three sites; Biodiversity surveys done opportunistically at other sites
Biodiversity	Biodiversity survey	MARINe biodiversity surveys	Approximately every five years at three sites; opportunistically at other sites
Foraging Function for Shorebirds	Activity surveys of birds	Presence data collected by Audubon and eBird, but does not capture activity	Opportunistic surveys / research

Table 5.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Invasive Species	Diversity and percentage of intertidal area covered by non-native species	Some inclusion of invasive species information in MARINe surveys, but not comprehensive for this metric	Annually
Human Activities	Intensity of use and activity measured by the number of people in count per unit area (e.g., shore-based fishing, ocean-based fishing)	MPA Watch program data on human activities led by Heal the Bay and LA Waterkeeper (trained community science program)	Opportunistic surveys
Sediment Deposition Events	Proximity to areas with high landslide potential or frequency	No current programs	No current programs
Presence of Disease	Percent of diseased individuals per species per site	Diseased sea stars (and possibly purple urchins) are quantified as part of MARINe surveys	Annually

Table 5.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Habitat Change due to Sea Level Rise	Projected habitat area loss	Could develop and apply existing models to rocky intertidal habitats as a research project (not completed)	Opportunistic research (could complete once and then as models are updated)
Temperature Change (Water and Air)	Surface water temperature	Remote sensing data (satellite); NOAA buoys; National Weather Service data; water temperature collected at three MARINe sites; SCCOOS Santa Monica Pier Station	Satellite data multiple times monthly (when clear); NOAA/NWS data daily or more frequent; MARINe sites annually; SCCOOS data averaged daily
	Air temperature	Weather station data	Multiple times daily
	Dissolved oxygen	No current programs	No current programs
Increased Storminess	Wave height frequency	NOAA/CDIP Scripps buoys	Daily
	Impacts to organisms	Indicator needs development	No current programs
Dissolution of Carbonate Structures (Organismal)	Indicator not developed	No current programs	No current programs

Data Sharing and Reporting

Rocky intertidal monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases like the MARINe database or other similar public data sharing portals.

Data Gaps and Future Studies

Major data gaps identified in the 2015 SotB Report included some indicators that had no data but were identified as priorities such as surfgrass presence and cover, sediment deposition events, presence of disease, and response to human disturbance or long-term monitoring of human activities in general. The extent of surfgrasses may be difficult to survey or quantify due to the depth of surfgrass habitat. While data were available for the development of the SotB Report, much of it came from published research as opposed to being generated by long-term monitoring programs. Additional recommendations included broadening the timing and spatial distribution of existing long-term biological monitoring sites by adding additional MARINe geographic locations and collecting data at MARINe stations on a wider variety of indicators.

New data gaps identified as part of the CMP development included recommendations for new habitat extent categorizations with finer resolution, including typically understudied categories such as coastal armoring, rocky / sandy habitat areas that shift seasonally or over time, and deeper rocky intertidal or lower intertidal zones. Additionally, all climate vulnerability indicators are identified as existing data gaps, and some indicators need to be further developed (e.g., increased storminess, dissolution of organism carbonate structures, projected habitat area loss). Additional gaps in indicators may be filled by emerging technologies such as drone surveys, modeling, or remote sensing data, which should be explored for their potential to help fill more than one data gap. These are all priorities for future monitoring programs. Table 5.5 summarizes priority data gaps identified for the rocky intertidal habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.4 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 5.2-5.5, especially the categories that are "no current programs" and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat. Note that Tables 5.2-5.4 may look complete, but still may have spatial or metric data gaps. New studies that are recommended include building on observational data for extreme tide events, adding monitoring stations or targeted research for many of the indicators above (e.g., percent cover of small, fast-growing opportunistic algae, abundance of upper shore rockweed, etc.), higher resolution / better geospatial coverage for invertebrate taxa data, more detailed spatial / frequency information on human use data such as through drones, in situ chemical and physical data from the rocky intertidal, and incorporation of new modeling efforts.

Many additional opportunities were identified for future studies and research across multiple indicators for this habitat. Drone or other remote survey methods may be used for aerial imagery to fill gaps across multiple indicators but would also require in situ data collection to calibrate or inform the metrics. Water quality and nutrient monitoring are also data gaps, and opportunities exist to develop nutrient input and response models or to collect additional information from storm drain outfall water quality data. For the biological indicators, bird activity and eDNA surveys may provide additional data supporting several indicators. Surveys utilizing eDNA may be especially useful for invasive species tracking and other biological indicators not covered by the MARINe program. A pilot study is recommended to evaluate the potential effectiveness of this survey type. Lastly, studies relating to marine organism physiology or stress responses may provide deeper insight into the stressor evaluation and climate vulnerability.

Table 5.5. Rocky Intertidal Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Rocky Intertidal Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Finer habitat categorization incorporating interspersed or buried rocks under sand, artificial beach armoring structures, jetties, etc.	Special study (new data acquisition, new methods/tools development)	Prop. 50, others (2019 CCMP Finance Plan Action #38)
	Characterization of seasonal or multi-year beach transition between sandy and rocky conditions	Special study (new data acquisition, new methods/tools development)	Prop. 50, others (2019 CCMP Finance Plan Action #38)
Ecological Condition	Expansion (timing and spatial distribution) of existing MARINe monitoring sites	Index component	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Nutrient levels in discharges onto rocky intertidal sites	Single metric; Special study (new data acquisition)	Prop. 50, others
	Biodiversity Survey	Special study (new data acquisition)	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Surveys of birds activity	Single metric; Special study (new data acquisition)	Unknown
Stressor	Diversity and percentage of intertidal area covered by non-native species	Single metric; Special study (new methods/tools development)	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Intensity of use measured by the number of people in count per unit area	Single metric	Unknown
	Proximity to areas with high landslide potential or frequency	Single metric	Unknown
	Percent of diseased individuals per species per site	Single metric	Unknown

Indicator Category	Rocky Intertidal Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Climate Vulnerability	Projected area of habitat loss	Special study (existing data, new data acquisition, new methods/tools development)	Unknown
	Surface and air temperature	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Increased storminess and extreme tide events	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Dissolution of Carbonate Structures (Organismal)	Single metric; special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

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SMBNEP Comprehensive Monitoring Program
Chapter 6 – Sandy Shores

Habitat Introduction

Sandy shores are complex, highly dynamic open coast ecosystems that link marine and terrestrial ecosystems and provide important ecological functions, including increased coastal resilience. For this document, sandy shores are defined as open coast sandy beaches (i.e., not estuaries, enclosed embayments, or mixed rocky beach areas). Sandy shore habitats include the surf zone, the intertidal beach, coastal strand, fore dunes, coastal dunes, and stabilized dunes. Sandy shores are the most prominent habitat along the Santa Monica Bay shoreline, extending for over fifty kilometers (Dobbs and Dorsey 2018). Santa Monica Bay beaches are highly prized for their social uses and their substantial contributions to California's economy, including receiving over 70 million visitors annually, and are also unique and biologically diverse ecosystems when in a more natural, less disturbed condition (Dugan et al. 2016).

When evaluating these habitats, the Bay can be divided into northern (aligned roughly west to east) and southern (aligned roughly north to south) regions at the point where Sunset Boulevard meets the Pacific Coast Highway (PCH). Specifically, in the northern area (north of Sunset Boulevard to the Ventura County line), the shoreline is backed by the Santa Monica Mountains, compressing development between the mountains and a narrow intertidal beach. Exceptions to this northern pattern exist where creek mouths have created additional sandy shore habitats, such as at Topanga, Malibu Lagoon, and Zuma Beach. In the southern region, past beach nourishment projects have created wide sandy expanses such as Santa Monica State Beach, Dockweiler Beach, etc.

Sediment for beaches in this region historically came from watersheds of several short, steep, mostly seasonal streams and erosion of the unstable cliffs and bluffs east of Point Dume. However, sediment input to the system has been reduced dramatically east of Point Dume due to development, including cliff stabilization and dams on Malibu Creek (Orme et al. 2011). Alongshore transport of sediment in this region is south and eastward. In the south (south of Sunset Boulevard to the Palos Verdes Peninsula), the shoreline is backed by coastal bluffs north of the Santa Monica pier, and an extensive back dune system to the south. This stabilized system is known as the LAX Dunes and is managed by City of Los Angeles, LA World Airports. Once a fully developed residential community, the infrastructure has been mostly removed to encourage native dune habitats to recolonize the area.

Development now obscures much of the historical back dune system sitting between beaches and the bluffs in the Bay. Historic sediment sources for beaches in this region came from Ballona Creek or the Los Angeles River, when it flowed out through Ballona

Creek. Now, despite stormwater runoff during rains and some dry-weather flow, Ballona Creek delivers little sediment to nearby beaches due to the heavily channelized watershed and trapped sediments behind debris basins in the upper watershed (Orme et al. 2011).

Sandy shore habitats in Santa Monica Bay are naturally dynamic. On natural intertidal beaches, sand is eroded in fall and winter through wave and storm events, erosion due to south swells, and is deposited in summer during calmer conditions, resulting in dramatic changes in beach slope and width and variations in position of the beach berm and the swash zone. During larger surf and storms, sand is moved offshore to form sandbars and redeposited in calm conditions onshore. Many beaches in the Bay become narrow in the winter and spring months but widen in summer. In coastal strand and dune habitats, wind shifts the sand around, causing natural formation and migration of dunes over time. Aeolian (wind driven) processes are most prevalent in the Bay in the spring months at many beaches.

In the Bay, sandy shore habitats were historically highly productive. The intertidal beach supported up to 90 species of beach endemic macroinvertebrates, including two clam species that previously were abundant enough to support commercial fisheries (Allen and Pondella 2006). Intertidal beaches are also important spawning habitat for the California grunion (*Leuresthes tenuis*), an endemic fish in the silverside family (Martin 2015). California grunion are a unique bare-handed recreational fishery during a portion of the year, but recent declines suggest greater protection is necessary (Martin et al. 2020). Recreational sportfishing also allows for the capture of common species such as corbina, perch, and croaker.

Dozens of species of shorebirds use intertidal beaches and the coastal strand for foraging and roosting. These habitats are also nesting sites for two federally listed birds, the California least tern (*Sterna antillarum browni*, endangered) and the western snowy plover (*Charadrius alexandrinus nivosus*, threatened) (Carreker 1985, Lafferty 2001, U.S. Fish and Wildlife Service 2007). Some Bay beaches are used by wintering flocks of western snowy plover (Ryan et al. 2017), and in 2017 western snowy plovers began nesting on Santa Monica Bay beaches after an absence of nearly 70 years (Ryan et al. 2019), beginning with a nest in the Santa Monica Beach Restoration Pilot Project, a beach restoration implemented by TBF. Finally, coastal dune habitats are home to rare species, such as the silvery legless lizard (*Anniella pulchra*) and endangered El Segundo blue butterfly (*Euphilotes battoides allyni*), that live in native vegetation.

However, sandy beaches are also some of the most disturbed habitats in the Santa Monica Bay and its watershed. Marina development and other major coastal construction projects have altered our historic shorelines (Flick 1993). All the stabilized back dune systems are disconnected from beach habitats by roads and parking lots (Cooper 1967). In many places, the shoreline has been further altered to maximize the width of the dry sand areas through beach nourishment or other physical alterations that are beneficial for recreational uses, but also bury beach and coastal strand habitats and species (Flick 1993, Orme et al. 2011). Regular grooming (raking and grading of sand) to remove trash and kelp wrack above the wet sand eliminates a large proportion of the native invertebrate species and prevents the establishment of coastal strand plants and the formation of coastal dunes. Infrastructure, such as roads, bike paths, volleyball courts, groins, and jetties, also alter the natural movement of sand and the formation of coastal dunes. These activities have left most sandy beach ecosystems in the Bay less able to provide physical and ecological services, dramatically reducing the number of species they support (Dugan and Hubbard 2009, Schooler et al 2019). However, it is important to recognize the cultural and economic value of these beaches to people as a component of this monitoring program, especially as California beaches are public and many are within a few miles of disadvantaged or underserved communities.

Recent research on storm and El Niño impacts to shorelines warns of climate change related effects in the future due to sea level rise and coastal erosion. Local studies such as the Los Angeles County Department of Beaches and Harbors SLR Vulnerability Study from 2016 and recent modeling conducted by local municipalities such as City of Santa Monica and City of Manhattan Beach project drastic potential for flooding and beach loss due to erosion. Some beaches have 100% loss projected by 2100, and others have significant infrastructure vulnerable to flooding (e.g., lifeguard facilities, restrooms, parking lots, roads and access paths, etc.). Recreational opportunities such as volleyball courts, surf camps, and others are also vulnerable. Monitoring data are important to assist in developing triggers and thresholds for potential adaptive actions to prevent loss or impacts from occurring.

Southern California beaches, in general, are very different than they were a century ago. Much of the Southern California coastline is now armored (e.g., seawalls, riprap) (Patsch and Griggs 2007). A majority of the easily accessible beaches are mechanically raked and graded, and the sediment deficit for beach sand budgets has been over a million cubic meters of sand per year for more than 50 years (Patsch and Griggs 2007; Gittman et al. 2015; Orme et al. 2011). The understanding of physical dynamics and long-term changes in the extent of beach habitats in Southern California is relatively detailed and advanced. The interpretation of decades of aerial photographs and comparisons to mapping done from the 1850s to the 1870s has provided a good basis for quantifying beach change over time (Orme et al. 2011). The effects of reductions in sediment supply caused by dams to the state's beaches have also been quantified (e.g., Willis and Griggs 2003). Shoreline change has been quantified more recently with NOAA and USGS studies using modern technology such as LiDAR (Hapke et al. 2009).

Ecological research in the Southern California Bight over the last decade has identified and quantified two of the major stressors on sandy beach ecosystems in the region: beach grooming (Dugan et al. 2003, Schooler et al. 2017, 2019), and coastal armoring (Dugan et al. 2008, Jaramillo et al 2020). A major gap in the understanding of the ecological impacts of beach nourishment is currently limiting the ability to accurately inform coastal policy and management. A major, long-term (~1970–1978) ecological survey effort of many beaches in the Southern California Bight followed the 1969 Santa Barbara oil spill. Many of these beaches have been re-surveyed in recent years, and comparative analyses of changes in the intertidal species richness of beaches across more than three decades suggest that local-scale human impacts are a stronger driver of biodiversity loss than regional processes (Schooler et al. 2017). Santa Monica Bay's urban beaches rank very low overall in species richness, compared to reference beaches with impacts detected over the entire intertidal zone (Schooler et al 2019). Assessing how far the baseline has shifted for beach ecosystems over longer time periods is challenging (e.g., Tomašových et al. 2017), since beach grooming and other major manipulations of beaches began in the 1940's in many areas of the Bay. However, a historical ecology analysis by Hubbard et al. (2014) of distribution patterns for two species of beach invertebrates over several decades in the Bight found that they had been extirpated from about 60% of their historically occupied beaches in the Bight, including all former sites in the Santa Monica littoral cell.

While research in Southern California on shoreline processes, restoration activities, and impacts caused by human activities on the ecological processes of intertidal beach habitat is extensive, ecological monitoring across all the zones in sandy shore habitat, from back dunes out to shallow subtidal, and encompassing the full range of ecosystem services is remarkably limited in California (Dugan and Hubbard 2016), and particularly in Santa Monica Bay (Foreman et al. 2015). While monitoring programs for selected individual species of wildlife that are listed as threatened or endangered exist, more comprehensive ecological monitoring is needed to establish baselines, track trends and evaluate change and impacts to sandy shore habitats.

Outreach and education, including citizen science programs, are also needed. For single species, such as California grunion, there are some outstanding citizen science programs in the Bay, including the Grunion Greeters (Martin et al. 2020). In MPAs, the MPA Watch program provides information on human activities, particularly extractive activities like fishing. Locations are limited, including Point Dume and several others. To help provide some basic data on a broader range of species and zones, a pilot citizen science program, called All Ashore, was developed and pilot tested (Martin et al. 2020). In this program, scientists collaborated with and trained volunteers to assess physical and biological features of beaches, human uses, current management policies, and coastal development. However, this program has not been funded for long term use. Professional-level quantitative data are also needed to provide more fine-tuned information. Monitoring of sandy shore habitats in Marine Protected Areas will help, but these studies are limited to intertidal beach habitats in specific locations. The 2015 State of the Bay (SotB) Report identified a significant need for quantitative scientific ecological monitoring in sandy shore habitats and an overall data gap for this widespread ecosystem.

In recent years (2016-2020), LMU's Coastal Research Institute and TBF have initiated several new programs to collect sandy shore data. One effort led by Dr. John Dorsey of LMU / CRI aims to characterize the biological and physical conditions of Santa Monica Bay beaches through opportunistic surveys along a broad geospatial area. Additional efforts led by TBF collect long-term monitoring data associated with specific beach restoration and living shoreline projects at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches, with several other locations seeking funding.

Much of the introductory information for sandy shores in this chapter was replicated and updated from information in the 2015 SotB Report (Foreman et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of sandy shore habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting sandy shores?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with sandy shores?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

Many additional potential indicators for sandy beach ecosystems were identified by the working group, including other biological groups of organisms, but the list was scaled down considerably to meet the habitat framework and to achieve a reasonable scope for the monitoring program. Indicators were prioritized to capture biological responses to various stressors across a range of types of wildlife and biota (e.g., inclusion of plants, invertebrates, birds, fish). Some of the challenges for this habitat were to acknowledge sandy beaches as providing recreational, health, and spiritual value to humans as well as their ecological functions. In some cases, anthropogenic services and natural functions of the systems may be in conflict or considered as a stressor, but it is important to recognize, especially for this habitat, that the beaches provide many benefits and services to people. Additional challenges for this habitat include considerations for the variability in how to define the area, and the extreme seasonal variability of the systems, and potential for future beach loss due to climate change stressors. Thus, physical and topographic change were also important to capture.

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The sandy shore habitat includes 15 indicators across four categories which will be used to detect changes in this environment (Table 6.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales. Note that the indicator list is not intended to be comprehensive or exhaustive, rather it is intended to be representative to capture extent, condition, and trends over time for this habitat.

Table 6.1. Indicators for sandy shore habitats in the Santa Monica Bay region.

Indicator Category	Sandy Shore Indicators
Habitat Extent	Area of Sandy Shore Habitats
Ecological Condition	Nursery and Habitat Provisioning for Fish
	Foraging Function for Birds
	Nursery and Roosting Function for Rare Birds
	Invertebrate Food Web Support
	Native / Invasive Flora
Stressors	Anthropogenic Infrastructure / Beach Hardening
	Habitat Protection
	Human Activities
	Beach Management Practices
	Beach Water Quality
Climate Change Vulnerability	Shoreline Erosion / Topography Change
	Nearshore Surface Water Temperature
	Coastal Flooding
	Hazard / Disturbance Response

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators for sandy beach ecosystems over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of beach habitats providing ecosystem functions by type (e.g., coastal strand, dunes, intertidal sand etc.); mapping and proportions of human use or specific recreational areas; biologically relevant or sensitive habitat areas; and location and mapping of back dune systems. Various geospatial layers can be used to inform this indicator, including grooming data from LACDBH, mapping data from CRI's beach characterization study, and other mapping data such as opportunistic research programs conducted by USC Sea Grant or other entities. Aerial photographs, such as from the California Coastal Records Project (www.californiacoastline.org), may also serve to inform this indicator or others below. In general, except for seasonal variations in beach width and sediment movement, data layers for habitat extent are unlikely to frequently exhibit substantial changes, but may be updated annually, biennially, or as new policies are put into effect.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 6.2, 6.3, and 6.4, respectively.

With the exception of the beach monitoring program led by CRI, data collected to inform trends associated with various indicators are often informed by monitoring or research programs that are conducted opportunistically or not comprehensive throughout the Santa Monica Bay. For example, regular UCSB surf zone fish surveys are only conducted on Leo Carrillo State Beach and Point Dume Beach, Malibu, and rare bird surveys for California least terns and western snowy plovers are only conducted on beaches they are known to use for roosting or nesting. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state "opportunistic surveys / research" or "no current programs" in the tables below as they may not currently be funded programs.

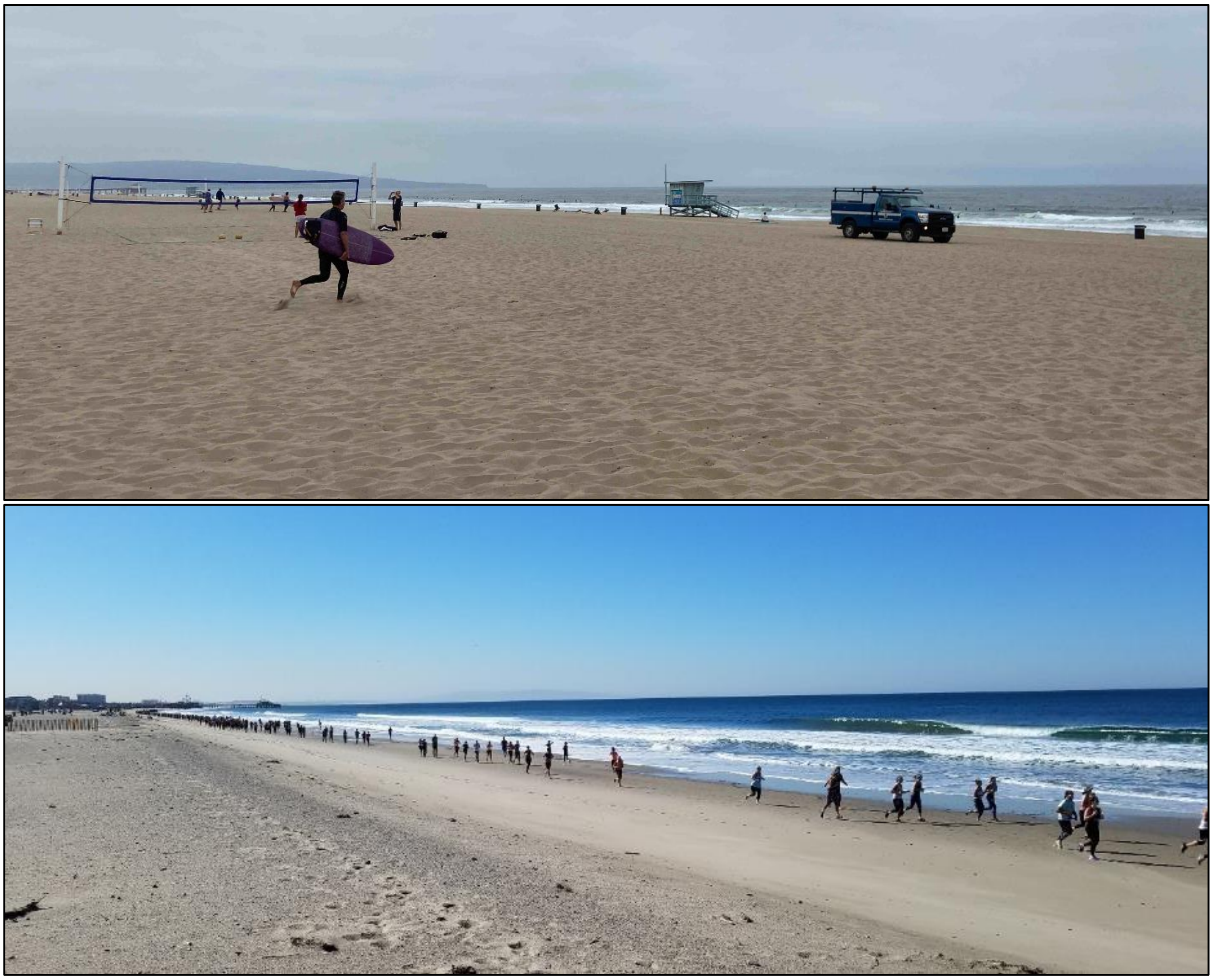

Figure 6-1. Groomed beaches in Santa Monica Bay with various recreational activities and driving occurring (top) and a marathon event (bottom, credit both: TBF).

Figure 6-2. Back dune in Manhattan Beach with invasive iceplant and groomed beach to the west (right) (credit: TBF).

Figure 6-3. Santa Monica Beach Restoration Pilot Project with native vegetation approximately four years after restoration (credit: TBF).

Table 6.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Nursery and Habitat Provisioning for Fish	Median grunion run size over time; grunion run distributions and geographic range	Pepperdine University (Grunion Greeters program) led by Dr. Karen Martin	Runs monitored by citizen scientists opportunistically annually between March and August
	Abundance, composition, and size structure of surf zone fish	Quantitative surf zone surveys (nearshore seines and motion cameras) collected in MPAs and reference sites (Point Dume SMR, Leo Carrillo State Beach) led by Dr. Jenny Dugan, UCSB	Three times annually at Point Dume SMR and Leo Carrillo State Beach
		Vantuna Research Group surf zone data (Occidental College) collected at several locations in the Bay; some research by Dr. Chris Lowe's Lab at CSULB	Annually; opportunistic Lowe research
Foraging Function for Birds	Presence and abundances of resident and migratory bird species	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
		Quantitative bird, wrack and beach characteristics surveys collected in MPAs and reference sites (Point Dume SMR, Leo Carrillo State Beach) led by Dr. Jenny Dugan UCSB	August – January monthly surveys (Point Dume SMR, Leo Carrillo State Beach)
		e-bird data (quality control checked citizen science)	Opportunistic data collection
	Bird activity observations	Audubon Christmas Counts (long-term data); some data collected by TBF / CRI associated with living shoreline projects; research projects (not comprehensive)	Annually in winter; Opportunistic surveys / research

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Nursery and Roosting Function for Rare Birds	Western snowy plover and California least tern abundances (roosting) over time	Plover and tern abundances and locations conducted by LA Audubon Society and Ryan Consulting	Monthly surveys
		Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Opportunistic surveys / research
	Western snowy plover and California least tern number of nests and successfully fledged chicks	Breeding bird surveys conducted by LA Audubon Society and Ryan Consulting	Monthly surveys during breeding season
	Sand crab and beach hopper zone fauna in intertidal areas	Schooler, Dugan, and Hubbard unpublished data (UCSB); MPA monitoring data (UCSB)	Opportunistic research; three times annually at Point Dume SMR and Leo Carrillo State Beach
	Food web support index	Schooler, Dugan, and Hubbard unpublished data (UCSB); MPA monitoring data (UCSB)	Opportunistic research; three times annually at Point Dume SMR and Leo Carrillo State Beach
	Indicator species (e.g., bean clams as an indicator of warmer waters)	Schooler, Dugan, and Hubbard unpublished data (UCSB); MPA monitoring data (UCSB)	Opportunistic research; three times annually at Point Dume SMR and Leo Carrillo State Beach
Native / Invasive Flora	Presence / cover of native vegetation; presence / cover of invasive vegetation	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	Wrack cover / presence by species; presence of invasive *Sargassum horneri*	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
		Wrack data collected by UCSB at Leo Carrillo State Beach and Point Dume	August – January monthly surveys and with all fish surveys (Point Dume SMR, Leo Carrillo State Beach) UCSB

Table 6.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Anthropogenic Infrastructure / Beach Hardening	Percentage of shoreline that has been armored; number, location, and type of infrastructure (e.g., pier, jetty, groin)	Dorsey beach characterization study results and mapping data; NOAA Office of Oil Spill Response and Restoration (Environmental Sensitivity Mapping)	Once and then tracking as infrastructure is changed over time
	Percentage of beach shoreline with beachfront infrastructure; number and location of structures and beach facilities	Dorsey beach characterization study results and mapping data; NOAA Office of Oil Spill Response and Restoration (Environmental Sensitivity Mapping)	Once and then tracking as infrastructure is changed over time
	Sand transport via wind direction and speed	National Weather Service – many stations throughout SM Bay	Hourly; downloaded as needed
Habitat Protection	Percentage of habitats under various levels of protection (e.g., grooming practices, MPA areas)	MPA area data from CDFW; maps of fenced areas (e.g., Santa Monica Beach pilot, Venice Least Tern Colony)	Once and then tracking as practices are changed over time
		Beach grooming data from LACDBH	Once and then tracking as practices are changed over time
Human Activities	Numbers, locations, and types of events on beaches (e.g., camps, cultural events, sports, trainings)	County Beach Commission – groups of over eight people or classes must register	As occurring
	Beach driving and other vehicle disturbance factors	County lifeguard data or LACDBH	Unknown
	Off-leash dogs on the beach	County lifeguard data and Audubon records	Opportunistic surveys / research
	Recreational fishing activities	Heal the Bay outreach surveys; MPA Watch; CDFW	Opportunistic surveys / research

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Beach Management Practices	Volume of dredge and fill for beach replenishment / nourishment	Army Corps data for locations of dredging and nourishment areas	Every few years or as needed
	Beach grooming activities	LACDBH activity logs and efforts (equipment used, weight and disposal of materials collected), varies by beach	Data collected daily; provided as requested from LACDBH
	Seasonal winter berm construction	See LACDBH winter berm report for details on locations	Annually between October and March
	Grunion protection zones / high tide line wrack protection	Pepperdine and LACDBH data	Annually between March and August
	Vegetation protection areas	Dorsey CRI beach characterization study results and mapping data	Opportunistic surveys / research
	Snowy plover protection zones (fencing, enclosures, signage)	Audubon Society (several chapters)	As occurring
	Fire safety, rings, and illegal bonfires	State Parks and LACDBH	Unknown
Beach Water Quality	Long-term FIB trends	Heal the Bay Beach Report Card data; outfall monitoring data by County and City	Daily
	Nutrient inputs and limitations	SCCOOS Santa Monica Pier Shore Station	Daily, calibrated monthly
	Temperature	SCCOOS Santa Monica Pier Shore Station	Daily, calibrated monthly

Table 6.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Shoreline Erosion / Topography Change	Beach width change; volume accretion / erosion	USGS models; Holland study - SLR/erosion	Opportunistic surveys / research
		aerial imagery; remote sensing data / NASA public data sets; LiDAR data over time	Opportunistic surveys / research
		Data on beach zone distribution, slopes, and widths collected by UCSB at Leo Carrillo State Beach and Point Dume for MPA monitoring	Three times per summer
		Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	New dune formations	Data collected by TBF / CRI associated with living shoreline projects and beach characterization studies	Semi-annually at Santa Monica, Zuma, Point Dume, Manhattan, and Dockweiler Beaches; opportunistic surveys at other beaches
	Outflow or runoff change / storminess	Possible LACDPW data	Unknown
	Slope and berm morphology (nearshore processes and beach face)	No current programs	No current programs
	Wave height and period	NOAA buoy data	Hourly

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Nearshore Surface Water Temperature	Surface water temperature	SCCOOS SM Pier data; National Weather Service offshore station data	Daily; calibrated monthly
	Larval abundance	No current programs	No current programs
Coastal Flooding	Sea level rise vulnerability	Apply CoSMoS/OCOF tool to model ecosystem responses (see Myers et al. 2017); apply CRI Site Suitability Model analyses	Opportunistic surveys / research
	Frequency and location of flooding events	CoSMoS/OCOF tool for southern California, CRI Site Suitability Model study; king tide citizen science surveys by USC Sea Grant	Opportunistic surveys / research
	Infrastructure vulnerability	Apply CRI Site Suitability Model analyses; king tide citizen science surveys by USC Sea Grant; Vulnerability studies conducted by LACDBH (2016), City of LA, City of Manhattan Beach, USC Sea Grant (2017) and other coastal municipalities	Opportunistic surveys / research
Hazard / Disturbance Response	Intensity of disturbances, e.g., aftermath of major storm events; modeling El Niño events and responses	Before / after LiDAR data and scans; side-scan sonar	Infrequent – every few years
		Opportunistic modeling research	Opportunistic surveys / research

Data Sharing and Reporting

Sandy shore monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually as appropriate. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases like the grunion monitoring portal (www.grunion.org) or other similar public data sharing portals. The non-profit Beach Ecology Coalition shares information with beach managers, resource agencies, lifeguards, and others at its semi-annual meetings.

Data Gaps and Future Studies

Former data gaps identified for sandy shore habitats by the 2015 SotB Report were extensive for sandy shores, including the indicator and metrics associated with the habitat extent category. However, significant progress has been made in recent years on the characterization of sandy shore habitats in the Santa Monica Bay led by Dr. John Dorsey, LMU and CRI, and by TBF. These new data will be reflected in SMBNEP's next SotB Report. Additional data gaps identified in the 2015 SotB Report include all or portions of the following indicators: beachfront protection, areas of development, armoring trends, sediment supply, beach management practices, nutrient inputs, invasive species, and trend data for native flora and fauna. Though some of these indicators have been evaluated and updated for this revised CMP, many of them continue to be reflected in Tables 6.2-6.4 as important condition metrics with data gaps.

Additionally, several indicators have some data (e.g., invertebrates, temperature) in specific locations, but not enough for broad scale trends throughout the Bay. There are other indicators such as "coastal flooding" that have partial data for a particular element such as tidal flooding, but a full data gap in the form of storm flooding on back beach areas or around infrastructure. "Best management practices" has similar gaps. There are also several indicators that need development and are without current monitoring programs, e.g., slope and berm morphology and larval abundance.

Several new metrics associated with the new "climate change vulnerability" category are also identified in the tables above as data gaps (e.g., marine larval studies associated with surface water temperature, comprehensive assessments of sediment change or movement, and many others such as nearshore bathymetry studies or detailed information on human impacts). Table 6.5 summarizes priority data gaps identified for the sandy shores habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.5 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 6.2-6.5, especially the categories that are “no current programs” or “unknowns” and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat. Note that Tables 6.2-6.4 may look complete in areas, but still may have spatial or metric data gaps. New studies that are recommended include building on observational data for extreme tide events, adding monitoring stations or targeted research for many of the indicators above (e.g., surfzone fishes), higher resolution / better geospatial coverage for invertebrate taxa data, more detailed spatial / frequency information on beach best management practices, and incorporation of new modeling efforts. Innovative ideas such as 3D mapping to detect shoreline change or dune formation, or single-beam or side-scan sonar in the nearshore environment to track seasonal shifts in sediment movement or sediment loss should also be explored. Lastly, developing indices and a rapid assessment framework for sandy shore surveys that could be applicable across the Southern California Bight or even standardized at the state level would allow for additional cross-comparisons of data and consistent analyses.

Additional future studies could contribute to a potential future revision of the indicator list, including indicators that were identified by the expert workgroup, but not included in this document. Examples of these new indicators could include marine mammal pupping or strandings, wrack cover and diversity, sediment grain size, microplastics, and other constituents of concern.

Table 6.5. Sandy Shores Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Sandy Shores Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Additional information on beach width, extent, and seasonal variation	Special study (supplement existing data)	USEPA, CRI, Sea Grant, Universities, NASA/JPL
Ecological Condition	Additional monitoring locations for surfzone fishes, and other native fauna	Index component; Single metric	OPC-MPA, UCSB, others
	Higher resolution / better geospatial coverage for invertebrate taxa data	Index component	OPC-MPA, UCSB, others
	Long-term trend data for Invasive flora	Single metric	OPC-MPA, UCSB, others
	Indices and rapid assessment framework for sandy shore surveys	Index development	Prop. 50, others
Stressor	Long-term tracking of percentage change of anthropogenic Infrastructure / Beach Hardening (beachfront protection, development, and armoring, etc.)	Index component	LACDBH, USGS, NOAA, others
	Detailed and expanded information on human impacts	Single metric; Special study (existing data, new data acquisition)	Unknown
	More detailed spatial / frequency information on beach management practices	Index component	LACDBH, others
	Data on nutrient inputs and limitations	Single metric	Unknown

Indicator Category	Sandy Shores Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Climate Vulnerability	New modeling efforts and innovative mapping to detect and assess shoreline change or dune formation, track seasonal shifts in sediment movement or sediment loss	Special study (new data acquisition, new methods/tools development)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Slope and berm morphology	Special study (new data acquisition)	Unknown
	Larval abundance studies associated with surface water temperature	Special study (new data acquisition)	Unknown

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SMBNEP Comprehensive Monitoring Program
Chapter 7 – Coastal Wetlands

Habitat Introduction

Coastal wetlands are low-lying areas of land that are frequently and regularly inundated with fresh and/or ocean water. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils (USEPA CWA Section 404). They are habitats that can be perennially open to the ocean (e.g., Ballona Creek Estuary) or function instead as bar-built lagoons that only have an intermittent connection to the ocean (e.g., Malibu Lagoon). Coastal wetlands often include vegetated habitats such as salt marsh wetlands and unvegetated habitats such as salt pans and mudflats. Additionally, the systems may have adjacent brackish or freshwater wetlands that do not always have a direct connection to the ocean. Coastal wetlands included in this assessment are predominantly estuarine wetlands and bar-built lagoons.

The largest set of coastal wetland habitats in the Santa Monica Bay watershed is within the approximately 577-acre Ballona Wetland Ecological Reserve ("Reserve"). The Reserve contains wetlands, adjacent salt flats, freshwater, and upland habitats that were primarily former salt marsh habitats (Dark et al. 2011). Located in the eastern portion of the Bay at the mouth of Ballona Creek and situated between Los Angeles International Airport and Marina del Rey, this area is part of a historic and large wetland complex of over 2,000 acres that included Lower Ballona Creek, Marina del Rey, Ballona Lagoon, Del Rey Lagoon, Oxford Flood Control Basin, portions of Venice Beach and the Venice Canal system, and other adjacent subtidal and freshwater marsh habitats (USEPA 2012). These remaining pieces of the former complex still exist as hydrologically distinct separate systems, and in some cases (e.g., Marina del Rey) have been completely converted to other habitat types (e.g., subtidal).

The Ballona Wetlands Restoration Project, a large-scale effort to rehabilitate the Ballona Wetlands Ecological Reserve, is currently in the planning and permitting stages. In December 2020, the State certified the Final Environmental Impact Report for the site, with CDFW as the lead agency (CDFW 2019). Next steps include the Army Corps finalizing the Environmental Impact Statement and continuing permitting. Additionally, smaller-scale restoration efforts to remove invasive species at the Reserve have been led by Friends of Ballona Wetlands, TBF, and CDFW.

In the north region of the Bay, several smaller wetlands are present. Largest among these is Malibu Lagoon, followed by Zuma Lagoon, Lower Topanga Creek and Lagoon, and Lower Trancas Creek. All these smaller systems are periodically or permanently closed to the ocean.

Coastal wetlands are among the most productive ecosystems, providing an essential habitat for a variety of species, including birds, fish, reptiles, invertebrates, mammals, and vegetation. In addition to the species common to most coastal wetlands in Southern California, the Bay's wetlands are home to several protected species, including, but not limited to, Belding's savannah sparrow (*Passerculus sandwichensis beldingi*, state endangered species), Tidewater Goby (*Eucyclogobius newberryi*, federal endangered species), and Southern Steelhead Trout (*Oncorhynchus mykiss irideus*, federal endangered species).

Urban development, oil and gas exploration, the construction of Marina del Rey, channelization, dredging, filling, and other human activities have reduced wetland acreage in the Bay watershed. While federal and state policies are in place to minimize future loss, and while much of the remaining habitat is under public ownership, restoration efforts are critical to preserving the diversity found in these habitats.

Over the past decade, TBF has led efforts to collect data at the Ballona Reserve and Malibu Lagoon, contributing to the long-term data sets for these systems. Although the comprehensive baseline monitoring program for the Reserve ended in 2015, targeted studies to inform the indicators below should be repeated. Additional efforts led by State Parks and Resource Conservation District of Santa Monica Mountains (RCDSMM) have started to collect data on several of the smaller systems in the northern Bay.

Much of the introductory information for coastal wetlands in this chapter was replicated and updated slightly from information in the 2015 SotB Report (Ambrose et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of coastal wetland habitat in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of this habitat and how has it changed over time?
3) What are the major stressors impacting coastal wetlands?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with coastal wetlands?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

The coastal wetland working group utilized and prioritized standardized data condition metrics where possible (e.g., California Rapid Assessment Method, CRAM), to allow for consistency in data collection and analysis. Additionally, the expert scientists identified existing monitoring programs for this habitat and prioritized indicators across a range of biological and physical parameters. Wetlands are well studied as a habitat type, and major stressors are commonly known. Some of the challenges for this habitat were due to a type conversion of wetlands into other habitats such as uplands, and the issues associated with coastal wetland loss and development over time. Additionally, recent regulatory changes to definitions of wetlands have occurred at both a federal and state level, which may cause challenges for cross-referencing data over time. Climate vulnerability was informed by the Climate Change Vulnerability Assessment (CCVA) conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The coastal wetland habitat includes 16 indicators across four categories which will be used to detect changes in the environment (Table 7.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales. Note that the indicator list is not intended to be comprehensive or exhaustive, rather it is intended to be representative to capture extent, condition, and trends over time for this habitat.

Table 7.1. Indicators for coastal wetland habitats in the Santa Monica Bay region.

Indicator Category	Coastal Wetland Indicators
Habitat Extent	Area of Wetland Habitats
Ecological Condition	Trophic Food Web Support and Pollution Tolerance Index
	Nursery and Habitat Provisioning for Fish
	Forage and Breeding Function for Birds
	Habitat Structure and Complexity
	Vegetation Community (Change)
Stressors	Eutrophication
	Sedimentation and Contamination
	Anthropogenic Disturbance and Land Use
	Altered Hydrology
	Physical Structure
Climate Change Vulnerability	Inundation
	Change in Freshwater Input to System / Flow
	Estuary Mouth Dynamics
	Dissolution of Carbonate Structures (Organismal)
	Ecosystem Metabolism

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of coastal wetland habitats providing ecosystem functions by type (e.g., perennial estuarine, bar-built estuary, unvegetated salt marsh, etc.); estimates of type-conversion or loss over time; and using jurisdictional wetland delineation data. Data may be acquired from historical topographical maps (referred to as t-sheets) data, categorizations through the Southern California Wetland Recovery Project archetypes, National Wetland Inventory data, and site-specific sources such as jurisdictional delineations. Aerial photographs such as from the California Coastal Records Project (www.californiacoastline.org) may also serve to inform this indicator or others below. In general, due to the protections afforded wetland systems in the State of California and the public ownership of many of the wetland systems in the Bay, this metric is unlikely to vary considerably in the future unless large scale restoration actions are taken. Data should be updated every few years or after major restoration activities.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 7.2, 7.3, and 7.4, respectively.

Data collected to inform trends associated with various indicators are often informed by monitoring or research programs that are conducted opportunistically, as components of restoration planning efforts, or not comprehensive throughout the Santa Monica Bay. For example, site-intensive baseline studies are being conducted beginning in 2020 at Topanga Lagoon to inform restoration planning for that site. Similarly, long-term data were collected at Malibu Lagoon through early 2019 (Johnston et al. 2019), which informed restoration trajectories and evaluated success criteria. New data at Malibu Lagoon will be collected in conjunction with the Estuarine MPA Monitoring program. There may be opportunities to integrate future Bight data as well. Note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs.

Figure 7-1. Topanga Lagoon, in Malibu, a small bar-built estuary (credit: TBF).

Figure 7-2. Malibu Lagoon, a small bar-built estuary, approximately six years after restoration. Top: low tide photograph looking towards estuary mouth; bottom: interpretive element intentionally covered during estuary mouth closure (credit: TBF).

Figure 7-3. Area A uplands in the Ballona Wetlands Ecological Reserve (credit: TBF).

Figure 7-4. Area B muted tidal channel in the Ballona Wetlands Ecological Reserve (credit: TBF).

Table 7.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Trophic Food Web Support and Pollution Tolerance Index	Pollution toleration indices for invertebrates	M-AMBI index data collected by SCCWRP; Bight Survey Program data collected by SCCWRP and partners	Opportunistic surveys / research
	Fish community assessments	Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Semi-annually
	Benthic invertebrate community	Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Semi-annually
	eDNA data	SCCWRP	Opportunistic surveys / research
Nursery Habitat Provisioning for Fish	Presence and size categories of estuarine fish	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; data collected by RCDSMM and UCLA; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA data semi-annually; others opportunistic
	Tidewater gobies, steelhead trout	Long-Term Steelhead Trout surveys by RCDSMM; Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; additional data collected by RCDSMM and UCLA; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA data semi-annually; RCDSMM steelhead surveys annually; others opportunistic
	SAV physical and biological characteristics	No current programs	No current programs
	Presence and size of macro invertebrates (e.g., crabs, shrimp)	Some data collected in conjunction with fish seining surveys (see above)	No current programs

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Forage and Breeding Function for Birds	Activity surveys of birds	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs	EMPA data semi-annually; others opportunistic
	Breeding surveys of Belding's Savannah Sparrow	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; eBird data	Opportunistic surveys / research
Habitat Structure and Complexity	CRAM index values for the biotic structure component	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; RCDSMM data for Topanga; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Previously conducted annually, now opportunistically; Topanga opportunistic; EMPA CRAM annually
Vegetation Community (Change)	Native/non-native vegetation cover change over time	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA CRAM data annually; others opportunistic
	Rare species presence/area	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs	Opportunistic surveys / research
	Codominant species or vegetation assemblages (vegetation mapping, CRAM)	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA CRAM data annually; others opportunistic
	Percent invasion (CRAM)	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA CRAM data annually; others opportunistic

Table 7.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Eutrophication	Dissolved Oxygen	Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA data downloaded monthly
	Submerged Aquatic Vegetation and algae cover	Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA data semi-annually
	Nitrogen and phosphorous levels	Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	EMPA data semi-annually
Sedimentation and Contamination	Concentrations of various contaminants in sediments (e.g., organics, heavy metals, trash)	No current programs	No current programs
	Channel cross-sections and flood-plain elevation	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs	Opportunistic surveys / research
Anthropogenic Disturbance and Land Use	CRAM index values for the buffer and landscape context component	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Opportunistic surveys / research; EMPA CRAM data annually

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Altered Hydrology	Flow	Flowmeters	Opportunistic surveys / research
	CRAM index values for the hydrology component	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Opportunistic surveys / research; EMPA CRAM data annually
Physical Structure	CRAM index values for the physical structure component	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs; Estuarine MPA data from Malibu Lagoon collected by CSULB and partners	Opportunistic surveys / research; EMPA CRAM data annually

Table 7.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Inundation	Water surface elevation and inundation area/time	Deployed water quality sondes (e.g., Hydrolab, YSI) in Malibu Lagoon as part of EMPA surveys (CSULB); deployed sonde in Topanga (RCDSMM)	EMPA and RCDSMM data downloaded monthly
	Key species distribution changes	Data collected by TBF / CRI associated with Ballona Wetlands monitoring programs; EMPA surveys in Malibu Lagoon (CSULB)	Opportunistic surveys / research; EMPA data semi-annually
	Adjacent buffer and adjacent habitat (CRAM)	Data collected by TBF / CRI associated with Malibu Lagoon and Ballona Wetlands monitoring programs	Opportunistic surveys / research
	SLR and thresholds of submergence	No current programs	No current programs
Change in Freshwater Input to System / Flow	Flow	Flowmeters	Opportunistic surveys / research
	Stream gauge data	LA County Public works stream gauges (5 min interval data loggers in multiple locations)	Data available upon request
	Salinity regimes	Deployed water quality sondes (e.g., Hydrolab, YSI) in Malibu Lagoon as part of EMPA surveys (CSULB); deployed sonde in Topanga (RCDSMM)	EMPA and RCDSMM data downloaded monthly
Estuary Mouth Dynamics	Frequency and length of closure of mouth opening	Satellite imagery (NASA/JPL)	Opportunistic surveys / research
		Camera stations or water level sensors for water surface elevation	Unknown
		Elevation/LiDAR/Bathymetry for estuary mouth dynamics	Opportunistic surveys / research

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Dissolution of Carbonate Structures (Organismal)	Indicator not developed	No current programs	No current programs
Ecosystem Metabolism	Net balance of O_2/CO_2	No current programs	No current programs
	Dissolved oxygen and salinity	Deployed water quality sondes (e.g., Hydrolab, YSI) in Malibu Lagoon as part of EMPA surveys (CSULB); deployed sonde in Topanga (RCDSMM)	EMPA and RCDSMM data downloaded monthly
	Temperature (water) or SST	Deployed water quality sondes (e.g., Hydrolab, YSI) in Malibu Lagoon as part of EMPA surveys (CSULB); deployed sonde in Topanga (RCDSMM)	EMPA and RCDSMM data downloaded monthly

Data Sharing and Reporting

Coastal wetland monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases like the California Rapid Assessment Method database or other similar public data sharing portals.

Data Gaps and Future Studies

Former data gaps identified for wetland habitats by the 2015 SotB Report were extensive, including a lack of development of most of the biological response indicators such as benthic invertebrate community, nursery function for fish, and forage function for birds. However, long-term datasets collected by TBF and partners at the Ballona Reserve and Malibu Lagoon began filling some regional gaps from previous monitoring periods. Additional data gaps identified in the 2015 SotB Report include all of the vulnerability indicators (not developed) and the biological response indicators (not developed). Some of these indicators have been evaluated and updated for this revised CMP and are reflected in Tables 7.2-7.4 as condition metrics. Several new metrics associated with the new "climate change vulnerability" category were identified in the tables above as data gaps (e.g., pCO_2, species migration, tracking bar-built estuary mouth closure patterns, camera stations or water level sensors for water surface elevation). Several indicators need to be more fully developed, such as 'SLR and thresholds of submergence' and 'dissolution of carbonate structures'. These indicators need metrics developed, monitoring plans compiled, and data to be collected.

Although Malibu Lagoon will be monitored as part of the Estuarine Marine Protected Area grant for at least one year with data evaluated and compared to previous monitoring data, most of the other wetland systems, including the Ballona Reserve, have no funding for long-term monitoring of any of the indicators listed in the tables above. Thus, while there was a substantial amount of new data included in the 2015 SotB Report, most of these systems still have temporal data gaps for many of the indicators in recent years. Most of the smaller systems in the northern Bay (e.g., Zuma, Big Sycamore, Trancas) have some opportunistic data collected associated primarily with tidewater gobies or steelhead trout surveys, but they are largely understudied and remain as a significant data gap for most of the indicators. Additionally, there are some indicators that have a lack of identified data collection for most or all sites (e.g., contaminants, SAV monitoring, ecosystem metabolism). Table 7.5 summarizes priority data gaps identified for the coastal wetlands habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.6 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 7.2-7.5, especially the categories that are "unknowns" and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat. Note that Tables 7.2-7.4 may look complete, but still may have spatial or metric data gaps. New studies that are recommended include habitat extent assessments for the smaller lagoon systems, assessments of commercially or recreationally important fish species, rare plants or birds, eutrophication studies, tracking plant invasions, hydrology studies especially associated with climate change stressors, and many others.

Table 7.5. Coastal Wetlands Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Coastal Wetlands Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Habitat extent assessments for the smaller lagoon systems	Special study (new data acquisition)	Prop. 50, others
Ecological Condition	Long-term monitoring of all indicators/indices (CRAM) Ballona Wetlands and Malibu Lagoon	Index component; Single metric	CDFW, others
	Baseline assessment for most indicators and long-term monitoring for all indicators/indices (CRAM) for most smaller systems in the northern Bay (e.g., Zuma, Big Sycamore, Trancas, many others)	Index component; Special study (new data acquisition)	Prop. 50, others
	Native/non-native vegetation cover change over time	Index component; Single metric	Unknown
	Survey of the condition (presence/area) of commercially or recreationally important fish species, rare plants or birds	Index component; Single metric	Unknown
Stressor	Long-term monitoring of all indicators/indices	Index component; Single metric	CDFW, others
	Eutrophication studies	Special study (existing data, new data acquisition)	Unknown
Climate Vulnerability	Hydrology studies associated with climate change stressors (inundation, freshwater input, estuary mouth dynamics, etc.)	Special study (existing data, new data acquisition)	Sea Grant, OPC, SCC, UCLA, CRI, others (2019 CCMP Finance Plan Action #36)

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SMBNEP Comprehensive Monitoring Program
Chapter 8 – Freshwater / Riparian

Habitat Introduction

There are 28 distinct drainage basins in the Santa Monica Bay watershed, with more located in the north part of the Bay watershed than the south. In the north, Malibu Creek is the largest un-channelized creek in the Bay watershed. Smaller drainage basins are present throughout the Santa Monica Mountains. Many in the eastern Santa Monica Mountains are confined to concrete channels for at least part of their lengths.

In the central Bay, the Ballona Creek drainage basin dominates. At 130 square miles, it is the largest sub-watershed draining into Santa Monica Bay. Ballona Creek drains portions of west central Los Angeles and several other cities, as well as the southeastern portion of the Santa Monica Mountains. Most of Ballona Creek was channelized in the 1930s for flood control purposes, and consequently, little riparian habitat remains. Smaller drainage basins can be found throughout the South Bay and the Palos Verdes Peninsula. Most of these have been buried or replaced with storm drains (LA Creek Freak 2012).

At one time, the Santa Monica Bay watershed was covered with a web of creeks, streams, and depressional freshwater wetlands that were fed by seasonal rains and natural springs (Stein et al. 2014). Many of the natural streams in the watershed were intermittent, with greatest flows occurring in the wet season during winter. The streams from the eastern Santa Monica Mountains and northern part of the Palos Verdes Peninsula would flow out of the hills and onto the coastal plain, where they would meander or braid before gradually making their way to the ocean through the once-expansive Ballona Wetlands.

These freshwater aquatic areas and the surrounding riparian zone provide important habitats for many plants, invertebrates, fish, amphibians, reptiles, and birds. In a natural state, these habitats comprise the stream or river and the stream or river banks that the water flows through or over at higher water levels. These banks are part of the flood plain, where sediment is held in place by the roots of the many types of vegetation found naturally in these areas, e.g., grasses, sedges, shrubs, and trees. When considered together, these zones slow water flows, allow for water to soak into the ground, and capture sediment and pollutants from the watershed around them, while supporting many species of animals, as listed above. In turn, healthy riparian zones supply downstream areas with water and sediments needed to maintain beaches and rocky reefs via natural patterns of erosion and transport.

Coastal sprawl and urban development in the Los Angeles region have left little natural habitat in the riparian zone and surrounding areas of the Santa Monica Bay watershed. In addition, efforts to prevent flooding and tame the intermittent but potentially massive flows of the creeks in the area resulted in the channelization of Ballona Creek and most of its tributaries. In the Santa Monica Mountains, a few streams, such as Arroyo Sequit, Cold Creek, and Solstice Creek, remain in relatively natural states.

When it does rain, the replacement of open space with impervious surfaces in the watershed and in creek channels prevents rainwater from soaking into the ground, resulting in more freshwater flushing out to the sea and less freshwater recharging aquifers. However, California's severe drought poses different problems. Many of the normally perennial streams in the Santa Monica Mountains are dry, eliminating a freshwater habitat for many organisms. The summer of 2015 was the first time this has happened in 25 years (Lee Kats, pers. comm. 21 August 2015).

Drought events make the difference between the heavily undeveloped areas and less developed ones even starker. Excessive outdoor water use in developed parts of the upper watershed leads to runoff, which causes many historically intermittent streams to flow year-round today and changes their character, and while efforts are being made to curb this due to the drought, it is still occurring. Furthermore, this runoff often contains pollutants, such as fertilizers, and picks up others from surrounding development, which puts wildlife and public health at risk.

All this development, plus the erection of dams, road crossings, and other man-made barriers in streams, has resulted in the loss of riparian and aquatic habitats for many species. For example, more than 80% of southern steelhead trout (*Oncorhynchus mykiss irideus*) spawning habitat and 60% of their rearing habitat is inaccessible in Malibu Creek as a result of these barriers (California Trout 2006). In fact, more species were listed as threatened or endangered in these habitats than any other habitat in the Bay and its watershed, except for terrestrial habitats. Other threatened and endangered species found in freshwater aquatic and riparian habitat of the Santa Monica Bay watershed include the Pacific lamprey (*Entosphenus tridentatus*), California red-legged frog (*Rana draytonii*), least Bell's vireo (*Vireo bellii pusillus*), Riverside fairy shrimp (*Streptocephalus woottoni*), California orcutt grass (*Orcuttia californica*), and others.

Riparian and freshwater aquatic habitats have also become home to spreading invasive species, such as the New Zealand mudsnail (*Potamopyrgus antipodarum*), Louisiana red swamp crayfish (*Procambarus clarkii*), American bullfrog (*Lithobates catesbeianus*), aquarium fish, mosquito fish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), and others. Year-round flows in once-intermittent streams are partly responsible.

While there are many challenges facing this habitat, there is also great potential for improvement. Efforts to protect and restore streams in the watershed have gained momentum and achieved some success in recent years. Several projects to remove barriers blocking fish passage and to control invasive species have been completed successfully, and further improvements are expected from similar, upcoming projects. Stream protection ordinances are also being discussed. Finally, the development and implementation of trash, metals, and nutrient Total Maximum Daily Loads (TMDLs) can help to reduce the adverse impacts of pollution on wildlife and habitat quality.

Much of the introductory information for freshwater aquatic and riparian habitats in this chapter was replicated and updated slightly from information in the 2015 SotB Report (Dagit et al. 2015).

The overarching questions for this habitat include the following:

1) What is the extent of freshwater aquatic and riparian habitats in the NEP study area and how has the geographic area changed over time?
2) What is the ecological condition of these habitats and how have they changed over time?
3) What are the major stressors impacting freshwater aquatic and riparian habitats?
4) How vulnerable and adaptable is this habitat to climate change stressors?
5) What are remaining data gaps associated with freshwater aquatic and riparian habitats?

Indicators for each habitat were grouped into four categories: habitat extent, ecological condition, stressors, and climate change vulnerability. The framework for each category included a maximum of five indicators per category. Indicators were developed by a group of expert scientists with significant recent expertise in the habitat. Note that the indicator list is not intended to be comprehensive or exhaustive; rather, it is intended to be representative and to capture extent, condition, and trends over time for this habitat. Indicators were prioritized by the expert scientists across two levels: 1) priority, and 2) data were available or feasible to collect broadly.

The freshwater aquatic and riparian habitat working group utilized and prioritized existing, previously developed indicators or indices where possible, and included standardized assessments (e.g., California Rapid Assessment Method). Several indices have already been developed for freshwater systems (e.g., benthic macroinvertebrates, algae, land cover change; see Cadmus Group 2013). In 2013, the USEPA Healthy Watershed Initiative supported the development of an integrated assessment of watershed health for California (CIAWH). The CIAWH combines a variety of existing statewide datasets into several indices that describe the health of freshwater aquatic systems, such as the health of the catchment area, vulnerability to risk, and stream health (Cadmus Group 2013). The CIAWH framework aligns closely with the framework developed by the TAC for this habitat, allowing for the use of the indicators, with minor adjustments and additions. The CIAWH is currently being updated by the California Healthy Watersheds Partnership. This effort will provide a set of indicators that could be incorporated into stream and riparian assessments.

These priorities allowed for the potential for consistency in data collection and analyses across multiple indicators and categories. Additionally, the expert scientists identified existing monitoring programs for this habitat and prioritized indicators across a range of biological and physical parameters. Some of the challenges for this habitat were updating information and consolidating many different indicators into various indices, and that some monitoring programs and indices no longer have data being collected to inform them. There was also some overlap between indicators that have not yet been fully developed (e.g., sedimentation, stream connectivity, and several of the climate indicators). These need to be further developed to make sure each indicator is covering unique aspects of the habitat assessment framework. Additionally, recent regulatory changes to definitions of wetlands and waters have occurred at both a federal and state level, which may cause challenges for cross-referencing data over time. Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (CCVA 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The coastal wetland habitat includes 14 indicators across four categories which will be used to detect changes in the environment (Table 8.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales. Note that the indicator list is not intended to be comprehensive or exhaustive, rather it is intended to be representative to capture extent, condition, and trends over time for this habitat.

Table 8.1. Indicators for freshwater aquatic and riparian habitats in the Santa Monica Bay region.

Indicator Category	Freshwater Aquatic and Riparian Indicators
Habitat Extent	Area of Freshwater / Riparian Habitats
Ecological Condition	Algal Index ASCI
	Benthic Macroinvertebrate Index CSCI
	Habitat Provisioning for Amphibians and Native Fish
	Physical and Biological Condition CRAM and IPI
	Stream Connectivity
Stressors	Land Cover Change Index
	Sedimentation
	Water Quality Index
	Anthropogenic Watershed Condition (Disturbance)
	Stream Quality Index (SQI)
Climate Change Vulnerability	Water Temperature Change
	Water Flow and Alteration
	Fire Vulnerability Index

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

Metrics for habitat extent for freshwater and riparian systems were not well defined. Previously, the 2015 SotB Report used CIAWH's Relative Watershed Condition Index to define 'extent'; the Index measures the capacity of the watershed to support healthy streams using spatial condition indicators. However, the CIAWH Index is not consistent with how other habitat extent indicators are defined throughout the CMP. Therefore, to improve consistency across habitats, this extent indicator and its metrics are a data gap that warrants further development. Some low resolution / low accuracy mapping data exist in portals such as the National Wetlands Inventory, but detailed wetland jurisdiction maps for these habitats throughout the Bay are not available. This indicator should be a priority to inform change over time. Data may also be informed by historic topographic sheet (t-sheet) analyses. This indicator is likely to vary considerably based on drought or annual weather variability, development, and other factors, and it should be assessed at least annually.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 8.2, 8.3, and 8.4, respectively.

Data collected to inform trends associated with various indicators are often informed by monitoring or research programs that are conducted opportunistically, as components of restoration planning efforts, or not comprehensive throughout the Santa Monica Bay. For example, site-intensive baseline studies are being conducted beginning in 2020 in Topanga Creek to inform restoration planning for the Lagoon. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs.

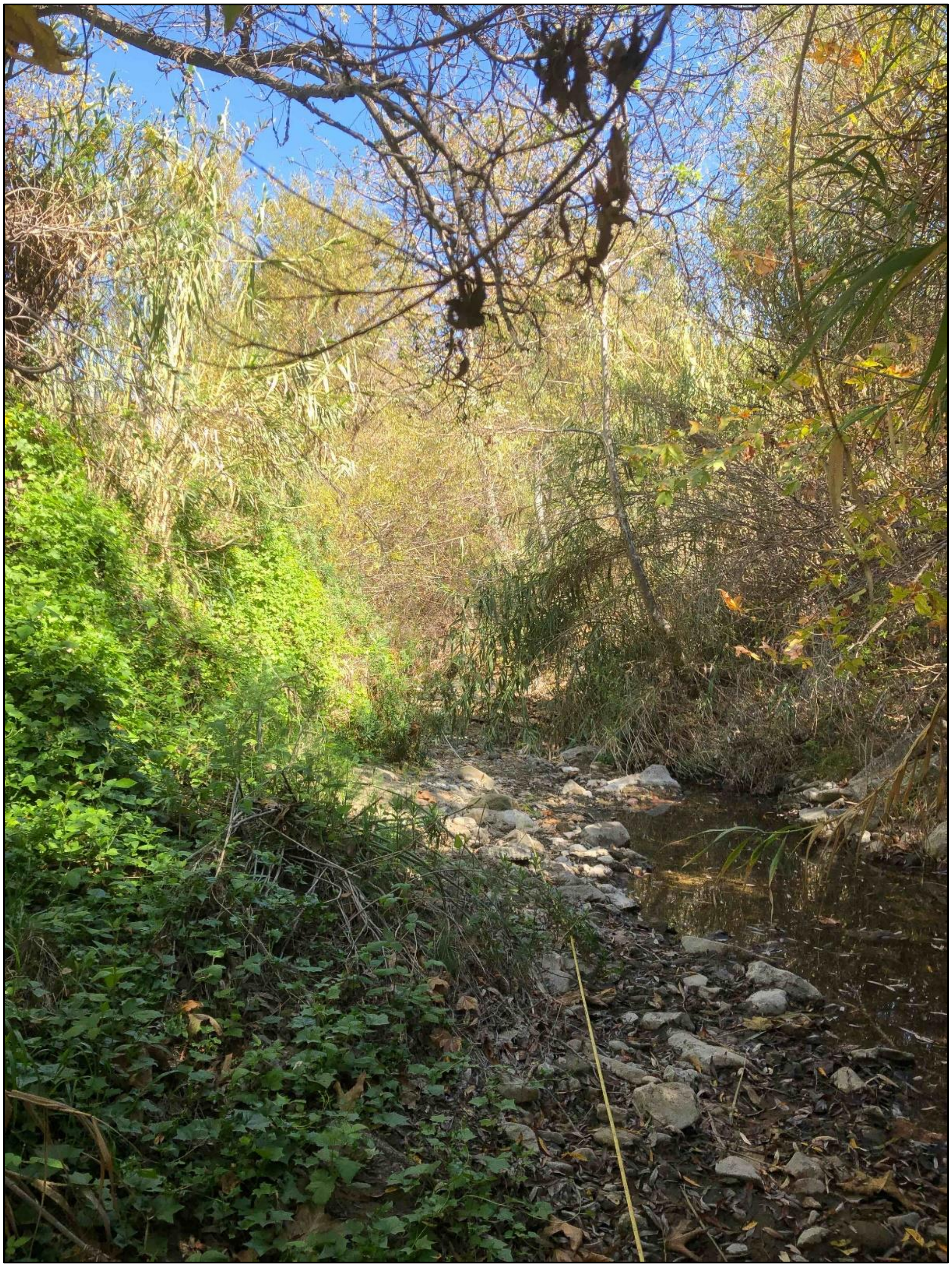

Figure 8-1. Topanga Creek and associated riparian habitat (credit: TBF).

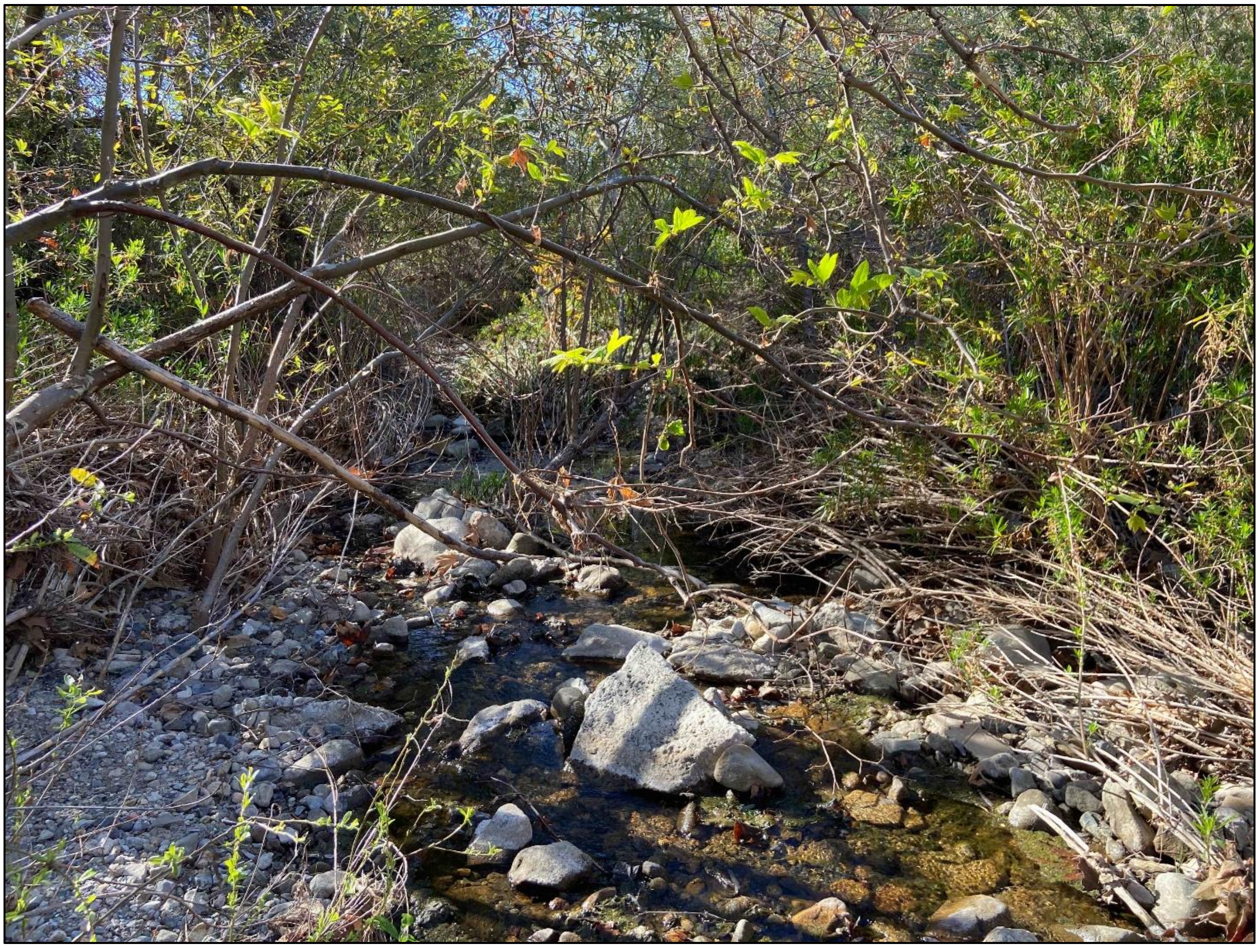

Figure 8-2. Topanga Creek and associated riparian habitat (credit: TBF).

Table 8.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Algal Index ASCI	Algal Stream Condition Index	SCCWRP	Annually
Benthic Macroinvertebrate Index CSCI	California Stream Condition Index Score	SCCWRP	Annually
Habitat Provisioning for Amphibians and Native Fish	Percent of monitored streams with species present	RCDSMM (four fixed herpetofauna locations; 36 snorkel survey sites) / NPS / USGS / SMC / CDFW / Malibu Creek Ecosystem Restoration Project	RCDSMM / NPS annual (herps); monthly (snorkel, when funding available)
	Species diversity	RCDSMM (four fixed herpetofauna locations; 36 snorkel survey sites) / NPS / USGS / SMC / CDFW / Malibu Creek Ecosystem Restoration Project	RCDSMM / NPS annual (herps); monthly (snorkel, when funding available)
	Percent of monitored streams with rearing and spawning habitat for rare species	RCDSMM (Topanga, Malibu and Arroyo Creeks) / NPS / USGS / SMC / CDFW / Malibu Creek Ecosystem Restoration Project	Multiple times per year for Topanga Creek, Malibu and Arroyo Creeks opportunistically
Physical and Biological Condition CRAM and IPI	CRAM (attributes for physical and biological structure)	SMC / USGS / TNC / LA County SEA	Unknown
	Physical Habitat (PHAB) Stream Assessment Index (IPI)	SMC / USGS / TNC / LA County SEA; RCDSMM (four sites in Topanga Creek)	RCDSMM annually
	Riparian tree cover / beetle invasion impacts	SMC / USGS / TNC / LA County SEA; RCDSMM (four sites in Topanga Creek)	SMC annually; RCDSMM annually
	Temperature from tree cover change	SMC / USGS / TNC / LA County SEA; RCDSMM (eight HOBO sensor sites in Topanga Creek)	RCDSMM April – Oct annually
	Percent natural land cover	No current programs	No current programs

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Stream Connectivity	Fish passage	RCDSMM fish passage data in Topanga, Arroyo, and Malibu	Monthly snorkel surveys when funding available
		CDFW fish passage data	Unknown
	Biological integrity index	SCAPE categorization tool in development (see Beck et al. 2019a)	Unknown

Table 8.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Land Cover Change Index	Projected land cover change	General plan and zoning maps	Opportunistic research
Sedimentation	Change in sediment deposition	No current programs	No current programs
	Stream flow alteration	SMC data on channel modification	No current programs
Water Quality Index	Median stream summer conductivity	SMC / City and County water action plan reporting / EWMPs / SWRCB data; conservation maps and plans	Unknown
	Nitrate concentrations and turbidity	SMC / City and County water action plan reporting / EWMPs / SWRCB data; conservation maps and plans	Unknown
	pH	SMC / City and County water action plan reporting / EWMPs / SWRCB data; conservation maps and plans	Unknown
Anthropogenic Watershed Condition (Disturbance)	Percent artificial drainage area	USEPA StreamCat database, SWAMP databases, SPoT data, EWMPs	Unknown
	Dam storage ratio	USEPA StreamCat database, SWAMP databases, SPoT data, EWMPs	Unknown
	Longitudinal connectivity	USEPA StreamCat database, SWAMP databases, SPoT data, EWMPs	Unknown
	Index of watershed integrity / index of catchment integrity	USEPA StreamCat database	Unknown
Stream Quality Index (SQI)	Stressor condition index	Four stream sites in SM Bay, data reported by SCCWRP (see Beck et al. 2019b)	Opportunistic surveys / research

Table 8.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Water Temperature Change	Water temperature (min, max, mean)	SMC / City and County water action plan reporting / EWMPs / SWRCB data; conservation maps and plans	Unknown
		RCDSMM (eight sites in Topanga Creek; Arroyo and Malibu Creeks historical data)	RCDSMM Topanga: April – Oct annually; Arroyo and Malibu opportunistic
	Ambient air temperature (as proxy for water)	National Weather Service stations throughout SM Bay	Daily; downloaded opportunistically
	Species invasion or distribution changes	Some data captured in RCDSMM snorkel surveys (Topanga Creek)	Monthly snorkel surveys when funding available
Water Flow and Alteration	Projected change in precipitation	UCLA / SW Climate Science Center	Unknown
	Snowpack	UCLA / SW Climate Science Center	Unknown
	Baseflow and surface runoff	UCLA / SW Climate Science Center; LA County (stream gauges on Ballona, Malibu, and Topanga Creeks)	Unknown
	Suitability models for key aquatic species	SCCWRP has flow ecology models that could be used to estimate habitat suitability	Opportunistic surveys / research
	Predicted stream flows	New model under California Environmental Flows Framework Project (three sites in SM Bay)	Unknown
Fire Vulnerability Index	Projected change in wildfire severity and fire regime condition class	CalFire risk mapping / forest disease areas mapping	Unknown
	Fire history, area, and overlap	CalFire history data (geospatial); TBF has preliminary research study	Opportunistic surveys / research

Data Sharing and Reporting

Freshwater aquatic and riparian habitat monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases like the California Rapid Assessment Method database or other similar public data sharing portals.

Data Gaps and Future Studies

While the freshwater and aquatic riparian habitat indicators have the highest number of developed indices and standardized metrics (e.g., CIAWH indices summarized in Cadmus Group 2013, CRAM, CSCI, etc.), there is a lack of consistent monitoring data available, especially across multiple years. Several of the indices also incorporate many variables. For example, the USEPA StreamCAT database includes variables to estimate an index of watershed integrity and an index of catchment integrity (Johnson et al. 2018, Kuhn et al. 2018), and the SCAPE model is currently being expanded.

Former data gaps identified for freshwater and riparian habitats by the 2015 SotB Report were substantial, predominantly relating to the frequency of available data and a lack of developed indicators or indices. Several new metrics associated with the new "climate change vulnerability" category are also identified in the tables above as priority data gaps (e.g., water temperature change and water flow and alteration; see Taylor et al. 2019), though there are some data from gauges in Malibu and Topanga Creeks. There was also some overlap between indicators that have not yet been fully developed (e.g., sedimentation, stream connectivity, and several of the climate indicators). These need to be further developed to make sure each indicator is covering unique aspects of the habitat assessment framework.

Because the habitat extent indicator was substantially updated since the 2015 SotB Report, there is a basic priority need for habitat extent maps to assess change over time. Some habitat mapping for steelhead trout in Arroyo, Malibu, and Topanga Creeks was provided in Dagit et al 2019, based on CDFW protocols. While this habitat has a higher number of standardized monitoring assessments and well developed indices as indicators, there is a gap in long-term collection of relevant data and a lack of consistent monitoring across a broad geographic area. Table 8.5 summarizes priority data gaps identified for the freshwater habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.7 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 8.2-8.5, especially repeated collection of data using the standardized metrics, categories that are “no current programs” or “unknowns” and require more information, as well as additional new studies that could further support the refinement of indicators for this habitat. Note that portions of Tables 8.2-8.4 may look complete, but still may have spatial or metric data gaps. New studies that are recommended include habitat extent assessments, development of habitat provisioning models and predictions (which could build from known occupancy areas and develop a site suitability model), using species specific flow ecology models (SCCWRP) that could be used to estimate suitability for key aquatic species, combining habitat provisioning metrics into an index, developing the stream connectivity indicator, filling geographic gaps, and acquiring consistent data across years and sites.

Table 8.5. Freshwater / Riparian Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Freshwater / Riparian Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Habitat extent map and assessment (both present and historical)	Special study (existing data, new data acquisition)	Prop. 50
Ecological Condition	Geographic gaps and long-term monitoring of all existing indicators/indices (ASCI, CSCI, CRAM and IPI)	Index component; Single metric	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
	Habitat provisioning models and predictions	Index development; Special study (existing data)	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
	Stream connectivity	Single metric, Index development	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
Stressor	Geographic gaps and long-term monitoring of all existing indicators including those that are components of existing indices (ASCI, CSCI, CRAM and IPI)	Single metric	SMC, City and County, SWRCB, USEPA
	Land cover change index	Index development	Unknown
	Sedimentation indicator	Single metric	Unknown
Climate Vulnerability	Water temperature change	Single metric	Sea Grant, OPC, SCC, LA County, cities, others (2019 CCMP Finance Plan Action #36)
	Water flow and alteration	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, UCLA, others (2019 CCMP Finance Plan Action #36)
	Fire vulnerability index	Index development	Sea Grant, OPC, SCC, UCLA, others (2019 CCMP Finance Plan Action #36)

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SMBNEP Comprehensive Monitoring Program
Chapter 9 – Data Gaps and Potential Funding Sources

This chapter of the document summarizes priority data gaps identified in each habitat chapter; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (Tables 9.1-9.7). The indicators identified throughout this document are priority indicators, as recommended by the TAC and external scientist contributors, but the list is not intended to be exhaustive for each habitat. Types of data gaps are identified as index development, index component, single metric, and special studies, including those that could explore existing data, new data acquisition, and new methods or tool development. Potential funding sources are further described below.

SMBNEP acknowledges that listed funding sources are neither exhaustive nor fully inclusive of all opportunities. New funding initiatives should be explored as they arise and not be limited to those included in this document. Additionally, listed existing funding opportunities are unlikely to be able to fully fund all the data gaps identified throughout this document. Furthermore, some existing studies or monitoring programs have consistent long-term funding (e.g., MARINe), and some may have currently identified funding, but only for a temporary or limited time frame (e.g., LMU beach characterization studies). These studies may then become future data gaps, once funding is exhausted, and may not be identified as gaps in this version of the CMP.

Successful implementation of the CMP depends on coordinated efforts of all responsible partners including agencies, organizations, and stakeholders to maintain existing core monitoring activities and fill identified data gaps. Implementation of the CMP relies on leveraged work and partnerships; it continues to rely primarily on independent, long-term funding by local, regional, state, and national entities, including compliance monitoring conducted by permittees, water quality and resource management agencies, research consortia, and volunteer organizations. These sources of funding are expected to be stable; they may also be sources of funding for filling data gaps identified in this CMP through resource exchange with existing monitoring or addition of special studies to the existing monitoring programs.

Some funding sources are currently available, but are non-recurring, while others need to be further identified and secured through additional fundraising efforts. By far, the largest potential source of near-term funding is the remaining $3.2 million balance in the Prop. 50 state bond funding that is specifically allocated to SMBRC and managed by SWRCB. This money has been prioritized to fill CMP data gaps. Although there may be requirements and / or restrictions on how these funds can be spent, this funding may potentially support a broad range of projects targeted to various habitats, data, and research types, though it is not enough to fill all remaining data gaps.

Funding allocated under other bond measures such as Prop. 68 and 84, managed by OPC, SCC, and other agencies are also applicable, but on a competitive basis. These funds are widely eligible for scientific research and monitoring, including innovative tools or technology, that directly address state management or policy needs; restoration or other on-the-ground projects that improve ecosystem health and water quality; and planning or implementation projects that advance climate adaptation and resiliency. Several funding priorities under Prop. 68 are especially applicable to the needs of CMP, including funding for monitoring and research that prepare for and minimize the harmful impacts of climate change on ocean ecosystems, promote the long-term health of coastal and marine ecosystems and sustainability of marine fisheries, develop innovative technology and tools, and inform adaptive management of California's MPA Network.

Funds allocated under other State programs, such as the OTC Interim Mitigation Program managed by OPC, may support projects filling data gaps for assessment of various habitats should they fit under the critical component of the program that "establishes and quantifies the expected ecological benefits of the MPA Network and understand what additional mitigation may be required to offset OTC impacts."

Federal funds may also be available including, but not limited to, USEPA's Superfund Program and NOAA's Remediation Program, which can potentially fund some habitat monitoring activities, especially for projects with a nexus to development of mitigation measures of the historical contaminated sites. At the local county and city level, the Scientific Studies Program under the Los Angeles County Safe Clean Water Program can potentially support activities such as scientific studies, technical studies, monitoring, and modeling that demonstrate multiple benefits of stormwater BMP implementation. Finally, 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 Bay monitoring and assessment but can potentially be more involved by adopting a model similar to the POTWs.

Finally, grant and other sources of funding obtained and managed by State and local academic institutions can also be important sources of funding for addressing many data gaps identified in this CMP, especially for index development, special studies, and development of new monitoring tools. One potential source of funding for these types of studies is Sea Grant Programs (i.e., California and USC). Focus areas of their 2018-2021 strategic plan include: Healthy Coastal Ecosystems, Sustainable Fisheries and Aquaculture, Resilient Communities and Economies, Environmental Literacy and Workforce Development (CASG 2018). Other funding sources may include national calls for research proposals through the National Science Foundation, NOAA, USEPA, or other sources. Potential future increases in appropriation of CWA Section 320 National Estuary

Program base funding may allow a portion of the funding to be allocated to future CMP monitoring efforts, and USEPA may also have future calls for proposals specific to National Estuary Program study areas or other water quality or habitat restoration opportunities. These may allow for all or a portion of the proposed grant to be allocated to CMP monitoring activities.

Looking to the future, collective actions among stakeholders are critical for the implementation of comprehensive monitoring of the habitats identified in this CMP, including exploring the establishment of a “funding pool” in combination with in-kind support, and streamlining compliance monitoring to meet the long-term funding needs for CMP implementation. There are several successful examples of this approach that the implementation of this CMP can be modeled after, including the Southern California Bight-wide survey, regional consortium for survey of kelp coverage, the Regional Monitoring Program for Toxic Substances in San Francisco Bay, and the San Gabriel River Regional Monitoring Program. Collaborative interdisciplinary efforts are becoming more prevalent in funding opportunities for larger scale programs. Many of the studies that would inform CMP data gaps would make for strong interdisciplinary efforts.

Table 9.1. Pelagic Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Pelagic Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Geographic gaps between monitoring stations	Single metric	CalCOFI, SCCOOS
Ecological Condition	Pelagic Zooplankton Community Index	Index development	CalCOFI
	Ichthyoplankton Community Index	Index development; Special study (existing data)	NOAA, SFSC Integrated Ecosystem Assessment
	Fish biomass change	Special study (existing data)	Unknown
	Marine mammal and seabird stranding	Single metric	NMFS and others
Stressor	Area of Hypoxia	Special study (existing data, new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	HAB Seasonal changes (species, domoic acid, P-N concentration	Single metric; Special study (existing data)	SCCOOS
	Marine debris and microplastics presence	Single metric	SCCWRP Bight Monitoring Program, LMU
Climate Vulnerability	Temperature trends	Single metric, special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Area and frequency of Ocean Acidification	Single metric, special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

Table 9.2. Soft Bottom Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Soft Bottom Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Eelgrass area mapping using side-scan sonar or similar methods	Single metric; Special study (existing data)	Prop. 50 (2019 CCMP Finance Plan Action #4)
Ecological Condition	SAV Survey of aboveground biomass, carbon, and nitrogen content	Index component	Prop. 50 (2019 CCMP Finance Plan Action #4)
	SAV Survey of invertebrate infauna and epifauna	Index component	Prop. 50 (2019 CCMP Finance Plan Action #4)
	Fish community condition or index informed by fishery	Index development; Index component	NPDES Program, SCCWRP
Stressor	CEC loading in fish	Single metric	SWRCB
Climate Vulnerability	Predictive evaluations of fish response to temperature changes	Special study (existing data)	Unknown
	Interactions between DO and ocean acidification or hypoxia	Special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Local faunal impacts of ocean acidification	Special study (new data acquisition)	Sea Grant, OPC, SCC, others

Table 9.3. Rocky Reef Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Rocky Reef Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	ROV, sonar, and other surveys for characterization of deep reefs, surfgrass habitats, and other sites	Special study (new data acquisition, new methods/tools development)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
	Metric for vertical complexity	Special study (new methods/tools)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
Ecological Condition	Expansion of existing CRANE surveys into new geographic regions in the Bay	Index component	Unknown
Stressor	Fishing Pressure Index	Index development; Index component	Prop. 50, others
	Point source discharge and runoff pollutant loading and plume mapping	Single metric; Special study (existing data, new methods/tools development)	Unknown
	Landslide event mapping and vulnerability assessment	Single metric; Special study (existing data)	Unknown
	HAB tracking with remote sensing	Single metric; Special study (new methods/tools development)	OPC, NOAA, MERHAB program (2019 CCMP Finance Plan Action #35)
Climate Vulnerability	Impacts of acidification on benthic invertebrate mortality	Special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

Table 9.4. Rocky Intertidal Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Rocky Intertidal Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Finer habitat categorization incorporating interspersed or buried rocks under sand, artificial beach armoring structures, jetties, etc.	Special study (new data acquisition, new methods/tools development)	Prop. 50, others (2019 CCMP Finance Plan Action #38)
	Characterization of seasonal or multi-year beach transition between sandy and rocky conditions	Special study (new data acquisition, new methods/tools development)	Prop. 50, others (2019 CCMP Finance Plan Action #38)
Ecological Condition	Expansion (timing and spatial distribution) of existing MARINe monitoring sites	Index component	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Nutrient levels in discharges onto rocky intertidal sites	Single metric; Special study (new data acquisition)	Prop. 50, others
	Biodiversity Survey	Special study (new data acquisition)	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Surveys of birds activity	Single metric; Special study (new data acquisition)	Unknown
Stressor	Diversity and percentage of intertidal area covered by non-native species	Single metric; Special study (new methods/tools development)	OPC, CCC, others (2019 CCMP Finance Plan Action #38)
	Intensity of use measured by the number of people in count per unit area	Single metric	Unknown
	Proximity to areas with high landslide potential or frequency	Single metric	Unknown
	Percent of diseased individuals per species per site	Single metric	Unknown

Indicator Category	Rocky Intertidal Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Climate Vulnerability	Projected area of habitat loss	Special study (existing data, new data acquisition, new methods/tools development)	Unknown
	Surface and air temperature	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Increased storminess and extreme tide events	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Dissolution of Carbonate Structures (Organismal)	Single metric; special study (new data acquisition)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

Table 9.5. Sandy Shores Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Sandy Shores Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Additional information on beach width, extent, and seasonal variation	Special study (supplement existing data)	USEPA, CRI, Sea Grant, Universities, NASA/JPL
Ecological Condition	Additional monitoring locations for surfzone fishes, and other native fauna	Index component; Single metric	OPC-MPA, UCSB, others
	Higher resolution / better geospatial coverage for invertebrate taxa data	Index component	OPC-MPA, UCSB, others
	Long-term trend data for Invasive flora	Single metric	OPC-MPA, UCSB, others
	Indices and rapid assessment framework for sandy shore surveys	Index development	Prop. 50, others
Stressor	Long-term tracking of percentage change of anthropogenic Infrastructure / Beach Hardening (beachfront protection, development, and armoring, etc.)	Index component	LACDBH, USGS, NOAA, others
	Detailed and expanded information on human impacts	Single metric; Special study (existing data, new data acquisition)	Unknown
	More detailed spatial / frequency information on beach management practices	Index component	LACDBH, others
	Data on nutrient inputs and limitations	Single metric	Unknown

Indicator Category	Sandy Shores Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Climate Vulnerability	New modeling efforts and innovative mapping to detect and assess shoreline change or dune formation, track seasonal shifts in sediment movement or sediment loss	Special study (new data acquisition, new methods/tools development)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)
	Slope and berm morphology	Special study (new data acquisition)	Unknown
	Larval abundance studies associated with surface water temperature	Special study (new data acquisition)	Unknown

Table 9.6. Coastal Wetlands Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Coastal Wetlands Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Habitat extent assessments for the smaller lagoon systems	Special study (new data acquisition)	Prop. 50, others
Ecological Condition	Long-term monitoring of all indicators/indices (CRAM) Ballona Wetlands and Malibu Lagoon	Index component; Single metric	CDFW, others
	Baseline assessment for most indicators and long-term monitoring for all indicators/indices (CRAM) for most smaller systems in the northern Bay (e.g., Zuma, Big Sycamore, Trancas, many others)	Index component; Special study (new data acquisition)	Prop. 50, others
	Native/non-native vegetation cover change over time	Index component; Single metric	Unknown
	Survey of the condition (presence/area) of commercially or recreationally important fish species, rare plants or birds	Index component; Single metric	Unknown
Stressor	Long-term monitoring of all indicators/indices	Index component; Single metric	CDFW, others
	Eutrophication studies	Special study (existing data, new data acquisition)	Unknown
Climate Vulnerability	Hydrology studies associated with climate change stressors (inundation, freshwater input, estuary mouth dynamics, etc.)	Special study (existing data, new data acquisition)	Sea Grant, OPC, SCC, UCLA, CRI, others (2019 CCMP Finance Plan Action #36)

Table 9.7. Freshwater / Riparian Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Freshwater / Riparian Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	Habitat extent map and assessment (both present and historical)	Special study (existing data, new data acquisition)	Prop. 50
Ecological Condition	Geographic gaps and long-term monitoring of all existing indicators/indices (ASCI, CSCI, CRAM and IPI)	Index component; Single metric	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
	Habitat provisioning models and predictions	Index development; Special study (existing data)	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
	Stream connectivity	Single metric, Index development	SCCWRP, RCDSMM, NPS, USGS, SMC, CDFW, TNC, LA County SEA
Stressor	Geographic gaps and long-term monitoring of all existing indicators including those that are components of existing indices (ASCI, CSCI, CRAM and IPI)	Single metric	SMC, City and County, SWRCB, USEPA
	Land cover change index	Index development	Unknown
	Sedimentation indicator	Single metric	Unknown
Climate Vulnerability	Water temperature change	Single metric	Sea Grant, OPC, SCC, LA County, cities, others (2019 CCMP Finance Plan Action #36)
	Water flow and alteration	Single metric; Special study (new data acquisition)	Sea Grant, OPC, SCC, UCLA, others (2019 CCMP Finance Plan Action #36)
	Fire vulnerability index	Index development	Sea Grant, OPC, SCC, UCLA, others (2019 CCMP Finance Plan Action #36)